IMPROVEMENT OF HAZARDOUS ROAD INTERSECTIONS AND MIDBLOCK SECTIONS: STUDY OF MIRPUR ROAD AND AIRPORT ROAD

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MASTER OF SCIENCE IN CIVIL ENGINEERING

(TRANSPORTATION)

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The thesis titled **'Improvement of Hazardous Road Intersections and Midblock Sections: Study Of Mirpur Road And Airport Road'** submitted by **Pallab Debnath**, Roll No. 100504429 (P), Session: October 2005, has been accepted as satisfactory in partial fulfillment of the requirements for the degree of **Master of Science in Civil Engineering (Transportation).**

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………………………..

Pallab Debnath

Roll No. 100504429P

Session: October, 2005

Dedicated to My

Heavenly Father

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ABSTRACT

Each year as reported by Bangladesh Police, more than 4000 persons are losing their lives in road traffic accidents in Bangladesh and many more sustain disabling injuries. In economic terms, road accidents in Bangladesh cost more than Tk. 5000 crore (US $ 850 million) which is nearly 2 percent of GDP. Metropolitan Dhaka accounted for about 23 percent of all reported accidents. Such unsafe conditions and losses as prevailing in roads and streets of metropolitan Dhaka dictate urgent need for research and investigations aimed at alleviating road distresses and improving overall traffic safety. If adequate attention is not given to find the reasons of accident and implement mitigation measures now, it will be very uncontrollable situation in future.

The identification and improvement of hazardous road locations is an important task of traffic safety management and very effective measure to reduce the traffic accident frequency and the losses of traffic accident. The maximum reduction in road trauma and its associated costs will result from a concentration of resources on known problems at known locations. Thus hazardous road locations (HRL) program forms the most cost-effective way of road safety improvements. Previously some other performance evaluation studies in the context of road safety were done for several intersections in Dhaka City. But to identify the HRL for both intersections and midblock is very much unique at the context of Dhaka urban roads. Among all the methods, at this study four methods are used to identify the black spots. The processes are Critical Number/Rate Method, Crash frequency method, Crash Severity Method and Equivalent Property-Damage-Only (EPDO) Methods. Due to lack of volume data some processes cannot be applicable for Dhaka City roads.

In case of the Intersections for Mirpur road HRL was identified as Shamoly and for Airport road it is Airport. For midblock of Mirpur road it is Shamoly to Technical section and for airport road it is Banani 1 to Banani 11. These were identified by the over mentioned processes and by analyzing all the midblock and intersection it is found that these are most critical by maximum methods. So later on field survey was completed to these locations and many factors considering with road, environment, users and also traffic condition were found to be responsible. By field visit the current safety hazardous of the selected spots (both intersection and midblock) are identified. All the intersection and midblock are full of many difficulties especially very inadequate provision for the pedestrians. All the footpaths and foot over bridges are illegally occupied by the shopkeeper at every spot. All the spots are also lacked by the road sign and

markings. Here in Bangladesh, the enforcement is not so strong that the drivers will obey the rules.

Apart from these with the help of MAAP5 database the important features of these intersections and midblock were identified. Most common feature of all of these are pedestrian is the most vulnerable for all the locations. In case of collision type also pedestrian is the most victimized category. And maximum of the accidents were happened during nice weather and good lighting condition. So it means that, there are some other factors involved for most of the cases except external factors. At last, one frame work for a whole corridor for identifying the accident black spots can be developed and it can be as followed.

Table of Contents

List of Figures

List of Tables

CHAPTER 1

INTRODUCTION

1.1 General

This is the first chapter of this thesis. At this chapter, mainly the background of this study, objectives of the study and the thesis outline is presented later on.

1.2 Background

The rapid economic growth, increasing disposal income and urbanization are raising the demands for transportation in developing countries drastically. As a result, the number of vehicles on the roads of developing countries is also increasing quickly. It contributes more congestion and severe accidents on road way. As road accident is a major cause of deaths, it is considered as a serious problem not only in our country but also all over the world.

The worsening situation in developing countries is particularly noted with a call to accelerate actions through multi-sectoral collaboration, sharing information and knowledge with strong institutional and political will. Around 88 percent of the 1.2 million deaths from road traffic injuries occur in the developing world (Peden, M., 2004). For every death, there are far greater numbers of injuries- four persons with severe/permanent disabilities, ten persons requiring hospital admission, and thirty persons requiring emergency room treatment. The economic costs of this epidemic are enormous, ranging from 1 to 5 percent of GDP for every nation. The road safety in low and middle income countries thus emerges clearly a critical and major public health issue.

Latest studies over road traffic accident have estimated that nearly 1 million deaths and 15 million injuries occur on roads each year (Peden, M., 2004). It is known as accident rates which are often 10 to 70 times higher in developing countries comparing to that of developed countries (Houqe et al 2006). As a part developing country, it is true for Bangladesh also. The motorisation of Bangladesh is increasing fast in the recent years. The vulnerability of fatal risk on Bangladesh road is the second worst, which are 44 per 10,000 vehicles in the Asia-Pacific region (Peden, M., 2004).

It is expecting that over the next ten years these developing countries will share the alarming increase in road traffic injuries. If we sum up all the economic loss due to accidents it will be highly surprising. It is more than 5000 crore taka annually which is equivalent to 2% of our annual GDP (Hoque M. M. 2005). A recent publication, for the financial year 2004-2005 shows that the accident cost is 0.6 per cent of GDP while suggesting that this may be 1.3 per cent of GDP as best estimate (Hoque M. M. 2005).

According to World Report on Road Traffic Injury Prevention figure 1.1 shows the affect of road accidents at upcoming years at world's context. And it is estimated that road traffic injuries will be the third leading cause of life years lost by 2020:

1990 **Disease or injury**		**2020 (Baseline scenario)** **Disease or Injury**
Respiratory	1.	Ischaemic heart disease
Diarrhoeal diseases	2.	Unipolar major depression
Perinatal	3.	***Road traffic accidents***
Unipolar major depression	4.	Cerebrovascular disease
Ischaemic heart disease	5.	Pulmonary
Cerebrovascular disease	6.	Respiratory
Tuberculosis	7.	Tuberculosis
Measles	8.	Diarrhoeal diseases
Road traffic accidents	9.	HIV
Congenital anomalies	10.	Perinatal
Malaria	11.	Congenital anomalies
Pulmonary	12.	Measles

Figure 1-1Change in rank of disease or injury happened for 12 causes
(Source: World Report on Road Traffic Injury Prevention 2005)

It is estimated that the actual fatalities could well be 10000-12000 each year taking consideration of underreporting and definitional inconsistency in Bangladesh. The situation is critical particularly in metropolitan Dhaka, one of the mega cities of the world today. Metropolitan Dhaka accounted for about 23 percent of all reported accidents (Houqe et al 2006). Such unsafe conditions and losses as prevailing in roads and streets of metropolitan Dhaka dictate urgent need for research and investigations aimed at alleviating road distresses and improving overall traffic safety. If adequate attention is not given to find the reasons of accident and implement mitigation measures now, it will be very uncontrollable situation in future.

The identification and improvement of hazardous road locations is an important task of traffic safety management and very effective measure to reduce the traffic accident frequency and the losses of traffic accident. The maximum reduction in road trauma and its associated costs will result from a concentration of resources on known problems at known locations. Thus hazardous road locations (HRL) program forms the most cost-effective way of road safety improvements. Previously some other performance evaluation studies in the context of road safety were done for several intersections in Dhaka City. But to identify the HRL for both intersections and midblock is very much unique at the context of Dhaka urban roads.

1.3 Objectives of the study

The specific objectives of this research are-

- To find suitable methods for identifying the hazardous road locations (HRL) for intersections and midblock sections of urban roads in Dhaka Metropolitan City
- To identify hazardous intersections and mid block sections for two major arterial of Dhaka metropolitan city using accident database
- To determine the current drawbacks at the context of road safety for the identified midblock and intersections by road safety survey
- To analyze the accident patterns of some selected spots and develop a corridor-wise safety improvements framework

1.4 Significance of This Study

Bangladesh is a poor developing country. The urbanization process in Bangladesh is gaining prominence with a current level of urban population of about 20 percent. Urban growth is generating new dwellings at the periphery of city and creating more demand for mobility and also contributing to the increase in traffic density at the city center. As more vehicles introduce each year accidents fatality rate also increasing day by day. It’s the time to be serious to handle the high mortality rate in accidents. So, it is a very basic need to improve roadway condition that helped us to reduce accident growth rate. At the end of 2015 the population is expected to be double of current. The availability of safe transport system should be ensured beforehand. Most importantly road must be designed that will be capable of operated safely and efficiently. Prior to all the hazardous intersection and mid block identification program is much more needed. Identification and treatment of hazardous road locations for cost-effective measures is indeed mammoth exercise. So the overall significance of this study is very high. Once hazardous road locations can be identified and the treatment can be applied properly the probability of the accident happening will be decreased time to time. The main advantage of this kind of study is that this is the most cost effective instrument against increased accident rates.

1.5 Thesis Structure

The contents of the remainder of this thesis are divided into six chapters.

Chapter 2 reviews the literature related to the theme of this study. At first of this chapter different types of definitions are added for those who are not related with accident analysis and investigation. Later the literature review helps to know about different types of safety research methodology for the urban intersection and midblock section

Chapter 3 represents the idea of the study area and safety research methodology used at this study. All the methods and the area are described in details at this chapter. Also the idea of the MAAP5 is described here.

Chapter 4 describes the overall ranking of the intersection and midblock at the selected routes of Dhaka metropolitan city. Total 4 procedures of are used and for each one the worst intersection/ midblock is identified. At this chapter to indentify these detailed data are presented.

Chapter 5 presents the analysis of collected data for the identified black spots with a consideration of Accident severity, Collision type, Casualty class analysis, Age of the casualty class, Weather condition, Lighting condition and Involvement of Different Types of Vehicles. It also summarizes the findings from the field visits of each of the intersection and midblock. The pictures of all the field visits are provided at Appendix.

Chapter 6 presents the conclusions, major findings of the study, and recommendations for minimizing the number of accident in future by location wise. The outline of this study is shown in the following flow chart:

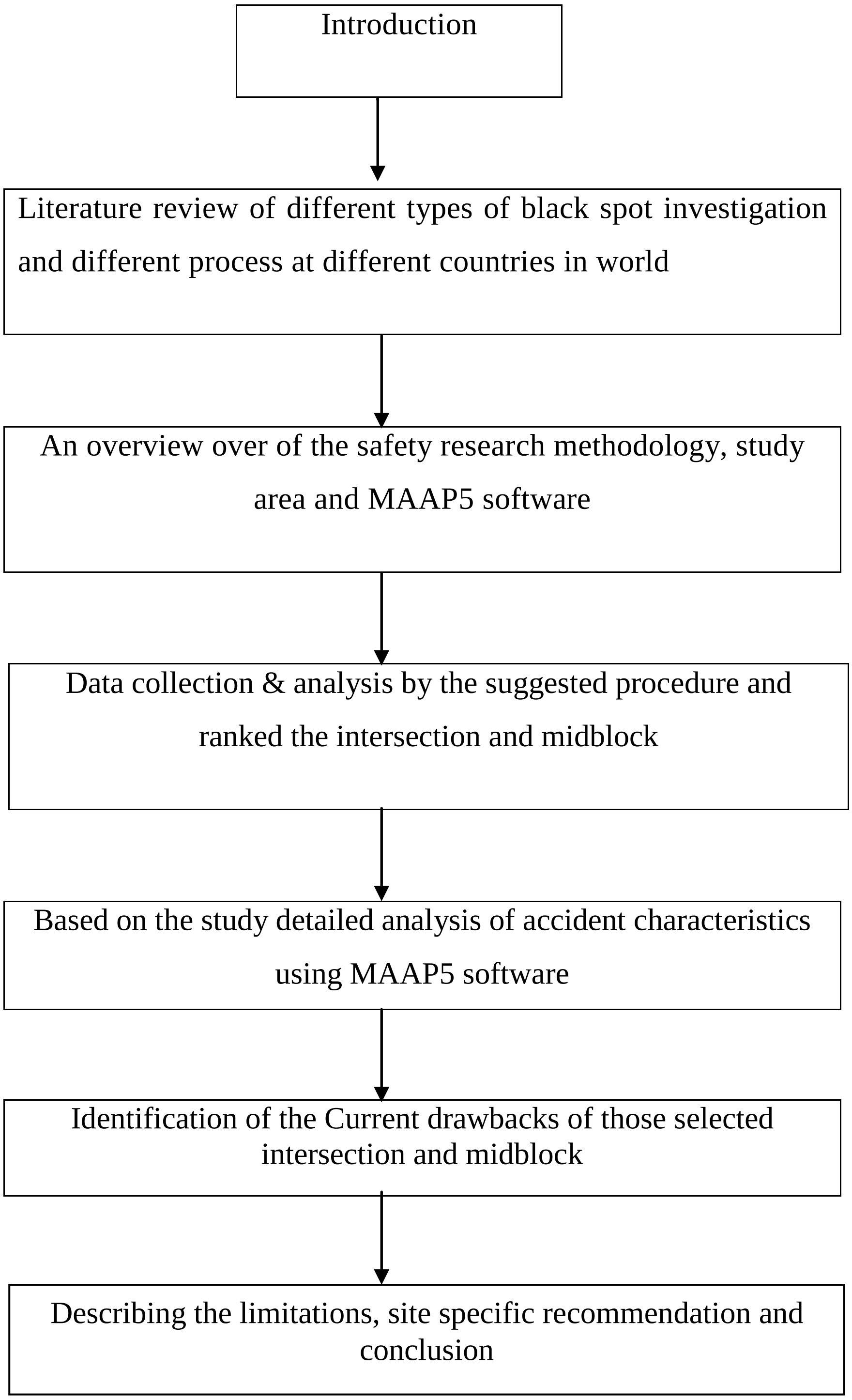


Figure 1-2 Flow chart showing outline of thesis

CHAPTER2

LITERATURE REVIEW

2.1 General

Generally, hazardous road locations are called Black spots in different countries. Normally it means all those locations of road sections or intersections where unusually large number of crashes is happened in different time of year. At this chapter, first some important definitions are described related with this thesis. Then some accident factors, integrated road traffic system and accident classification are discussed. In case of Hazardous location Identification program some experiences from Australia, Belgium, China, Malaysia and Iowa (USA) are elaborately discussed to get the idea of advancement of the developed world at this context. Then in brief a study of Bangladesh by Accident Research Institute is also described. At the end of this chapter summary of all the methods applied in different countries is provided.

2.2 Some Important Definitions

Accident

The definitions of accident can be given as follows:

- Heinrich (1959) defined accident as an unplanned and uncontrolled event in which the action or reaction of an object, substance or person results in personal injury probability thereof.
- A working definition of accident is given by Chapanis (1963): an accident is an unexpected and undesirable event, which arises directly from a work situation that is from faulty equipment or inadequate performance of a person. There may or may not be personal injury, damage of equipment or property.
- Haddon (1964) defined that an accident is an unexpected occurrence of physical damage to animate inanimate structure.
- According to the definition given by TSM (1992) an accident is rare, random, multifactor event and always proceeded by a situation in which one or more road users fail to cope with their environment.

Safety

This term is actually related with accidents. To check road traffic accident i.e. unwanted and unavoidable circumstances at road which may lead to lose of physical and financial assets is called safety.

Intersection

It is to be defined a place where two or more road intersects or join and include the area where vehicles traveling on different joining or intersecting roads may collide.

Midblock Section

A midblock is called the road length of two adjacent intersections. We may call this also Midblock.

2.3 Accident Factors, Classification and Other:

2.3.1 Accident Factors

To differ different factors of road traffic accidents William Heddon, one of the pioneers of scientific approach to trauma Analysis construct a matrix which is commonly known as Heddon matrix shown in Table 2.1.

Table 2.1 Heddon matrix, Crash factors

		People	**Vehicle**	**Road**
Pre-crash	Crash prevention	Education/ training impairment Attitudes/ Behavior (e.g. avoidance of drink driving)	Primary safety(e.g. braking, roadworthiness, visibility) speed Exposure	Delineation Road Geometry Surface Condition Visibility
Crash	Injury prevention	In- vehicle restraints fitted and worn	Secondary safety (restraint, crashworthiness, maintenance)	Protection(Barrier) Pedestrian crossing
Post-crash	Life sustaining	Emergency medical services	Ease of access Fire risk	Restoration of road and traffic devices

(Source: Ogden, (1994) "PH @ a Glance: Road Safety", Wbln0018.worldbank.org/HDNet/hddocs.nsf)

Accident factors can be grouped under the following headings:

- Road users: The actions of vehicle drivers, cyclists, motor cyclists, passengers and pedestrians

- Vehicles: The design, condition, and faults of vehicles
- Road environment: The planning, design and care of roads and the roadside environment

2.3.2 Integrated Traffic System

Road traffic accidents result from failures in the interaction of humans, vehicles and the road environment- the elements which produce the road traffic system. The combination of these various elements to produce road accidents means that the road safety itself has to be tackled in a multi-functional manner in order to break the chains of events that lead to accidents and the eventual injuries of road users. The integrated traffic-safety system in order to understand the complex relationships that influence accident occurrence, have been shown in Figure 2.1.

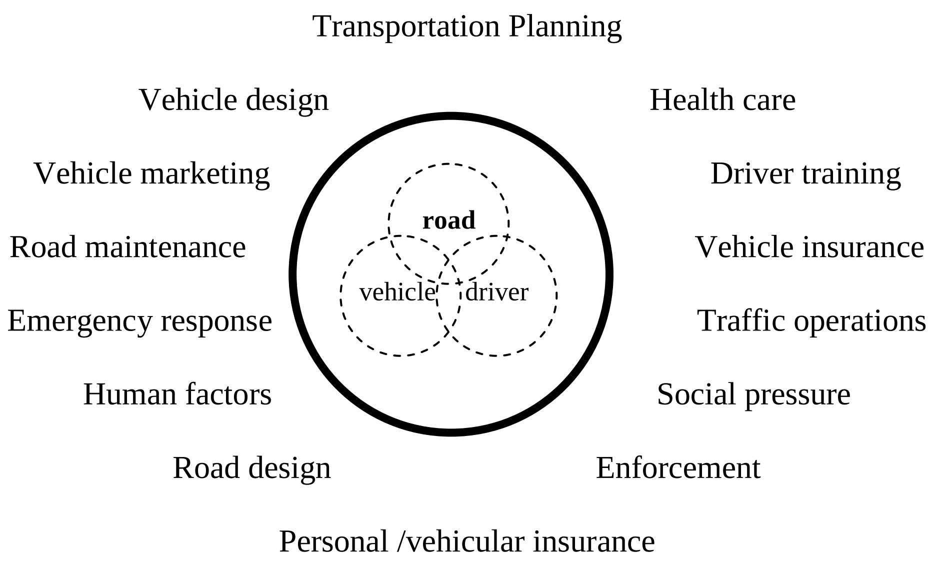


Figure 2-1 The Integrated Road Traffic-Safety System

(Source: Hoque M. M (2005) Presentation "*Road Safety Audit Case Studies*", National Workshop cum Training Course "Road Safety Audit", BUET, 16-18 March 2005)

2.3.3 Accident Classification

Primary Classification

Police reported road traffic crashes mainly classified into two categories

- Road traffic casualty accident
- Road traffic non-injury accident

<u>Road traffic casualty accident</u>

It is one in which one person is either dead or injured. It is also of two types

- Fatal accident: When one or more person dead.
- Personal injury accident

a) Grievous injury: Refers to a person has to admit hospital due to accident.

b) Simple injury: Refers to a person who is victim but not has to admit in the hospital

Road traffic non-injury accident

This is referred to as PDO which means property damage only.

Secondary Classification

Secondary classifications are being categorized by:

- Location: Rural or urban
- Collision or non collision event
- Single vehicle or multivehicle accidents

There can be a combination of collision and no collision in conjunction with accident location. Further desegregation is necessary to develop detailed "accident types" based on accident events. Accident types are particularly important for development of specific accident counter measure.

2.4 Hazardous Road Locations

The identification, analysis and treatment of hazardous road locations are widely regarded as one of the most effective approaches to road accident prevention. It is correct that a number of studies from different parts of the world have reported large reductions in the number of accidents when safety measures were introduced at road accident blackspots. Many of these studies are, however, Simple before-and-after studies that do not take account of any confounding factors that might affect the number of accidents. In particular, it is known that an abnormally high recorded number of accidents at a certain location can result from random fluctuation in the number of accidents. To the extent that an abnormally high number of accidents, or an abnormally high accident rate, is the result of random fluctuations, a subsequent decline in the number of accidents (or the accident rate) must be expected even if no safety treatment is applied.

2.4.1 Hazardous Road Location Identification Programs in Different Countries

Australia:

This process is developed by RACV consulting Services at 1985. The research into procedures for urban intersections on the main road network has shown that:

The identification method "casualty accident rate significantly greater than system average" identified a list of sites with the maximum benefit-cost ratio following investigation and treatment, for the installation budgets considered.

The identification method "casualty accident rate after number" was not inferior to 'casualty accident rate significantly greater than system average" in terms of identifying sites representing the best investment of a given installation budget. However, the former method had the distinct advantage of requiring exposure data only for the sub-set of sites initially selected by casualty accident number significantly greater than system average.

The best number-based identification method* (casualty *There has been and still is, considerable debate as to the value of accident numbers or accident rates to identify hazardous locations. The choice often lies in the objectives of the program. If the objective is to minimize cash loss, accident numbers are used as the principal identifier but, if the objective is to minimize loss but take into account movement, mobility and exposure, accident rates are used as the principal identifier.

Both methods are used throughout Australia, indicating the objectives of each State. This research, which was related only to the cost-effectiveness criteria for the program clearly identified casualty accident rates as a better identification method providing greater cost-effectiveness of the program accident number) identified sites with significantly lower benefit-cost ratios than the rate identification methods described above.

This evaluation tentatively suggested that the economic benefits of an objective identification and treatment program (where only those sites treated are those expected to be cost-beneficial) were only marginally greater than those where all identified sites within practical limits are treated. This conclusion appeared to hold particularly for the relatively small installation budgets. For lower installation budgets, there was no advantage in using a three-year identification period compared to the two year period for either of the rate identification methods described above. However, identification periods as short as one year should be avoided, and for higher installation budgets three years was still preferred.

The measure of intersection exposure based on the "square root of the product of conflicting flows" was marginally superior, in terms of economic performance, to the "sum of entering volumes" measure. The "product of conflicting flows" measure resulted in relatively poor economic performance and should be avoided.

As these investigations indicated an identification method based on a "casualty accident* rate significantly greater than the system average- identified a list of sites providing the maximum benefit-cost ratio for a given implementation budget, this is the recommended procedure.

Throughout these Guidelines a casualty accident refers to an accident in which at least one person requires medical treatment. Even if reliable information is available on Total accidents the research has shown that for the purpose of identification it is detrimental to the procedure to include such accidents.

However, the investigations have shown also that an identification method based on a "casualty accident rate after casualty accident number significantly greater than the system average' is not significantly inferior in terms of identifying sites representing the best investment for a given implementation budget. This methodology requires fewer resources because exposure data need only be collected for a limited number of sites.

If resources are limited this alternative may be the more appropriate to use. It was not possible to compare the identification procedures for rural intersections due to the low number of intersections with accident records sufficiently high to be identified as hazardous locations. Therefore, it is suggested that the intersections should be considered by a similar identification process to that recommended for the urban intersections.

The data requirements for identification and investigation phases are similar, particularly that related to accidents, so it is generally appropriate to prepare a Total data base at the initial stages. The data requirements, which are similar for both the recommended and alternative procedures are summarized below.

Identification Data

The only data absolutely necessary are the intersecting road names or a recognized method of identifying intersecting roads. However, if using a computerized system it may be appropriate to detail other identification data which could be used in subsequent monitoring of countermeasure performance. The useful data would include:

- Intersection reference number
- Hierarchy of intersecting roads (primary arterial, secondary arterial, collector, local) where a hierarchy has been defined
- Configuration (multi-leg, cross, tee)
- Control (signals, roundabout, stop, give way, uncontrolled).

Accident Data

The accident data required are:

- Accident numbers by severity (fatalities and personal injury, both of which are used in the Identification Phase, and property damage only, which may be used in the Investigation Phase)
- Accident numbers by type of accident for use in the Investigation Phase
- Accident details for use in the Investigation Phase, particularly those related to weather, road conditions and lighting availability.

Traffic Volume Data

For each location, or for those identified in the initial analysis of the alternative procedure, the two way annual average daily traffic (AADT) is required for each leg of the intersection.

If AADT volumes are unavailable, estimates can be made. Similarly, if count data is not available for every year being considered, interpolation between years is acceptable since the calculation is not sensitive to minor estimation errors.

For multiple leg intersections the traffic volumes on the least important leg(s) can be added to the traffic volumes on the nearest important cross route(s) to create a cross intersection for ease of computation of the exposure measure.

Period for Data

The research has demonstrated that data should be collected for an identification period of three years but, if resources are limited, a period of two years is acceptable. Identification periods of one year must be avoided.

Critical Accident Rates

The casualty accident rate for each intersection is directly compared to the system-wide average to determine whether the accident record of each location is significantly greater than the system average. The annual casualty accident rate per kilometer for each section is also compared.

The statistical significance above the system average is determined by standard critical values (upper 5% value, one tailed) given by Deacon (1975) and found by Jorgensen (1966) to be accurate approximations to the true critical values based on a Poisson distribution for accident numbers.

The critical accident rate is calculated for each intersection using the formula:

$CR = A + 1.645 \bullet\ (A/M) + 1/(2M)$

Where, CR is the critical rate, A is the average accident rate per exposure, M is the measure of exposure

1.645 is based on a 95% confidence limit implying there is a 5% chance that the intersection may be indicated as having a significantly high accident rate even though the intersection is not specifically hazardous.

Those intersections for which the casualty accident rate is above the critical rate are considered worthy of detailed investigation. The critical intersections, however, are not ranked at this stage

Critical Accident Number

The initial stage compares the individual intersection casualty accident number to the system-wide average to determine whether the accident record of each location is significantly greater than the system average. This usually reduces the group of intersections to be considered substantially.

Statistical significance above the system average is determined by reference to the critical casualty accident number.

In this instance the accident rate of the previous equation is replaced by the accident number, and the exposure term (M) is omitted. Therefore, the critical number equation becomes:

$CN = A + 1.645 \bullet\ A + 1/2$

Where, CN is the critical number, A is the average number of accident

1.645 is based on a 95% confidence limit implying there is a 5% chance that the intersection may be indicated as having a significantly high accident number, even though the intersection is not specifically hazardous

Belgium:

Methods developed for identifying accident concentrations traditionally apply to black spots (Silcock and Smith 1985, Nguyen 1991, Joly et al. 1992, Hauer 1996, Vandersmissen et al. 1996). The existence of black zones comes from the awareness of the evident spatial interaction existing between contiguous accident locations (Flahaut et al., in press). Black zones reveal concentrations and hence suggest spatial dependence between individual occurrences: they may be due to one or several common cause(s). The overall objective of this paper is to present the potential of GIS and point pattern techniques for defining accident concentrations in an urban agglomeration. This enables suggestions for causal dependence, illustrated through the analysis of spatial shifts of accident concentrations by introducing traffic-calming measures.

The most straightforward use of GIS for accident analysis is the examination of spatial characteristics of accident locations. Point-in-polygon overlays combine the characteristics of the surroundings to the characteristics of the accident. Point-on-line overlays make it possible to add attributes of the road infrastructure. These techniques are useful to find relations between the characteristics of the different key factors of an accident, such as the surrounding, the infrastructure, the vehicles, and the road users. Here, for the analysis of the spatial patterns, a more advanced use of topological relations is required. In the analysis of traffic safety, the spatial patterns can reveal underlying relations between locations in terms of proximity and connectivity.

Proximity is used as a basis for most spatial clustering techniques. The Simpleest way of defining a cluster is as a localized excess incidence rate that is unusual in that there is more of some variable than might be expected. Spatial clusters can be further used for pattern detection in a GIS environment (Openshaw 1995, Openshaw and Turton 2001). When dealing with spatial concentrations of road accidents, Huguenin-Richard (1999) also examined the issue of contiguity. In the analysis of accidents in Lille (France), she makes a difference between accident concentrations on the same or on adjacent spatial units, and accident concentrations on close but not contiguous spatial units. Proximity can be a matter of time as well as space. Banos developed a flexible tool to analyse proximity in terms of both space and time of the occurrence of accidents (Banos 1999). In the present paper, although time is taken into account by making a distinction between the situation before and after traffic-calming measures, the identification of accident concentrations is primarily based on geographical proximity.

Connectivity is an important concept when dealing with traffic analyses. One way of dealing with connectivity in a GIS environment is the representation of connected points or segments in a network, as parts of routes. In this paper, routes are defined by combining connected roads based on their function and the traffic flows. These routes serve as a basis for the computation of accident concentrations which may be related to traffic flows. Clustering techniques based on proximity may reveal different potential common causes for the accidents than clustering techniques based on connectivity.

An important issue when dealing with cluster identification is the search radius. In the two-dimensional method based on the commercial GIS software used in this study, Arcview 3.2 (Ormsby et al. 1998, based on Silverman 1986), only a fixed search radius is possible. The optimal search radius is obtained by testing different fixed radius lengths. The effect of using a variable search radius on two-dimensional clustering of road accidents is not presently discussed. For the linear clustering technique, a variable search radius was used. The effect is discussed in a companion paper (Flahaut et al., in press).

<u>Research methodology</u>

The use of GIS for the definition of accident 'hot spots' involves:

- The automation of accident locations on a map, and
- The identification of statistically significant spatial clusters of accidents.

The physical meaning of the spatial clusters is examined by discussing the impact of traffic-calming measures on the location and type of accident concentrations in the city of Mechelen.

China:

There are several methods to identify Black spots in or out of china, as follows:

<u>Accident Frequency Method</u>

This method is that taking an accident number as identification criterion, if the accident umber of identified section is more than the criterion, the section is regarded as Black spots. It is good for the method to choose, calculate and be clear at a glance. But shortcoming is that it is difficult to identify the Black spots when this accident number is as much as that, that is because the difference of road condition and traffic condition is not taken into account in the method. It may result in thinking nothing of Black spots as Black spots. So it is the conclusion that the method is suitable for the section and intersection of mini-scope.

Accident Rate Method

After 1940, the developed country develops the traffic survey. When identifying Black spots, the accident rate method is advanced because of holding the great of traffic number data. This method takes the accident number of million motor-kilometer of one year as identification criterion in section, million motor in intersection. So when the accident rate exceeds the criterion, the field is regarded as Block spots. This method is better than accident frequency method, but it is two shortcomings for the method, one is that accident rate value is high in the section where traffic number value and accident number value is low; another is that accident rate value is low in the section where traffic number value and accident number value are high. So when taking use of this method to identify, it may make identifying result inaccurate.

Matrix Method

This method takes accident number and accident rate as the criterion, the level axis denotes accident number, upright axis presents accident rate. One matrix cell expresses one section of road. The matrix cell value shows the degree of risk of section. The riskiest section has the highest accident number and accident rate in down right corner of the matrix. It is merit for method to think over the accident number and accident rate, but there are some shortcomings. It can show the degree of risk of section, but can not distinguish these sections in which accident number is low and accident rate is high or accident number is high and accident rate is low, only to regard them as nothing of Black spots and can't consider the criterion and severity of accident.

Total Equivalent Accident Number Method

If the value of accident number, severity of which is different, Simpley calculates, it results in that the identifying result is inaccurate. For example, the number value of two sections is the same, but the death number value of one is higher than another. Apparently, the fatalness in the section where the death number value is high is higher. To identify

Black spots correctly, taking into account the severity of the accident, the Total Equivalent accident number method is developed (Pei, 2002). This method calculates the degree of severity of accident through calculating modulus of injured number and death number. Because of lack of thinking over traffic number and the length of section, it is the same shortcoming as accident rate method and the modulus have great influence on the identifying result.

Quality Control Method

In 1956, the people such as Norden, develops quality control method which is different from others. firstly, on the assumption that the accident number in section submits to the Piosson distribution, then compare the accident rate with the equal accident rate in the similar section. According to notability, the highest value and the lowest value of synthesis accident rate are ascertained in Black spots. If the accident rate is higher than the highest, the section is though of as Black spots. In fact, quality control method is one that bases on hypothesis. It is shown that the method is better than others when applied, but the precedence order that Black spots are reconstructed is not fixed and the severity of accident is not considered.

Critical Rate Method

In 1997, J. S. CHEN and S. C. WANG summarize the merit and shortcoming of methods above to develop Critical rate method. In this method, the accident rate which the user of road can stand is regarded as critical rate. According to notability, there is different lowest value of accident rate corresponding to different critical rate. When the accident rate of one section is across critical rate, the section is thought of as Black spots. Thinks to considering the characters of Black spots, the method is better than methods above, and can fix the order that the Black spots is reconstructed though choosing different critical rate. But the critical rate is changing with economy development and standard of living improvement, so the data should be updated to make sure the critical rate based on traffic accident and building fund (Jodi, C. et al., 2001).

From the analysis of several methods above, although the several methods identify Black spots from different way, some conditions, such as traffic volume, road condition or severity of accident can be ignored, this makes veracity of identification result reduce. Therefore, each method should be applied in comfortable condition. When identifying

Black spots, it is supposed to take into account these conditions to study the method to make the result exact (Sean, T. D. et al., 2000).

Malaysia:

Since 1990 Universiti Pertanian Malaysia (UPM), Ministry of Science, Technology and Environment under the mechanism of IRPA and the National Road Safety Council (MKJR) have been funding research programs to improve the accident data collection and analysis system in Malaysia. The programs also aim to encourage wider usage of the system to assist in the identification and effective .treatment of accident black spots to improve road safety in this country. In view of the massive number of accident records to be analyzed (96,500 nationwide in 1991), the use of computer based analysis systems was investigated in early 1990 and a micro computer accident analysis package, MAAP licensed by the Transport Research Laboratory (TRL), United Kingdom, was customized to fulfill the requirement.

A pilot project on the diagnosis system for analyses of road accidents was then carried out under the funding of the research sub-committee MKJR with the cooperation of the Royal Malaysian Police (PDRM) and TRL, United Kingdom. The two districts of Shah Alam and Seremban were selected as pilot areas where the P'DRM agreed to cooperate by using a redesigned report form in addition to their current accident form, POL27 (Pin 1987). The new police accident form, POL27 (Pin 90 - Pilot Project), was designed to be easier to complete and incorporated several new items of information of importance to highway engineers; in particular, more accurate location data and collision diagrams. Following appropriate training of relevant police officers in the completion of the new form, it was introduced fully in these two districts from the beginning of 1991.

During the course of this trial period several improvements to the form were recommended, though these were relatively minor in nature. A revised version of the form known as POL27 (Pin 1/9 1) was then printed in late 1991 for its full-scale implementation in January 1992. An extensive training program for the police investigation officers over the whole country was carried out prior to 1992.

Theoretical Framework of the Study is presented below:

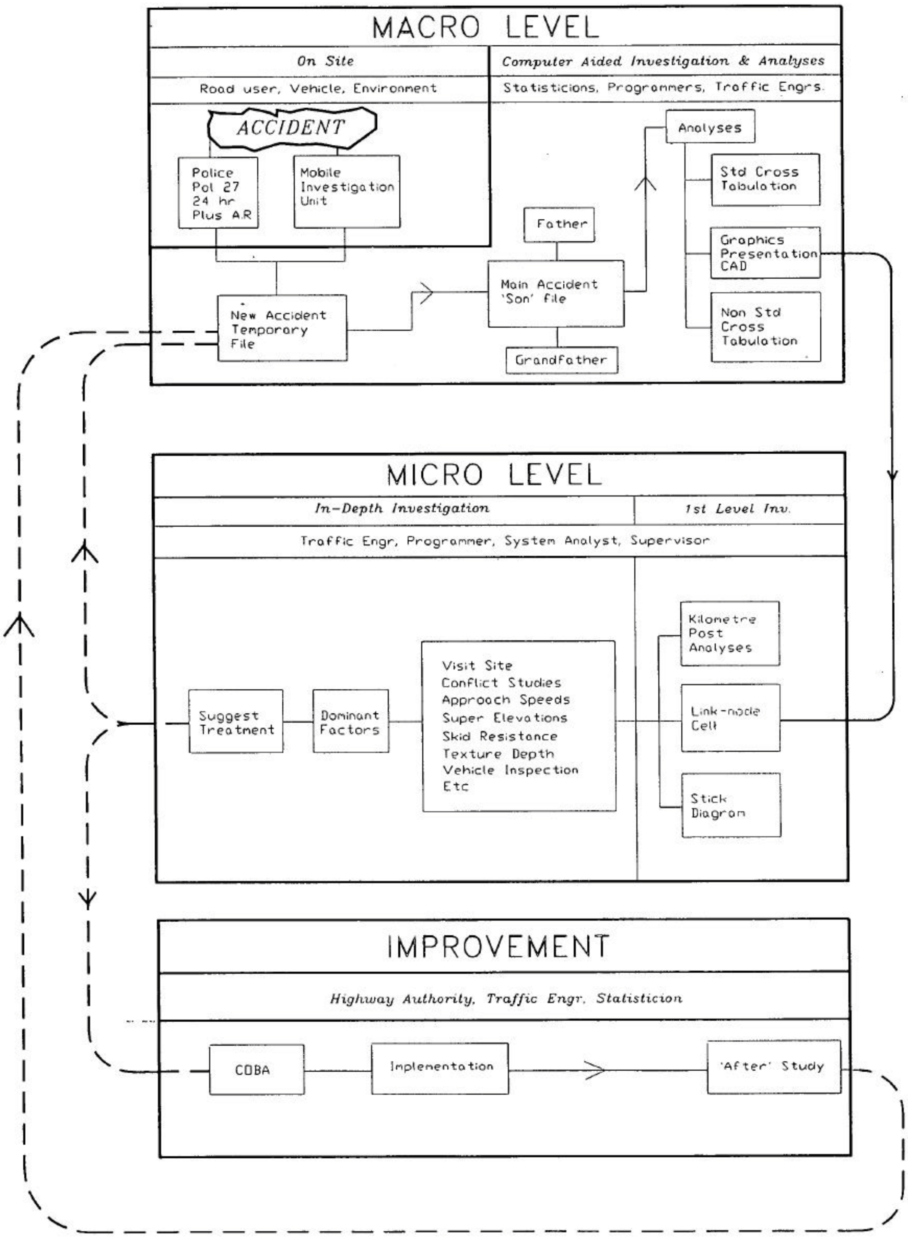


Figure 2-2Black spot Investigation and Treatment Process in Malaysia

Iowa (USA):

<u>Safety Improvement Candidate Location (SICL) Methods</u>

Methods for determining Candidate Locations, High Hazard Locations, or Sites with Promise enable practitioners to determine those sites that they focus their limited safety funds on improving. Identification of these locations is a vital component of hazard reduction and safety improvement. Focusing on the locations identified, practitioners can address safety concerns and ultimately reduce crash frequency and/or severity. The federally-mandated Highway Safety Improvement Program (HSIP) required each state to "develop and implement, on a continuing basis, a highway safety improvement program which has the overall objective of reducing the number and severity of crashes and decreasing the potential for crashes on all highways." A comprehensive HSIP consists of three components: planning, implementation, and evaluation.

The planning component should consist of processes which:

- Collect and maintain data (including crash, traffic, and roadway data),
- Identify hazardous locations and elements,
- Conduct engineering studies, and
- Establish project priorities (i.e., utilize some type of benefit/cost analysis).

Implementation usually involves taking the results of the last two planning components and defining projects, through design and specification. If these projects meet appropriate funding requirements (including benefit/cost requirements) they will then be constructed or implemented.

Evaluation is performed post-construction or implementation to determine the effectiveness of the projects and to improve future HSIP efforts. Evaluation can many times involve some of the same processes as the planning component, namely data collection, identification, and engineering studies.

The crash or hazard mitigation process, as defined by the HSIP, has sometimes been divided into six steps:

1. Identify sites with potential safety problems
2. Characterize crash experience
3. Characterize field conditions
4. Identify contributing factors and appropriate countermeasures
5. Assess countermeasures and select most appropriate
6. Implement countermeasures and evaluate effectiveness

Step 1 is the same as process 2 of the implementation component, steps 2 through 5 essentially restate processes 3 and 4 from the planning component, and step 6 restates the implementation and evaluation components. Thus, evidence exists supporting the importance of the identification phase to overall safety improvement efforts, whether they are reactive or proactive. In fact, the identification process is the basis, in both listings, for the further processes, in that identification of sites provides analysts and evaluators with a starting point for further study. Without this, they could potentially be faced with the prospect of analyzing and evaluating innumerable sites.

Given this, the identification process needs to be as accurate and informative as possible, resulting in a defensible listing of the sites that are "most hazardous" or that have the "most promise" of crash frequency and severity reduction. However, creating an accurate and informative identification process is not Simplee and efforts are ongoing to improve and enhance the identification process with both reactive and proactive purposes in mind. This fits well with the HSIP requirement of continuing development and implementation of a highway safety program.

Old Iowa Method

In Iowa, in an approach similar to that of the Weighted Rank Method, three ranking lists are generated and then the ranks from these three lists are combined into a single rank. The three sub-lists are a frequency rank, a rate rank, and a severity rank, this last based on "value loss" at the site.

The three sub-rankings have historically been generated using a link-node system for crash location. The link-node system involved the placement of nodes at locations including intersections, grade separations, bridges, ramp termini, severe curvature, and railroad crossings.

These locations all have a unique identifier for its geographic location. Each crash at these locations is referenced to this unique location, or reference node. Crashes between these locations are referenced to both the nearest node (the reference node) and the node at the other end of the roadway link (the direction node), with a distance from the reference node specified as well. The Total number of crashes that occur at each reference node and reference node/direction node pair can then be easily tabulated. However, only a list for reference node crashes is generated. To enter the first list the number of crashes must meet one of three certain criteria: a fatality, X number of injury crashes, or Y number of property damage crashes. Currently, X is set at 5 and Y is set at 8.

This list typically results in 10,000 to 11,000 locations annually. However, the link-node system has been abolished and a switch to a coordinate-based system is in effect. Adjusting the Iowa SICL method to reflect this is one of the challenges for the Office of Traffic and Safety. The first two rankings lists are generated much the same as, respectively, the crash frequency/density methods and the crash rate method. Because Iowa has historically relied on a link-node system, the definition of a site, whether spot or section, is slightly affected. In fact, three different types of sites were generally defined:

- Intersections include all road-to-road intersections, except alleys, ramp terminals, and complex intersection or interchange sites.
- Links include sections of road between intersections or nodes.
- Nodes include rail to road intersections, grade separations, bridges, road ends, 90 degree turns, county lines, and major signalized commercial entrances.

Steps involved in the Iowa Safety Improvement Candidate Location (SICL) development process are:

1. The crash statistics are searched to identify all locations (intersections, links, and nodes) in the State that meet at least one of the following crash frequency requirements for the designated five-year time period to develop the candidate location file:

   a. At least one fatal crash, or

   b. At least four personal injury crashes, or

   c. At least eight Total crashes.

2. The candidate location file created in Step 1 is sorted by descending frequency of crashes and a frequency rank is assigned.

3. For each site in the candidate location file, the frequency of each category (as defined by the KABCO scale) of injury is determined. A value loss is determined using these injury severity frequencies using the following values (updated in 2001):

   a. Fatalities x $1,000,000, plus

   b. Major Injuries x $150,000, plus

   c. Minor Injuries x $10,000, plus

   d. Possible/Unknown Injuries x $2,500, plus

   e. Actual Total Property Damage or $2,500 if unknown.

A value loss rank, generated by sorting the value losses in descending order, is assigned.

4. Crash rates per million entering vehicles are calculated for sites with known traffic exposure data. The sites are sorted by rank in descending order and a crash rate ranking is assigned to each site. Sites with no traffic exposure data are initially assigned a rank of 0 to give these sites the highest possible priority in the rate ranking. Traffic volumes are then determined, from any credible source, for sites with a rate rank of 0 that fall within the top

200. This process continues until all sites within the top 200 have valid rank values for rate.

Crash rates per million entering vehicles are calculated as:

Rate = (Frequency) (1,000,000)/ (DEV) (5 Years) (365 Days/Year)

Where, DEV is the actual DEV for spot locations and road segments up to 0.6 miles long. For road segments 0.6 miles long and longer the DEV is calculated as:

DEV=ABS (Link Length/0.3) (DEV))

This calculation adjusts the daily entering vehicles by the number of 0.3 mile sections within the segment to correlate the crash rate for longer segments closer to that for a spot location or shorter segment. This is an attempt to enable comparisons between spot locations and segments and enables one rank list, rather than 2 or 3, to exist.

5. The three rankings, frequency, value loss, and rate, are summed to create a composite rank factor. The sites are then sorted in ascending order by this composite rank factor and assigned a composite state ranking.

The Iowa method has many of the same positive features and negative features of those methods it incorporates: frequency, rate, and severity.

New Iowa Method (Intersections) - In Iowa, the approach used is similar to that of the Weighted Rank Method. Three ranking lists are generated and these three rank lists are subsequently combined into a single rank. The three sub-lists are a frequency rank (Total crashes), a rate rank (crashes/volume), and a severity rank ("value loss" at the site).

The first step in the process is to identify the crashes that can be assigned, for this purpose, to each intersection. The crashes within 75 feet of urban intersections and 150 feet of rural intersections are assigned to the intersection, using a Geographic Information System (GIS). This information is then exported to a file which is later imported into SAS (SAS Institute Inc., Cary, NC). The file contains the crash assignation data for all intersections that have had at least one crash in a five year time range. There are roughly 45,000 such intersections that meet this criteria.

Within SAS, the values for the separate rankings as well as the combined ranking are calculated. The first two ranking lists (frequency and rate) are generated much the same as the crash frequency/density methods and the crash rate method. The third ranking list (severity) is generated using a severity index method, based on criteria determined by the Iowa Department of Transportation (Iowa DOT) Office of Traffic and Safety (TAS). The three are combined using a weighting method, determined by TAS, to emphasize high severity locations.

Steps involved in the Iowa Safety Improvement Candidate Location (SICL) development process are:

1. The crash statistics are searched to identify all locations (intersections) in the State that have, for the designated five-year time span, at least one crash. There are typically roughly 45,000 intersections that meet these criteria. A file identifying cases assigned to each intersection is generated. A file detailing the road segments entering each intersection is also generated.

2. Both files are imported into SAS and further analyses are performed:

a. The crash frequencies for the five-year time span are calculated. The frequencies determined include Total crashes, Total fatalities, and Total major injuries.

b. The daily entering vehicles (DEV) for each intersection are calculated by summing the 2-way volumes for each road segment associated with each intersection and dividing by 2. This is not absolutely correct given the nature of the road segmentation but it is a compromise made due to the systematic, statewide nature of the analyses and the large number of intersections for which data needs to be obtained. (An Iowa intersection database is under development.)

c. Given the Total crash frequencies and the DEV, the crash rates are calculated.

d. Given the injury severity level frequencies, the severity indices are calculated using the following procedure:

  i. The first fatality at any one site is converted to a major injury to partially mitigate the effect of random chance, seatbelt use, age-related skeletal musculature frailty, etc.

  ii. The following values are multiplied against frequency of injury severity level:

    1. Fatality = 200

    2. Major Injury = 100

    3. Minor Injury = 10

    4. Possible or Unknown Injury = 1

  iii. These values are summed for each intersection to determine the severity indices.

e. Each category (frequency, rate, and severity) are ranked individually. Ties are allowed.

f. The rank list for each category is normalized using the highest rank value. Thus, if the highest rank value for rate is 5,000; all rank values for rate are divided by 5,000. The normalization is done to minimize the impact of any large number effect within a particular rank list when calculating the combined value for the subsequent combined rank.

g. The three normalized rank lists are weighted using values of 1/5 for frequency, 1/5 for rate, and 3/5 for severity index. The combined value is attained by summing these three.

h. The combined values are used to produce the combined statewide rank list. This list with a host of supporting information is exported to file.

3. Within Excel, column headers, borders, headers, and the like are applied to the list table.

Though all these methods develop lists for further consideration, they are not the only ways that sites can be identified as hazardous. Many non-crash based methods exist which might aid in proactively determining hazardous locations prior to existence of a crash history. These methods may also complement the identification of hazardous sites by verifying the existence of problems or by clarifying those problems.

Utilize Complementary Methods for Identifying Hazardous Locations- Complementary methods utilize non-crash indicators to aid in identifying the most hazardous location. They include:

1. Results of road skid testing
2. Hazard Indicator reporting
3. Observed minor crashes
4. Observed near-crashes
5. Evidence of potential hazards such as skid marks at intersection approaches
6. Maintenance records
7. Median or shoulder encroachment wheel marks
8. Volume to capacity ratios
9. Stopping and passing sight distance
10. Access points (driveways)
11. Traffic conflicts analysis
12. Erratic maneuver observations
13. Reports of hazardous locations by highway personnel, police, department personnel, motor clubs, motorists, and others.

Though all of these "state-of-the-practice" methods have proven useful, none address the identification of high crash locations thoroughly. In addition to the problems with each stated previously, all the methods ignore a significant majority of the system-wide sites in their analyses. Sites without any crashes in the time period analyzed are routinely ignored. This directs all mitigation measures to a reactive, rather than proactive, role. While consideration of only those sites having a crash history makes direct sense from a crash reduction standpoint, consideration of sites without a crash history is more difficult to justify.

However, inclusion of sites without a crash history allows for analysis of those factors about the sites that might lend themselves to safety or the lack thereof. Of course, to determine the problems on a systematic basis requires much more effort than obtaining crash histories and traffic volume data. To properly analyze sites to determine their deficiencies, a system-wide database containing the relevant attributes must be polled, thereby increasing the level of effort required to create a ranking list.

2.4.2 Hazardous Road Location Identification Programs in Bangladesh

According to some study from Accident Research Institute (ARI) of BUET the HRL identification method for urban roads is stated below:

Intersections:

ARI analyzes the intersections by dividing the intersection accident data into two time slots 1998-2003 and 2001-2003. Between 2001 and 2003, a total of 616 accidents took place in at intersections of metropolitan Dhaka. Those 56 intersections constituted nearly 75 percent of all intersection accidents that occurred during 2001 and 2003. Total 57 intersections are identified from Dhaka city and those are categorized according to the number of accidents for this two time period. Based on this, during 2001-2003, intersections that have greater than 50 percent of all the accidents occurred between 1998 and 2003 were taken for further analysis. But this analysis is done totally on the basis of number of accidents at intersections.

Midblock:

As the links of Dhaka city road are not well defined ARI did an overall safety research work for link analysis. ARI selected some long route which consists of more than one links actually and exclude all intersections accidents in those links. Then calculate the total length of that route and by dividing the total number of accidents happened in that route actually the ratio of accidents per kilometer length per year got for analysis. Through this process, the links of Dhaka city were ranked according to priority. Then they go for high frequency links. In fact, 2189 nos. accidents happened in these link roads, which is 71% of total link accidents (3093). For link analysis ARI uses accident data from 1998to 2003.

Like intersections here also the main criteria for indentify is the number of accidents at these linked roads.

2.5 Summary of All the Methods and finalization of the methods for Dhaka

At this study, from the experience of different countries revealed current and past methods of determining hazardous locations include the following:

1. Critical Accident Rate Method
2. Critical Accident Number Method
3. Spot Map Method
4. Crash Frequency/Crash Density Methods
   a. Crash Frequency Method
   b. Crash Density Method
5. Crash Rate Method
6. Quality Control Methods
   a. Number Quality Control Method
   b. Rate Quality Control Method
7. Crash Severity Methods
   a. Equivalent Property-Damage-Only (EPDO) Method
   b. Relative Severity Index (RSI) Method

- **Critical Accident Rate Method:**

The casualty accident rate per kilometer for each section is directly compared to the system-wide average to determine whether the accident record of each location is significantly greater than the system average.

The critical casualty accident rate is calculated for each intersection using the formula:

CR = A + 1.645 • (A/M) + 1/(2M)

Where,

CR is the critical rate

A is the average casualty accident rate per exposure

M is the measure of exposure

1.645 is based on a 95% confidence limit implying there is a 5% chance that the intersection may be indicated as having a significantly high accident rate even though the intersection is not specifically hazardous.

Those intersections for which the casualty accident rate is above the critical rate are considered worthy of detailed investigation. This method can be used for Dhaka as all types of data are available.

- **Critical Accident Number Method:**

The initial stage compares the individual intersection casualty accident number to the system-wide average to determine whether the accident record of each location is significantly greater than the system average.

In this instance the accident rate of the previous equation is replaced by the accident number, and the exposure term (M) is omitted. Therefore, the critical number equation becomes:

$CN = A + k \cdot (A) + 1/2$

CN = Critical Number

A = Average accident of a given period

K = 1.645 for 95% confidence limit

This method can be used for Dhaka as all types of data are available. As it mentioned it can be applicable for the intersection very effectively.

- **Spot Map Method:**

The spot map method involves the creation of a map showing clusters of symbols at spots and on segments of road network. The map is then examined for geographic clustering of crashes and those having the greatest numbers of Total crashes (or Total crashes of a particular type) are identified as being high crash locations. The spot map method is extremely Simple and easy to use; however it only provides a very rough estimate of high crash locations and does not provide a list of such locations. The spot map method is suitable for small areas and low numbers of crashes but fails for large areas or numbers of crashes. In the latter case, another high-crash identification method would be more advisable. This method can be used for Dhaka as all types of data are available. But as it mentioned it is a rough estimate at this study we prefer not to use this method.

- **Crash Frequency/Crash Density Methods:**

<u>Crash Frequency Method -</u> Closely related to the spot map method, the crash frequency method summarizes the number of crashes for spot locations. Locations are ranked by descending crash frequency and those with more than a predetermined number of crashes are classified as high crash locations to be further scrutinized for statistical significance.

Critical crash frequencies can be computed with crash data for the entire state or region using the following equation:

$$F_{cr} = F_{av} + sF$$

Where:

F_{cr} = critical crash frequency,

F_{av} = average crash frequency for all locations of a given type, and

sF = standard deviation of crash frequency for all locations of this type.

Compare the location's crash frequency to the critical crash frequency. If the critical crash frequency is equaled or exceeded, classify the location as a high-crash location. The crash frequency is typically used as a basic measure of the safety at a spot location while crash density is used for roadway sections. This method can be used for Dhaka as all types of data are available for both intersection and midblock.

Crash Density Method - Closely related to the crash frequency method, the crash density method summarizes the number of crashes per mile for highway sections. Critical crash densities can be computed with crash data for the entire state or region using the following equation:

$$D_{cr} = D_{av} + sD$$

where:

D_{cr} = critical crash density,

D_{av} = average crash density for all locations of a given type, and

sD = standard deviation of crash density for all locations of this type.

Compare the location's crash density to the critical crash density. If the critical crash density is equaled or exceeded, classify the location as a high-crash location.

The merits of the crash frequency and crash density methods include their Simplicity and the fact that locations with many crashes would be studied. However, no consideration for exposure (e.g., traffic volumes) in the prioritization occurs. This lack can result in misleading results if traffic volumes vary considerably throughout the road system. The crash frequency and crash density methods tend to rank high volume locations as high-crash locations, even if the relative number of crashes is low given its volume. Many agencies that use the crash frequency and crash density methods only use them to develop an initial list and evaluate the locations in the list in more detail using other methods.

This method can be used for Dhaka as all types of data are available for both intersection and midblock. In fact it is and the crash frequency method is same but it can be used for the midblock only.

- **Crash Rate Method:**

The crash rate method factors the risk of exposure into the determination of high crash locations. The method uses crash rate (number of crashes divided by vehicle exposure) as a basis for ranking. Rates are given in crashes per million entering vehicles (crashes/MEV) for spot locations and crashes per million vehicle-miles (crashes/MVM) for sections.

Locations with higher than a predetermined rate are classified as high-crash locations.

Crash rates are calculated using:

Crash rate = a/v

where:

a = the number of crashes at a location during a specified time

v = the traffic volume using the location during that same time

Due to the rarity of crashes, this rate is generally multiplied by one million or one hundred million.

Two kinds of rates are generally computed, one for spots and one for sections:

1. The spot crash rate involves the number of crashes per million vehicles entering the spot:

$$R_i = 2 (A) (1{,}000{,}000) / (T) (V)$$

Where:

R_i = spot crash rate expressed in crashes per million entering vehicles

A = number of crashes during the days of the study

T = time period in days

V = Total average daily traffic entering and departing the intersection

2. The section rate considers section length in addition to volume. Because road sections vary in length, they provide different exposure to crashes; thus, rates for road sections must be in terms of crashes per one million miles or one hundred million miles. Road sections are generally longer than half a mile and usually 100 million vehicle miles are used. The section rate is calculated using:

$$R_s = (A) (100{,}000{,}000) / (T) (V) (L)$$

Where:

R_s = section rate in crashes per 100 million vehicle miles

V = average annual daily traffic on a section (vehicles per day)

T = period (days) for which crashes are counted, usually 365 days

L = length of section in miles

This method cannot be used for Dhaka as the volume data are not available for both intersection and midblock.

- **Quality Control Methods:**

Number Quality Control Method - The number quality control method identifies those sites where crash frequency or crash density is greater or significantly greater than the average crash frequency or density for similar sites across the state or similar region. Similar to the crash frequency and crash density methods, the number quality control method adds some form of statistical control for selecting the critical crash frequency/crash density.

To compute the critical crash rate for a site, use the following equation:

$$Fc = Fa + k (Fa/M)1/2 + 1 / 2M$$

where:

Fc = the critical crash frequency/density

Fa = average crash frequency/density for the entire population of sites within the category

k = a probability constant, where the higher the value of k,

The higher the value of the critical crash frequency/density. Some common k values are:

k = 3.090 for a 99.9% level of confidence

k = 2.576 for a 99.5% level of confidence

k = 1.645 for a 95% level of confidence

k = 1.282 for a 90% level of confidence

M = millions of vehicle miles (or kilometers) for sections or millions of vehicles for spots

Rate Quality Control Method - The rate quality control method identifies those sites where crash rate is greater or significantly greater than the average crash rate for similar sites across the state or similar region. Similar to the crash rate method, the rate quality control method adds some statistical control for determining the critical crash rate.

By using the Following equation:

$$Rc = Ra + k (Ra/M)1/2 + 1 / 2M$$

where:

Rc = the critical crash rate

Ra = average crash rate for the entire population of sites within the category

k = a probability constant, where the higher the value of k,

The higher the value of the critical crash rate. Some common k values are:

k = 3.090 for a 99.9% level of confidence

k = 2.576 for a 99.5% level of confidence

k = 1.645 for a 95% level of confidence

k = 1.282 for a 90% level of confidence

M = millions of vehicle miles (or kilometers) for sections or millions of vehicles for spots

Use of a high k value will result in a shorter list of critical sites but confidence that those sites are hazardous is increased.

As all the data are available this process can be applicable for Dhaka. As similar types of methods decided to take into consideration for Dhaka at this study these methods won't be used.

- **Crash Severity Methods:**

Equivalent Property-Damage-Only (EPDO) Method - In the equivalent property damage only (EPDO) method weights fatal and injury crashes against a baseline of property-damage only crashes. Each of the injury levels (KABC) are given a specific number weight that is compared against property-damage-only crashes, which are given a weight of 1. These weight coefficients are based on the relative average crash costs by severity. K-type and A-type crashes often have the same weight. The weights are incorporated into the SICL process by either computing a EPDO index or an EPDO rate.

Calculate the EPDO Severity Index (SI) using the following equation:

$$SI = [WKK + WAA + WBB + WCC + P] / T$$

Where:

SI = Severity Index for the site

W = the respective weight coefficients

K = frequency of fatal crashes at the site

A = crash frequency involving A-type injuries at the site

B = crash frequency involving B-type injuries at the site

C = crash frequency involving C-type injuries at the site

P = frequency of PDO crashes at the site

T = Total crashes at the site

Calculate the EPDO index using the following equation:

$$\text{EPDO Index} = WKK + WAA + WBB + WCC + P$$

Where the variables are the same as above.

Relative Severity Index (RSI) Method - The relative severity index (RSI) method incorporates the weighted average cost of crashes at sites. This method is best-suited for the further evaluation of sites already identified by other methods as high-crash sites. In the RSI method, crash frequency at each severity level is multiplied by the average "comprehensive cost" for crashes at that severity level. The subtotals for each of these severity-specific costs are summed and the sum is divided by the Total crash frequency.

Compute the RSI value for the site, utilizing the severities in the following equation:

RSI = [CFK+CAA+CBB+CCC+CPP]/(K+A+B+C+P)

Where:

Ci = the average comprehensive cost per crash for a crash of severity level "i" from K thru P. K, A, B, C, and P are as defined above in the EPDO method.

This method can be used for Dhaka as all types of data are available for both intersection and midblock. But the cost is indefinable at our context so the RSI cannot be applied.

All of the above methods described are mainly used in the developed countries. Developing countries like India did not practice this type of study or even if they practice those are not found in the library of IIT. After compilation and examining all the processes the finalized process of this study are mainly four: Critical Number/Rate Method, Crash Frequency method, Crash Severity Method and Equivalent Property-Damage-Only (EPDO) Methods. Out of these any of them cannot be chosen because it is still not clear that how these processes can have some limitations over Dhaka. So it is decide that combined analysis method can be followed and with the help of all four methods final intersection or midblock can be decided as HRL.

CHAPTER 3

STUDY DESIGN AND METHODOLOGY

3.1 Introduction

At this chapter, aspects of study, study area, methodology of the study and how data's are being collected and analysis are discussed in details. As all the accident data are collected by using MAAP-5 software so it is obvious to describe the procedure of the software also.

3.2 Theoretical Aspect of the Study

Though various types of study are carried over Dhaka Metro roads, but there is no such process of identifying hazardous locations of urban roads in Bangladesh. Theoretically it is quite important to identify one procedure to find out the black spots of urban roads. For this reason theoretically the study is very important in the context of Bangladesh.

3.3 Study Area

At this study the area for research are two major arterials of Dhaka Metro City. Some basic features of Dhaka Metropolitan City are given below:

- Population – 14 Million with a growth rate of 8 percent per annum.
- Dhaka as percent of Bangladesh – 8 percent, and accounts for 33 percent of total urban population
- Poverty incidence – 54 percent (highest among all Asian cities)
- Dhaka's contribution to national GDP – nearly 15 percent
- Road vehicles nearly 250,000 with huge number of rickshaws (500,000)
- Trip percent catered by Mass Transport – 10 percent.
- Cost of congestion and accidents – Tk. 3,000 crore (US$ 520 million per annum)
- Air pollution and noise level 4 (in 1-10 scale)
- Urban road accident fatalities – 400 (reported per annum)
- Percent road fatalities who are pedestrians – more than 60 percent

Between 1974 and 2001, Dhaka grew from 2.3 million populations to 10 million showing an annual growth of approximately 1.48. The motorized vehicles in Dhaka increased from 4800 in 1971 to 14224 in 2001 with an annual increase over 3.7 Percent. There was no source to current vehicle population operating exclusively in the Dhaka Metropolitan area.

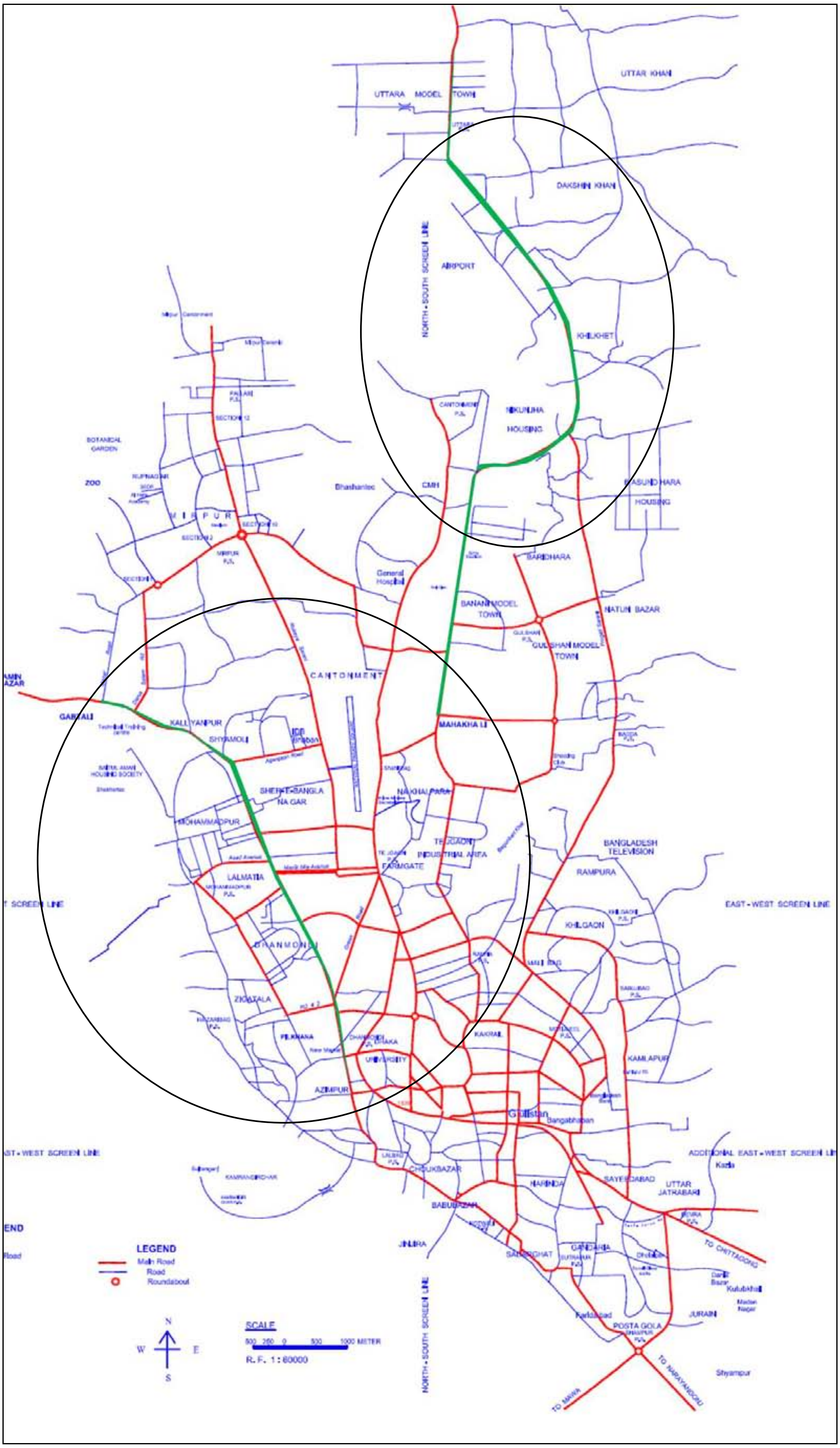


Figure 3-1 Map of Dhaka City Road network

The combined effect of such an increase of vehicles, large scale urbanization and influx of huge number of people from rural areas, inadequate traffic sense of road users and poorly managed traffic control systems in conjunction with inherent deficiency in planning, designing and maintenance of roadway and traffic systems has created a hazardous travel environment in the metropolis

Mirpur road is one of the major arterials in Dhaka City where previously non motorized vehicles are allowed to run, but from 2003 at certain portion of this road rickshaws are banned to pass. As at both sides of the road there are a lot of markets, shopping centre, schools everyday a large number of cars and public buses are passed through this road. So this road is very important in respect to Dhaka city’s transportation. Another road is Airport road which is eventually the best road (in consideration of road width) of Dhaka city. From Mohakhali Bus Terminal many intercity buses of different districts of Northern part run through this arterial. As this road has a tremendous width and no non-motorized vehicles are allowed to use, the average free flow speed of this road is more than 70Km. The sections of the study are Mohakhali intersection to House building intersection which is a part of Airport road and Azimpur intersection to Technical intersection which is a part of Mirpur Road. Between these sections all the midblock and major intersections are identified at our study and analyzed.

At Mirpur Road Section, there are total 13 intersections and 12 midblock sections located. On the other hand, at the study area of Airport Road, 9 intersections and 8 midblock sections are found. The road length of Mirpur road under the study is 7.3 kilometer from Azimpur intersection to Technical intersection. On the other hand, Airport road is 11 kilometer which is from Mohakhali to House Building intersection.

Google Coordinate	From	To
Airport Road	23º 43’36.86” N 90º 23’10.99”E	23º 46’53.56” N 90º 21’6.57” E
Mirpur Road	23º 46’42.43” N 90º 23’52.84”E	23º 52’29.32” N 90º 24’1.97” E

Mirpur Road (Azimpur – Technical)

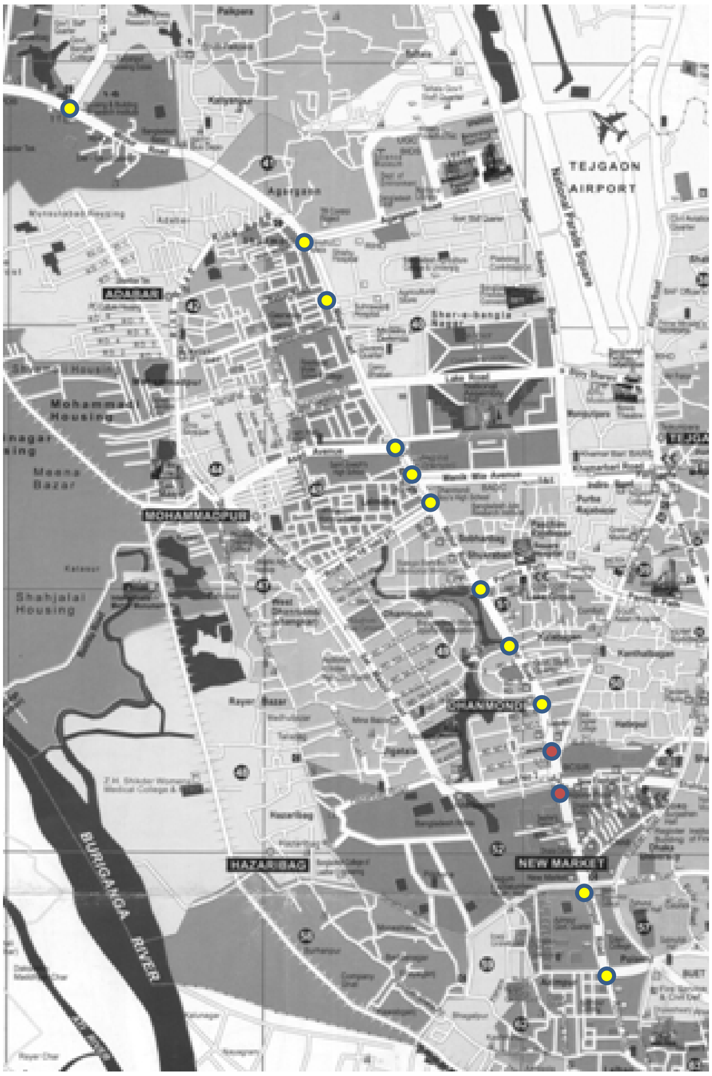


Figure 3-2Map of the study area of Mirpur Road

Figure 3-3 Map of the study area of Airport Road

3.4 Safety Research Methodology in This Study

Among all the methods mentioned above at this study four methods are used to identify the black spots. For identifying the black spots of intersection four methods are applied and hazardous locations were identified. In case of intersection the processes are Critical Number Method, Crash frequency method, Crash Severity Method and Equivalent Property-Damage-Only (EPDO) Methods. The details formulas of all the methods are stated below:

For Intersection:

1. Method 1: **Critical Number Method**

CN = A + k • (A) +1/2

CN = Critical Number

A = Average casualty accident of a given period

K = 1.645 for 95% confidence limit

2. Method 2: **Crash Frequency Method**

Fcr = Fav + Sf

Fcr= Critical Crash Frequency

Fav= Average crash frequency for all locations for intersection

Sf= Standard deviation of crash frequency for intersection

3. Method 3: **Crash Severity Method**

SI = [WKK + WAA + WBB + WCC] / T

SI = Severity Index for the site

W = the respective weight coefficients, 3, 1.8, 1.3 & 1.0

K = frequency of fatal crashes at the site

A = crash frequency Grievous crashes injuries at the site

B = crash frequency Simple crashes injuries at the site

C = crash frequency involving collision crashes injuries at the site

T = Total crashes at the site

4. Method 4: **Equivalent Property-Damage-Only (EPDO) Method**

EPDO Index = WKK + WAA + WBB + WCC

Where, the variables are the same as above.

In case of mid blocks the processes are Critical Rate Method, Crash frequency method, Crash Severity Method and Equivalent Property-Damage-Only (EPDO) Methods.

1. Method 1: **Critical Rate Method**

CR = A + k • (A/M) +1/ (2M)

CR= Critical Rate

A= Average casualty accident rate per exposure

M= Measure of exposure

k=1.645 for 95% confidence limit

2. Method 2: **Crash Frequency Method**

Fcr = Fav + Sf

Fcr= Critical Crash Frequency

Fav= Average crash frequency for all locations for midblock

Sf= Standard deviation of crash frequency for midblock

3. Method 3: **Crash Severity Method**

SI = [WKK + WAA + WBB + WCC] / T

4. Method 4: **Equivalent Property-Damage-Only (EPDO) Method**

EPDO Index = WKK + WAA + WBB + WCC

The weighted coefficients are used at this study are 3, 1.8, 1.3 and 1.0 for fatal, Grievous, Simple and collision type accidents accordingly. These values are on the basis of a study of RTA (1988, 1990) where 3 used for fatal; 1.8 for serious; 1.3 for other injuries and 1.0 for non injury crashes.

For all the methods, consecutive accident data of 3 years should be used. As accident data from 2002-2007 are available, all the data will be split into two time divisions 2002-2004 and 2005-2007. Then for each time divisions accident data of the intersections and mid blocks will be analyzed. After doing the ranking of all sections, the intersections and midblock carried the highest number will be considered to be the most vulnerable. The intersections or mid blocks ranked top positions in the list most of the times will be considered to be the most critical of all the hazardous location.

3.5 Data Collection Process by MAAP5

3.5.1 Background

At 1972 Overseas Centre of TRL began research about accidents at developing countries. They gave a complete report on accident recording and analysis system in developing countries.

The fact they got was that there was no computer based data entry system in the developing countries. As a result of that finding overseas center began development of MAAP.

First trial of MAAP software was introduced in Egypt at 1983.

At our country 1995 MAAP introduced in Northern Police Division of Metropolitan Dhaka (Cantonment, Gulshan & Uttara). Now in all over Bangladesh Police are collecting the accident data with the help of MAAP5 database.

3.5.2 Implementation of MAAP5 at Dhaka Metropolitan

To promote road safety in Bangladesh Overseas Development Administration (ODA), UK and World Bank gave commitment of funding. As a result, at 1995 MAAP has been introduced in Northern Police Division of Metropolitan Dhaka (Cantonment, Gulshan & Uttara). Now at 2005 MAAP5 is being used to analysis accidents all through Bangladesh.

3.5.3 Setting up MAAP5

There are six stages to set up MAAP5 software:

1. Main program (from TRL)
2. User specific configuration files
3. PCX map files
4. Accident data files
5. Location files from various computers in Bangladesh
6. MS-DOS mouse drive

3.5.4 Objectives of MAAP

- Identify characteristics/patterns of accidents
- Prioritizing hazardous sites or areas
- Assisting in the selection of appropriate remedial actions and
- Evaluation of the safety implementation

3.6 Process of Accident Data Collection and Data Analysis at this study:

Accident data for each intersection and midblock section are collected by the polygon analysis method.

- At first one has to select the location map, and then DMP-N and DMP-S can be added. Any of the maps should be loaded.
- Then from right side “plot accidents” should be chosen. For plotting the accidents for the study different time series data and different types of intersection types (for intersection type 2-6 and for midblock type1) are chosen at different time.

- Then by drawing polygon for both intersection and midblock are saved in the bang folder. Polygon can be drawn easily by clicking one after another; at any time it can be blocked.
- At the table a code is used that is the name by which one can find the intersection or midblock for this study from MAAP5 database.

The advantage of the polygon analysis is the intersection or midblock section can be seen and drawn according to the researcher’s wish and perfection.

CHAPTER 4

RANKING AT TWO SELECTED ROUTES OF DHAKA METROPOLITAN CITY

4.1 General:

At this chapter mainly two time series data are analyzed and then the hazardous road locations are identified on the basis of the available ranking in different methods. The main HRL are founded the basis of 2005-2007 but the identified intersection or midblock is checked with the previous time series data. Some short terms used at this report specially for this chapter are like F=Fatal; G= Grievous; C= Collision; S=Simple.

4.2 Hazardous Road Location during 2002-2004:

4.2.1 Ranking of intersections at Mirpur Road :

After collection all the data of year 2002-2004 critical, crash frequency and critical number have been calculated. From the following table, critical crash frequency was found.

Table 4.1 Accidents at Mirpur road-intersections (Azimpur-Technical)

	Intersection	Code	Type of Control	Type of Junction	F	G	S	C	Total Acc	Total Acc/year	SI	EPDO Index
1	Azimpur	MI1	A	Cross	0	0	1	0	1	0.33	1.30	1
2	Newmarket	MI2	A	Cross	0	0	0	1	1	0.33	1.00	1
3	Science Lab	MI3	A	T	0	0	0	0	0	0.00	-	-
4	City College	MI4	A	Cross	0	0	0	0	0	0.00	-	-
5	Dhanmondi-6	MI5	A	Cross	0	2	1	0	3	1.00	1.63	5
6	Kalabagan	MI6	A	Cross	0	0	0	0	0	0.00	-	-
7	Sukrabad	MI7	A	T	0	1	0	0	1	0.33	1.80	2
8	Dhanmondi-27	MI8	A	T	0	3	0	2	5	1.67	1.48	7
9	Manikmiah	MI9	A	T	2	1	0	1	4	1.33	2.20	9
10	Asad Gate	MI10	A	T	5	2	0	1	8	2.67	2.45	20
11	Chienese	MI11	A	Cross	1	1	0	1	3	1.00	1.93	6

12	Sishu Mela	MI12	A	T	2	1	0	0	3	1.00	2.60	8
13	Shamoly	MI13	A	T	3	4	0	1	8	2.67	2.15	17
14	Technical	MI14	A	T	1	4	0	0	5	1.67	2.04	10
	Total				14	19	2	7	42	14.00		

Here,

Method 1:

Critical number for Dhaka City= 2.42

Total number of intersection accidents during 02-04= 994

Total number of intersections= 1613

So, A= average accidents per intersection are= 0.46

Then for 95% confidence level, critical number is 2.42.

Method 2:

Average crash frequency=1

Standard Deviation of all the accident is=0.92

So, Critical crash frequency= 1.92

From Table 4.2, it can be seen that Asad gate and Shamoly intersections are in worse condition. From the frequency of accidents each intersection, it can be said that previous two Shamoly and Asad gate are still over the critical number.

The following table shows how severity index and EPDO index were found.

Method 3: By considering the weight coefficients of 3, 1.8, 1.3 & 1.0 for fatal, Grievous, Simple & collision respectively, highest severity index for this route is Shishumela.

Method 4: By calculating the EPDO Index highest index is found for Asad gate.

So, the final ranked intersections of Mirpur road are for 2002-2004 period: Asad Gate, Shamoly and Sishumela. Asad gate is considered to be the highest accident prone intersection of this route by above three methods.

4.2.2 Ranking of Intersections at Airport Road

After collection all the data of year 2002-2004, critical crash frequency and critical number were determined for this route. From the following table, critical crash frequency can be calculated.

Table 4.2 Accidents at Airport road (House Building-Mohakhali)

	Intersection	Code	Type of Control	Type of Junction	F	G	S	C	Total Acc	Total Acc/year	SI	EPDO Index
1	House Building	RI1	M	Cross	4	3	1	2	10	3.33	2.07	21
2	Jasim Uddin	RI2	M	T	7	6	0	3	16	5.33	2.18	35
3	Airport	RI3	M	Cross	8	8	0	1	17	5.67	2.32	39
4	Kuri Bishwa Road	RI4	M	T	5	1	0	0	6	2.00	2.80	17
5	Kakoli	RI5	A	Cross	3	5	1	4	13	4.33	1.79	23
6	Banani-11	RI6	M	T	1	1	0	0	2	0.67	2.40	5
7	Banani-1	RI7	A	T	1	0	1	0	2	0.67	2.15	4
8	Mohakhali-Amtoli	RI8	A	T	5	2	0	3	10	3.33	2.16	22
9	Mohakhali-BCPS	RI9	M	T	1	3	0	6	10	3.33	1.44	14
	Total								86	28.667		

Here,

Method 1:

Critical number for Dhaka City= 1.49 (calculation is shown above).

From the frequency of accidents at each intersection it is seen that there are many intersections which are over the critical number. Those are - House Building, Jashimuddin, Airport, Kuril Bishwa Road, Kakoli, Mohakhali-Amtoli and Mohakhali-BCPS.

Method 2:

Average crash frequency= 3.19

Standard Deviation of all the accident is=1.81

So, Critical crash frequency= 5.0

Therefore, it is seen that Jashimuddin and Airport intersections exceed this frequency.

.**Method 3:** By considering the weight coefficients of 3, 1.8, 1.3 & 1.0 for fatal, Grievous, Simple & collision respectively, highest severity index for this route is Kuril Bishwa Road.

Method 4: By calculating the EPDO Index highest index is found for Airport.

Hence Airport Intersection is found to be the highest accident prone intersection of this route during 2002-2004 by above three methods.

4.2.3 Ranking of Midblock at Mirpur Road

After collection all the data of year 2002-2004, critical crash frequency and critical number were calculated. From the following table, critical crash frequency can be determined. And critical rate for each midblock section can also be calculated.

Table 4.3 Accidents at Mirpur road-midblock section (Azimpur-Technical)

Sl No.	Intersection 1	Intersection 2	Link	Length, KM	Total Cas. Accs.	Total Cas. Accis/ Km / yr	CR	F	SI	EPDO Index
1	Azimpur	Newmarket	ML1	0.6	2	1.11	3.79	1.23	1.80	4
2	Newmarket	Science Lab	ML2	0.65	6	3.08	3.65	3.39	2.40	14
3	Science Lab	City College	ML3	0.25	6	8.00	6.08	12.28	1.96	14
4	City College	Dhanmondi-6	ML4	0.4	4	3.33	4.66	4.90	1.88	9
5	Dhanmondi-6	Kalabagan	ML5	0.45	4	2.96	4.38	5.13	1.53	9
6	Kalabagan	Sukrabad	ML6	0.45	4	2.96	4.38	3.42	2.40	10
7	Sukrabad	Dhanmondi-27	ML7	0.65	8	4.10	3.65	4.52	2.55	20
8	Dhanmondi-27	Manikmiah	ML8	0.2	2	3.33	6.95	7.14	1.93	6
9	Manikmiah	Asad Gate	ML9	0.25	3	4.00	6.08	8.77	1.28	6
10	Asad Gate	Chienese	ML10	0.5	0	-	4.15	-	-	-
11	Chinese	Sishu Mela	ML11	0.95	15	5.26	3.07	7.49	2.15	43
12	Sishu Mela	Shamoly	ML12	0.27	4	4.94	5.81	6.35	2.10	8
13	Shamoly	Technical	ML13	1.7	24	4.71	2.42	5.69	2.14	60
				7.32	82					

Here,

Method 1:

For the calculation of Critical rate,

Total number of midblock accidents during 02-04= 1346

Total length of road network = 1281 Km

So, A= average casualty accidents per Km per year are= 0.92

For 95% confidence level, critical rate is calculated.

Critical Rate = A + k • (A/M) +1/(2M)

A= Average Casualty accident rate per exposure; here exposure is length of the midblock.

Then for 95% confidence level, K= 1.645

Therefore, it is seen that the list of the midblock sections of Mirpur Road are Science Lab-City College; Sukrabad-Dhanmondi27; Chinese- Shishumela.

Method 2:

Average crash frequency= 1.03

Standard Deviation of all the accident is=3.30

So, Critical crash frequency= 4.32

Therefore, it is seen that Science Lab-City College, City College-Dhanmondi-6, Dhanmondi-6-Kalabagan, Sukrabad-Dhanmondi-27, Dhanmondi-27-Manikmiah, Manikmiah-Asad Gate, Asad Gate-Chienese, Chinese-Sishu Mela, Sishu Mela-Shamoly, Shamoly-Technical are not operated safely.

The following table includes the values of severity index and EPDO index.

Method 3: By considering the weight coefficients of 3, 1.8, 1.3 & 1.0 for fatal, Grievous, Simple & collision respectively, highest severity index for this route is Sukrabad-Dhanmondi 27.

Method 4: By calculating the EPDO Index highest index has been found for Shamoly-Technical.

So the final ranked midblock of Mirpur road during 2002-2004 is: Sukrabad-Dhanmondi27.

4.2.4 Ranking of Midblock at Airport Road

After collection all the data of year 2002-2004, critical crash frequency and critical number were calculated for this route. Critical crash frequency is presented in the following table.

Table 4.4 Accidents at Airport road-midblock (House Building-Mohakhali)

Sl No.	Intersection 1	Intersection 2	Link	Length , KM	Total Cas. Accs.	Total Cas. Accis/ Km / yr	CR	F	SI	EPDO Index
1	House Building	Jasim Uddin	RL1	1.35	48	12	2.65	12.35	2.44	122
2	Jasim Uddin	Airport	RL2	0.75	15	7	3.41	7.56	2.48	42
3	Airport	Kuril Bishwa Road	RL3	3.625	64	6	1.89	6.16	2.70	181
4	Kuri Bishwa Road	Kakoli	RL4	3.75	51	5	1.87	6.04	2.24	152
5	Kakoli	Banani-11	RL5	0.3	3	3	5.47	3.33	2.60	8
6	Banani-11	Banani-1	RL6	0.3	3	3	5.47	4.44	2.50	10
7	Banani-1	Mohakhali-Amtoli	RL7	0.7	4	2	3.52	1.90	2.70	11
8	Mohakhali-Amtoli	Mohakhali-BCPS	RL8	0.3	-	-	5.47	-	-	-

				11.075	188					

Here,

Method 1:

For the calculation of Critical rate,

A= average casualty accidents per Km per year are= 0.92

For 95% confidence level, critical rate is calculated.

Critical Rate = A + k • (A/M) +1/(2M)

A= Average Casualty accident rate per exposure; here exposure is length of the midblock.

Then for 95% confidence level, K= 1.645

Therefore, it is seen that the list of the midblock sections of Airport Road are House Building-Jasim Uddin, Jasim Uddin-Airport, Airport-Kuril Bishwa Road, Kuril Bishwa Road-Kakoli..

Method 2:

Average crash frequency= 2.4

Standard Deviation of all the accident is=3.78

So, Critical crash frequency= 6.18

Therefore, it is seen that House Building-Jasim Uddin, Jasim Uddin-Airport are operated dangerously.

Severity index and EPDO index can be shown in the following table.

Method 3: By considering the weight coefficients of 3, 1.8, 1.3 & 1.0 for fatal, Grievous, Simple & collision respectively, highest severity index for midblocks of Mirpur road is Airport-Kuril Bishwa Road.

Method 4: By calculating the EPDO Index, highest index is found for Airport-Kuril Bishwa Road.

So the final ranked midblock of Airport road is Airport-Kuril Bishwa Road which is found to be the highest accident prone midblock of this route by above three methods.

4.3 Hazardous Road Location during 2005-2007

4.3.1 Ranking of Intersections at Mirpur Road

After collection all the data of year 2005-2007, critical crash frequency and critical number were identified. From the following table, critical crash frequency was determined.

Table 4.5 Accidents at Mirpur road-intersection (Azimpur-Technical)

	Intersection	Code	Type of Control	Type of Junction	F	G	S	C	Total Acc	Total Acc/year	SI	EPDO Index
1	Azimpur	MI1	A	Cross	0	0	0	0	0	0.00	-	-
2	Newmarket	MI2	A	Cross	0	0	0	0	0	0.00	-	-
3	Science Lab	MI3	A	T	0	1	1	0	2	0.67	1.55	3
4	City College	MI4	A	Cross	1	0	0	0	1	0.33	3.00	3
5	Dhanmondi-6	MI5	A	Cross	1	0	0	0	1	0.33	3.00	3
6	Kalabagan	MI6	A	Cross	0	0	0	0	0	0.00	-	-
7	Sukrabad	MI7	A	T	2	1	1	1	5	1.67	2.02	10
8	Dhanmondi-27	MI8	A	T	0	1	0	2	3	1.00	1.27	4
9	Manikmiah	MI9	A	T	0	1	0	1	2	0.67	1.40	3
10	Asad Gate	MI10	A	T	3	0	1	1	5	1.67	2.26	11
11	Chienese	MI11	A	Cross	1	3	0	1	5	1.67	1.88	9
12	Sishu Mela	MI12	A	T	3	2	2	0	7	2.33	2.17	15
13	Shamoly	MI13	A	T	4	1	0	2	7	2.33	2.26	16
14	Technical	MI14	A	T	2	1	0	2	5	1.67	1.96	10
					17	11	5	10	43	14.33		

Here,

Method 1:

Critical number for Dhaka City during 2005-2007= 1.19

Total number of intersection accidents during 05-07= 420

Total number of intersections= 3400

So, A= average accidents per intersection are= 0.12

Then for 95% confidence level, critical number is 1.19.

So, the dangerous intersections comparing to the critical number are Sukrabad, Asad Gate, Chinese, ShishuMela, Shamoly and Technical.

Method 2:

Average crash frequency= 1.02

Standard Deviation of all the accidents for this route is= 0.85

So, Critical crash frequency= 1.87

Therefore, it is seen that Shishumela and Shamoly intersections are in undesirable condition. From the frequency of accidents each intersection, it is seen that previous two Shamoly and Shishumela are still over the critical number.

From the following table, severity index and EPDO index can be calculated.

Method 3: By considering the weight coefficients of 3, 1.8, 1.3 & 1.0 for fatal, Grievous, Simple & collision respectively, highest severity index for this route are City College and Dhanmondi6.

Method 4: By calculating the EPDO Index, highest index is found for Shamoly.

By analyzing all the four methods during 2005-2007, at Mirpur road the most hazardous intersection is Shamoly.

4.3.2 Ranking of Intersections at Airport Road

After collection all the data of year 2005-2007, critical crash frequency and critical number were calculated for this route. Critical crash frequency is shown in the following table.

Table 4.6 Accidents at Airport road-intersection (House Building-Mohakhali)

	Intersection	Code	Type of Control	Type of Junction	F	G	S	C	Total Acc	Total Acc/year	SI	EPDO Index
1	House Building	RI1	M	Cross	0	0	0	1	1	0.33	1.00	1
2	Jasim Uddin	RI2	M	T	3	3	0	3	9	3.00	1.93	17
3	Airport	RI3	M	Cross	5	4	1	0	10	3.33	2.35	24
4	Kuri Bishwa Road	RI4	M	T	6	2	0	2	10	3.33	2.36	24
5	Kakoli	RI5	A	Cross	3	3	0	0	6	2.00	2.40	14
6	Banani-11	RI6	M	T	2	1	0	1	4	1.33	2.20	9
7	Banani-1	RI7	A	T	0	0	0	0	0	0.00	-	-
8	Mohakhali-Amtoli	RI8	A	T	0	2	0	1	3	1.00	1.53	5
9	Mohakhali-BCPS	RI9	M	T	2	0	0	1	3	1.00	2.33	7
									46	15.33		

Here,

Method 1:

Critical number for Dhaka City during 2005-2007= 1.19 (calculation is shown above)

From the frequency of accidents each intersection, it is seen that there are many intersections which exceed the critical number. Those are Jashimuddin, Airport, Kuril Bishwa Road, Kakoli and Banani-11.

Method 2:

Average crash frequency = 1.7

Standard Deviation of all the accident is =1.27

Critical crash frequency= 2.97

Therefore, it is seen that Jashimuddin, Airport and Kuril Bishwa Road intersections are worse.

Method 3: By considering the weight coefficients of 3, 1.8, 1.3 & 1.0 for fatal, Grievous, Simple & collision respectively, highest severity index for this route is Airport.

Method 4: By calculating the EPDO Index, highest index is found for Airport and Kuril Bishwa Road.

Airport Intersection is found to be the highest accident prone intersection of this route by all the four methods during 2005-2007.

4.3.3 Ranking of Midblock at Mirpur Road

After collection all the data of year 2005-2007, critical crash frequency and critical number were calculated. From the following table, critical crash frequency was found. And also critical rate for each midblock section was determined.

Table 4.7 Accidents at Mirpur road-midblock (Azimpur-Technical)

Sl No.	Intrsection 1	Intrsection 2	Link	Length, KM	Cas. Accs	Cas. Accidents / Km / yr	CR	F	SI	EPDO Index
1	Azimpur	Newmarket	ML1	0.6	1	0.56	4.3	1.23	3.00	3
2	Newmarket	Science Lab	ML2	0.65	5	2.56	4.15	3.39	2.07	12
3	Science Lab	City College	ML3	0.25	3	4.00	6.73	12.28	2.03	6
4	City College	Dhanmondi-6	ML4	0.4	2	1.67	5.23	4.90	1.40	6
5	Dhanmondi-6	Kalabagan	ML5	0.45	2	1.48	4.93	5.13	1.93	6
6	Kalabagan	Sukrabad	ML6	0.45	2	1.48	4.93	3.42	3.00	6
7	Sukrabad	Dhanmondi-27	ML7	0.65	2	1.03	4.15	4.52	1.55	3
8	Dhanmondi-27	Manikmiah	ML8	0.2	1	1.67	7.65	7.14	1.80	2
9	Manikmiah	Asad Gate	ML9	0.25	1	1.33	6.73	8.77	2.00	4
10	Asad Gate	Chienese	ML10	0.5	0	-	4.69	-	1.00	1
11	Chinese	Sishu Mela	ML11	0.95	15	5.26	3.52	7.49	2.14	45
12	Sishu Mela	Shamoly	ML12	0.27	4	4.94	6.45	6.35	2.70	11
13	Shamoly	Technical	ML13	1.7	27	5.29	2.83	5.69	2.70	78
				7.32	65					

Here,

Method 1:

For the calculation of Critical rate,

Total number of midblock accidents during 05-07= 1795

Total length of road network = 1281 KM

So, A= average casualty accidents per Km per year are= 1.17

For 95% confidence level, critical rate is calculated.

Critical Rate = A + k (A/M)^.5 +1/(2M)

A= Average Casualty accident rate per exposure; here exposure is length of the midblock.

Then for 95% confidence level, K= 1.645

Therefore, it is seen that the list of the midblock sections of Mirpur Road are Chinese-Shishumela, Shishumela-Shamoly and Shamoly-Technical.

Method 2:

Average crash frequency per KM per midblock = 0.83

Standard Deviation of all the accident is = 2.29

So, Critical crash frequency= 3.12

Therefore, it is seen that Newmarket-Science Lab, Science Lab-City College, City College-Dhanmondi-6, Manikmiah-Asad Gate, Chinese-Sishu Mela, Sishu Mela-Shamoly, Shamoly-Technical are in unacceptable condition.

From the following table, severity index and EPDO index can be found.

Method 3: By considering the weight coefficients of 3, 1.8, 1.3 & 1.0 for fatal, Grievous, Simple & collision respectively, highest severity index for this route is Azimpur – New market, kalabagan-Sukrabad.

Method 4: By calculating the EPDO Index highest index is found for Shamoly-Technical.

So, the final ranked midblock of Mirpur road is: Shamoly-Technical. The reason is this is found by three methods during 2005-2007 in case of midblock analysis.

4.3.4 Ranking at Midblock at Airport Road

After collection all the data of year 2005-2007, critical crash frequency and critical number were calculated for this route. From the following table, critical crash frequency was found.

Table 4.8 Accidents at Airport road-midblock section (House Building-Mohakhali)

Sl No.	Intersection 1	Intersection 2	Link	Length , KM	Cas. Accs	Cas. Accidents / Km / yr	CR	F	SI	EPDO Index
1	House Building	Jasim Uddin	RL1	1.35	12	3	3.07	3.46	2.34	33
2	Jasim Uddin	Airport	RL2	0.75	14	6	3.89	7.56	2.51	43
3	Airport	Kuril Bishwa Road	RL3	3.625	67	6	2.24	6.44	2.70	189
4	Kuri Bishwa Road	Kakoli	RL4	3.75	41	4	2.22	4.53	2.28	116
5	Kakoli	Banani-11	RL5	0.3	2	2	6.09	2.22	3.00	6
6	Banani-11	Banani-1	RL6	0.3	7	8	6.09	7.78	3.00	21
7	Banani-1	Mohakhali-Amtoli	RL7	0.7	9	4	4.01	4.76	2.56	26
8	Mohakhali-Amtoli	Mohakhali-BCPS	RL8	0.3	5	6	6.09	6.67	1.78	11
				11.075	157					

Method 1:

For the calculation of Critical rate,

So, A= average casualty accidents per Km per year are= 1.17

For 95% confidence level, critical rate is calculated.

Critical Rate = A + k • (A/M) +1/(2M)

A= Average Casualty accident rate per exposure; here exposure is length of the midblock.

Then for 95% confidence level, K= 1.645

Therefore, it is seen that the list of the midblock sections of Airport Road are Jashimuddin-Airport, Airport-Kuril Bishwa Road, Kuril Bishwa Road-Kakoli and Banani1-Banani11.

Method 2:

Average crash frequency= 2

Standard Deviation of all the accident is=2

So, Critical crash frequency= 4

Therefore, it is seen that Jashimuddin-Airport, Airport-Kuril Bishwa Road, Kuril Bishwa Road-Kakoli, Banani1-Banani11, and Banani-1-Mohakhali are not in tolerable limit of critical value.

Method 3: By considering the weight coefficients of 3, 1.8, 1.3 & 1.0 for fatal, Grievous, Simple & collision respectively, highest severity index for midblocks of Airport road is Kakoli-Banani11 and Banani11-Banani1.

Method 4: By calculating the EPDO Index highest index is found for Airport-Kuril Bishwa Road.

So, the final dangerous midblock of Airport road are Banai11-Banai1 which is identified by three out of four processes from above.

4.4 Comparison of the findings from two time series data:

The result obtained from the methods of intersection and midblock in 2005-2007 for is placed by following matrix:

Intersections		
Process	Airport Road	Mirpur Road
Critical Number	Jashimuddin **Airport** Kuril Bishwa Road Kakoli Banani-11	Sukrabad Asad Gate Chinese Shishumela **Shamoly** Technical
Crash Frequency	Jashimuddin **Airport** Kuril Bishwa Road	Shishumela **Shamoly**
Crash Severity	**Airport**	City College Dhanmondi6.
EPDO	**Airport** Kuril Bishwa Road.	**Shamoly**
Midblock		
Critical Rate	Jashimuddin-Airport Airport-Kuril Bishwa Road Kuril Bishwa Road-Kakoli and **Banani1-Banani11**	Chinese- Shishumela Shishumela-Shamoly **Shamoly-Technical**
Crash Frequency	Jashimuddin-Airport Kuril Bishwa Road-Kakoli **Banani1-Banani11** Banani-1-Mohakhali	New market-Science Lab Science Lab-City College City College-Dhanmondi-6 Manikmiah-Asad Gate Chinese- Shishumela Sishu Mela-Shamoly **Shamoly-Technical**
Crash Severity	Kakoli-Banani11 **Banani11-Banani1**	Azimpur – New market Kalabagan-Sukrabad
EPDO	Airport-Kuril Bishwa Road.	**Shamoly-Technical**

In case Mirpur road during 2002-2004, also at Shamoly many accidents happened. So this intersection is in a critical from very early also. In case of midblock of that road also the finding of the 2005-2007 is very much common with the previous time frame. On the other hand for Airport Road it is seen that in 2002-2004 time, Airport is in critical position. Banani1 to Banani11 mid block is the only section where manly 2005-2007 many more accidents happened.

So the finally selected intersection and midblock as black spot analyzed during 2005-2007 is:

Intersection	**Mirpur Road**	**Shamoly**
	Airport Road	**Airport**
Midblock	**Mirpur Road**	**Shamoly to Technical**
	Airport Road	**Banani 1 to Banani 11**

CHAPTER 5

DETAIL STUDY OF HAZARDOUS ROAD LOCATIONS

5.1 General

At this chapter mainly the findings from Maap5 software related with the accident factors are found for 10 years data. Some detail analysis is done and later on the experience from the field visits of these particular intersections and midblock are described.

5.2 Detailed Analysis of the Shamoly Intersection in Mirpur road

Shamoly intersection is a three legged intersection. One of its approaches is coming from Asad gate, another goes toward Technical and the third one proceeds toward the ring road.

Figure 5-1 Shamoly Intersection by Google Map

5.2.1 Present Condition of Shamoly Intersection

From the data of 1998 to 2007, it is observed that Total 19 accidents happened and out of these 47% are fatal and 32% are Grievous type. As it is a major arterial of Dhaka city, the speeds of the vehicles are very high and for this reason maximum of the accident types are fatal and grievous. Out of all the casualties, 82% are male and 18% are female. From the yearly distribution also it is observed that last few years the intensity of the accidents are very high in comparison with the previous years.

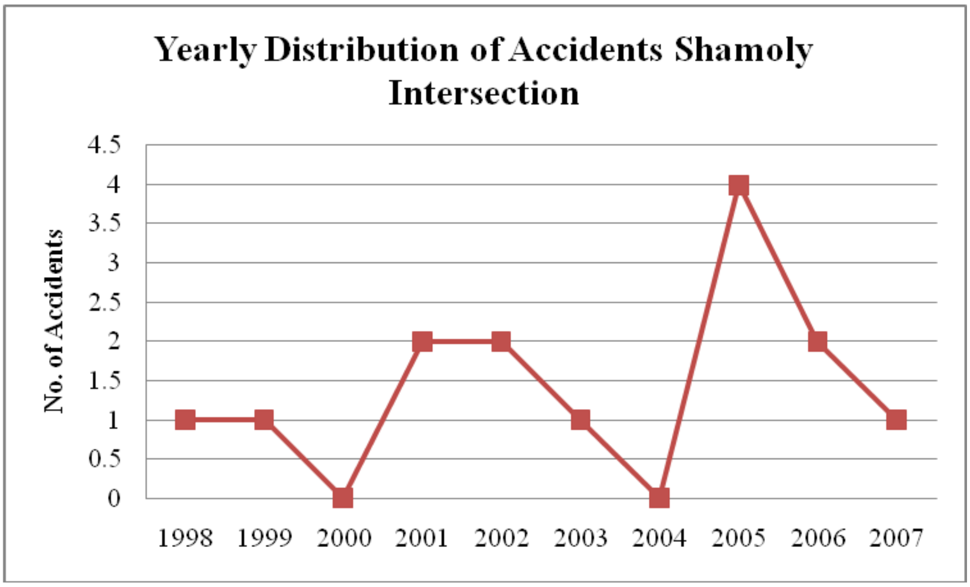


Figure 5-2 Yearly Distribution of Accidents at Samoly intersection (1998-2007)

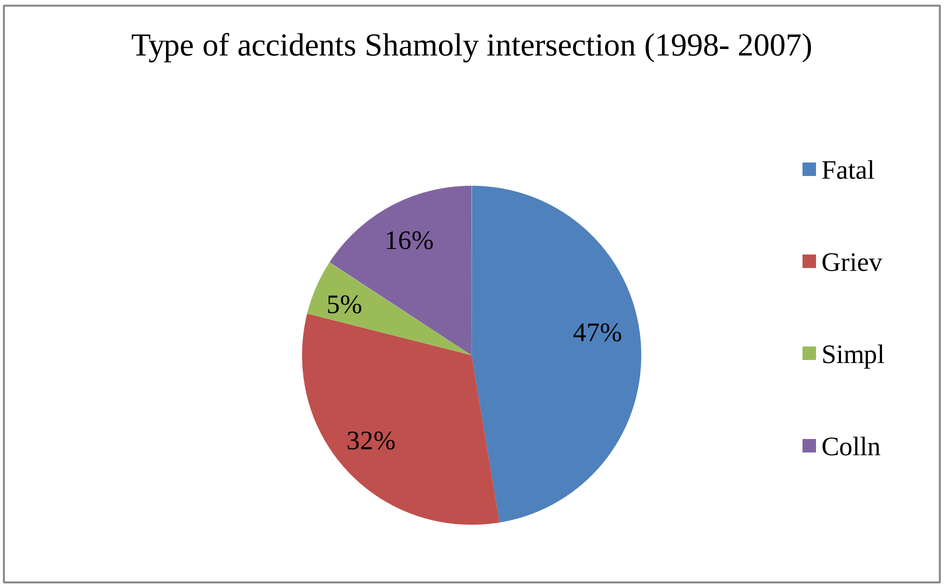


Figure 5-3 Different types of accidents at Shamoly intersection (1998-2007)

5.2.2 Casualty class of Shamoly Intersection

If the casualty classes are analyzed, it can be seen that 44% are pedestrian and the second highest share holder is baby taxi (now called CNG). Like all the spots of Dhaka city, pedestrian is in more vulnerable situation comparing to other involved classes.

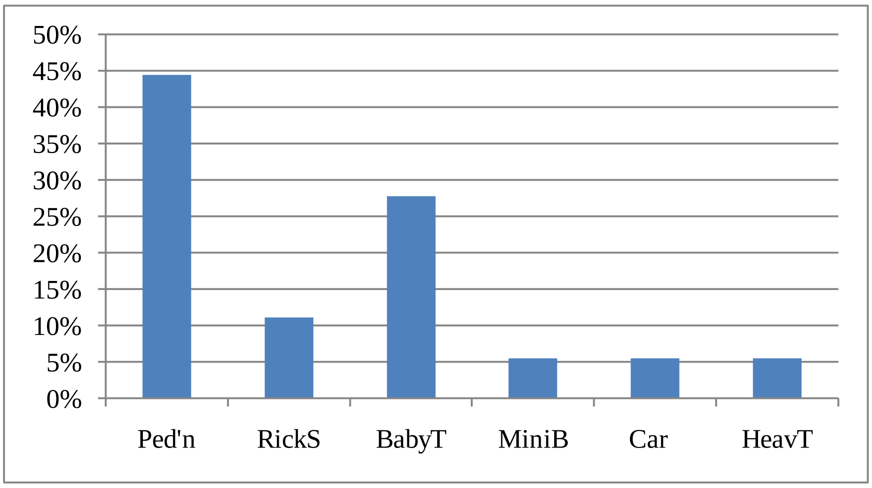


Figure 5-4 Casualty Class of accidents at Shamoly intersection (1998-2007)

5.2.3 Age category of casualties Shamoly Intersection:

If all the age category of the casualties is analyzed most of them are in age range 36-40. 16-20 years range also facing a fair percentage of accidents (25%).

Table 5.1 Different age classes at Shamoly intersection (1998-2007)

	Fatal	Grievous	Simple	Total	%
0-5	0	0	0	0	0%
6-10	0	0	0	0	0%
11-15	0	0	0	0	0%
16-20	3	0	0	3	25%
21-25	0	0	0	0	0%
26-30	0	1	1	2	17%
31-35	1	1	0	2	17%
36-40	4	0	0	4	33%
41-45	0	0	0	0	0%
46-50	0	0	0	0	0%
51-55	0	0	0	0	0%
56-60	1	0	0	1	8%
61-65	0	0	0	0	0%
66-70	0	0	0	0	0%
71-75	0	0	0	0	0%
>75	0	0	0	0	0%
Total	9	2	1	12	100%

5.2.4 Collision type by year of Shamoly Intersection:

At Shamoly intersection in case of collision type of accidents it is observed that 42% are due to pedestrian and 32% are rear end collisions. Second one indicates the drivers are in a hurry at the intersection so the accident percentage is so high.

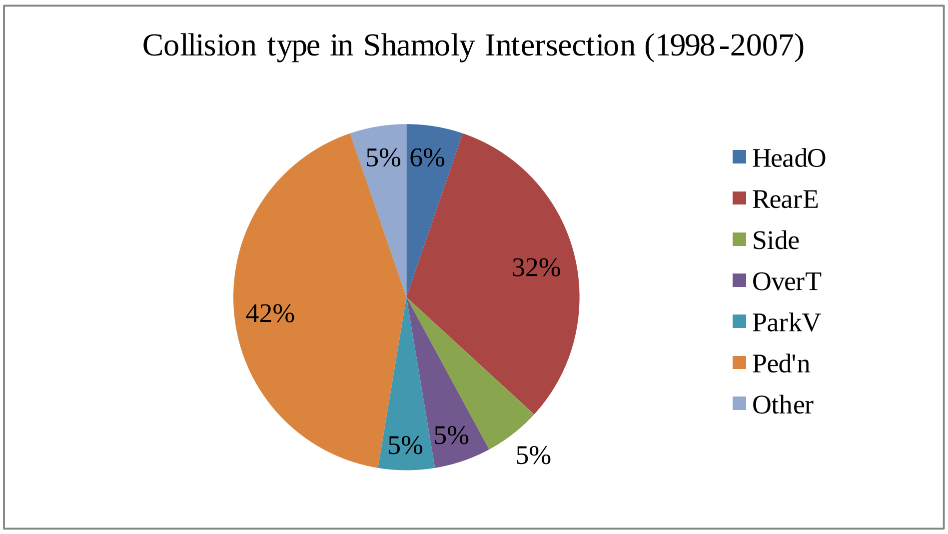


Figure 5-5 Different types of Collision at Shamoly Intersection (1998-2007)

5.2.5 Day of week by Year of Shamoly Intersection

At Shamoly most of the accidents are held at Monday and Saturday. Monday is a weekday so the intensity of vehicles is heavy but at Saturday also the intensity of accidents is huge. The reason could be that at this road many markets and commercial places are located.

Table 5.2 Day wise Classification at Shamoly intersection (1998-2007)

	Fatal	Grievous	Simple	Collusion	Total	
Mon	1	2	1	1	5	26%
Tue	1	1	0	0	2	11%
Wed	1	1	0	0	2	11%
Thu	1	0	0	0	1	5%
Fri	0	2	0	1	3	16%
Sat	4	0	0	1	5	26%
Sun	1	0	0	0	1	5%
Total	9	6	1	3	19	100%

5.2.6 Lighting condition Vs year of Shamoly Intersection

From the following table it is clearly visible that most of the accidents are held during good lighted condition. So it is obvious that lack of lighting is not responsible for fair number of cases.

Table 5.3 Lighting condition during accidents at Shamoly intersection (1998-2007)

	Fatal	Grievous	Simple	Collusion	Total	
Day	4	3	1	2	10	53%
Day-dawn	0	1	0	0	1	5%
Night-Lighted	5	2	0	1	8	42%
Night-Unlight	0	0	0	0	0	0%
Total	9	6	1	3	19	100%

5.2.7 Weather conditions vs. Year of Shamoly Intersection

It can be understood from the following table that in case of Shamoly intersection most of the accidents were held during fair weather.

Table 5.4 Weather condition during accidents at Shamoly intersection (1998-2007)

	Fatal	Grievous	Simple	Collusion	Total	
Fair	9	6	1	2	18	95%
Rain	0	0	0	0	0	0%
Wind	0	0	0	1	1	5%
Fog	0	0	0	0	0	0%
Total	9	6	1	3	19	100%

5.2.8 Involvement of Different Types of Vehicles at Shamoly Intersection:

At this intersection in case of vehicles' involvement it is found that Heavy truck, Bus and minibus are the main share holders. In fact through this route many buses and minibuses passed. So the drivers may not be so cautious for accident prevention.

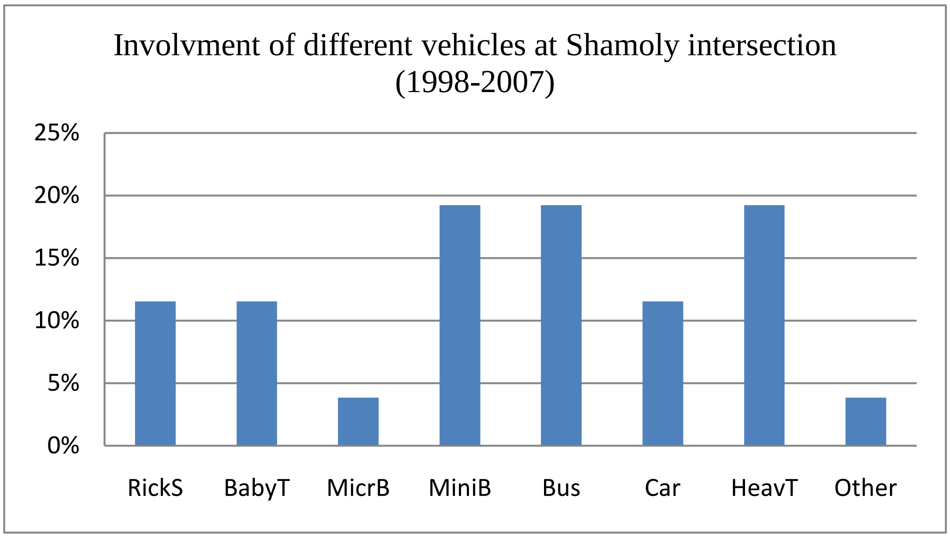


Figure 5-6 Involvement of Different Types of Vehicles at Shamoly Intersection (1998-2007)

5.3 Detailed analysis of the Airport Intersection in Airport road

Airport intersection is located at the airport road. This is a four legged intersection and there is a roundabout at the center. One of its approaches goes toward the international airport, the other one is toward the Hazi camp of Dhaka. From Bishwa road intersection one approach met with it where else another went towards Jashimudddin intersection of Uttara.

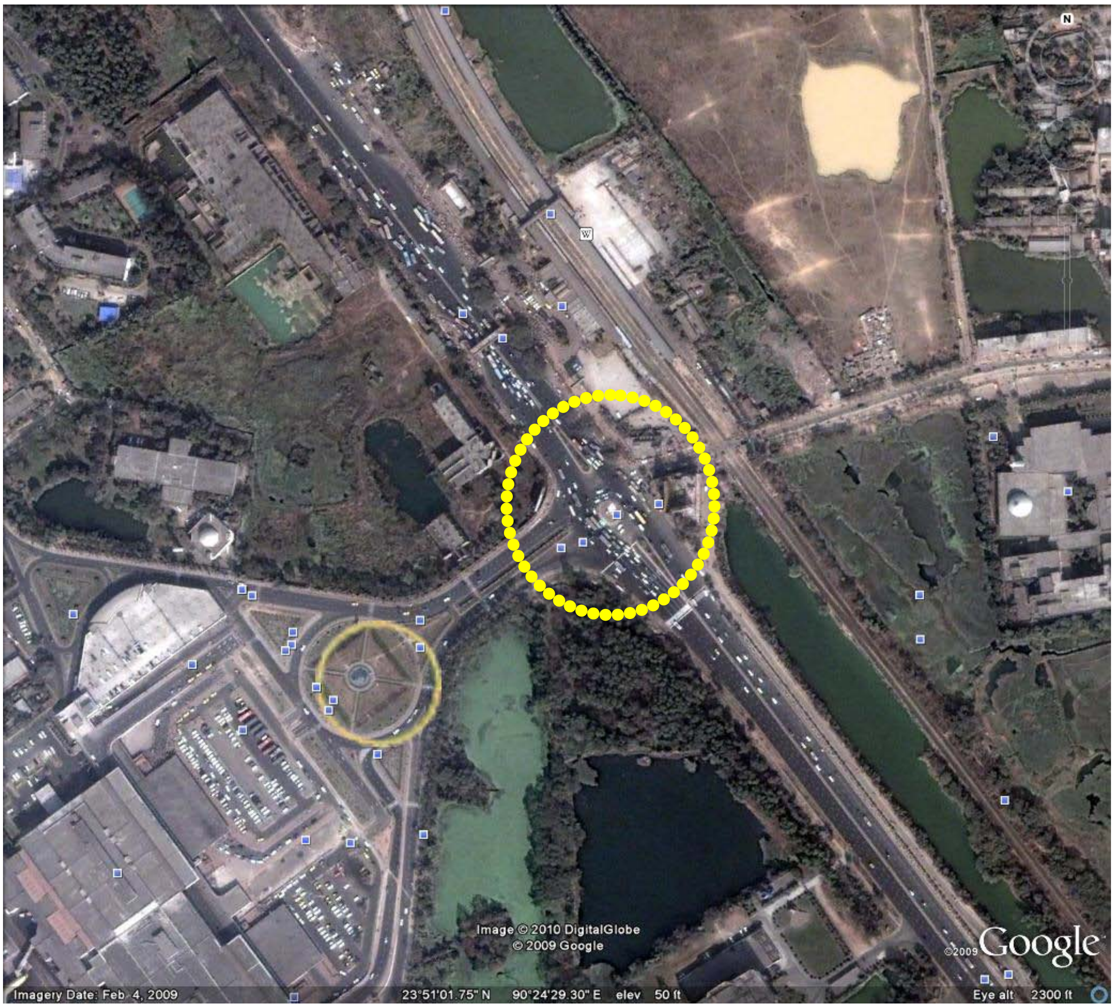


Figure 5-7 Airport Intersection by Google Map

5.3.1 Present condition of Airport Intersection

From the data of 1998 to 2007 it is observed that Total 31 accidents happened and out of these, 47% are fatal and 44% are Grievous type. This intersection is the part of a national highway. So the speeds of the vehicles are very high and for this reason maximum of the accident types are fatal and grievous. Out of all the casualties 91% are male and only 9% are female. Yearly distribution of the 10 years accidents are shown below:

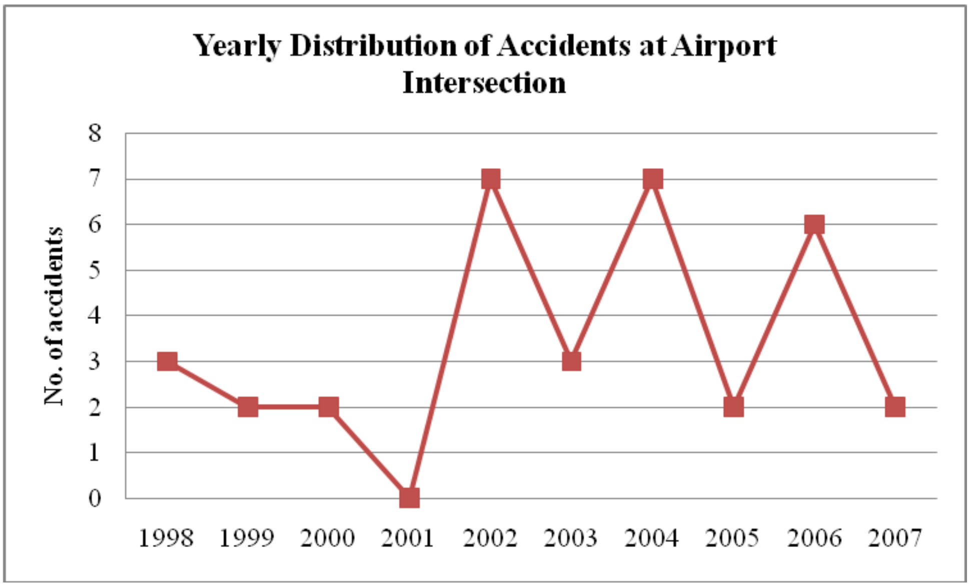


Figure 5-8 Yearly Distribution of Accidents at airport intersection (1998-2007)

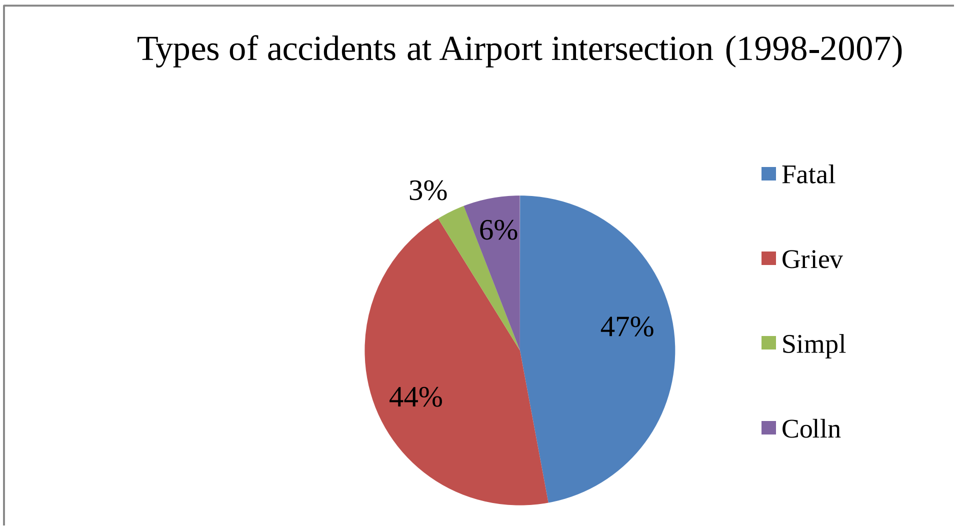


Figure 5-9 Different types of accidents at airport intersection (1998-2007)

5.3.2 Casualty class of Airport Intersection

If the casualty classes are analyzed it is seen that 42% are pedestrian and the second highest share holder is minibus. So the pedestrian is very much vulnerable in consideration of involved class.

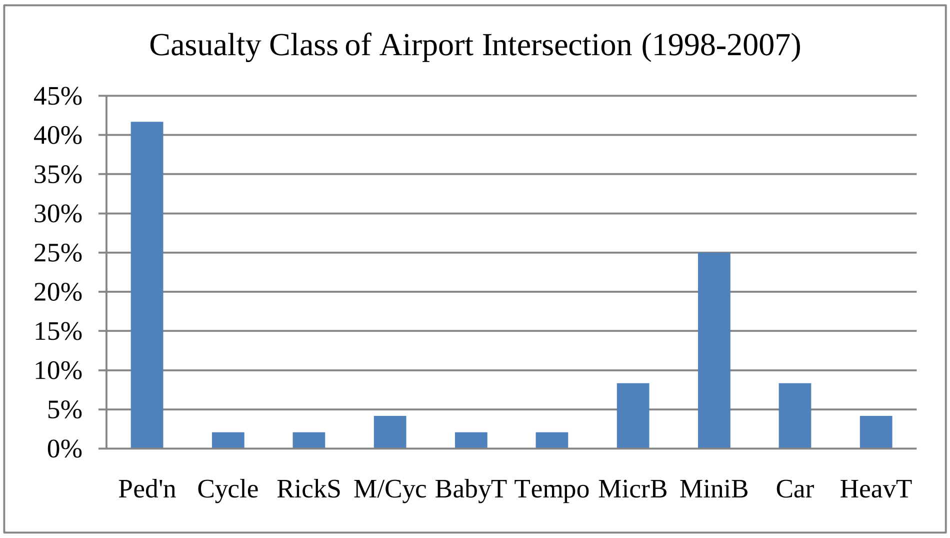


Figure 5-10 Casualty Class of accidents at airport intersection (1998-2007)

5.3.3 Age category of casualties Airport Intersection

If all the age category of the casualties is analyzed most of them are in age range 36-40.

Table 5.5 Different age classes at airport intersection (1998-2007)

	Fatal	Grievous	Simple	Total	
0-5	2	1	0	3	9%
6-10	1	0	0	1	3%
11-15	2	1	0	3	9%
16-20	0	0	0	0	0%
21-25	3	0	0	3	9%
26-30	2	3	0	5	15%
31-35	1	1	1	3	9%
36-40	4	4	0	8	24%
41-45	1	2	0	3	9%
46-50	1	0	0	1	3%
51-55	0	0	0	0	0%
56-60	1	1	0	2	6%
61-65	0	0	0	0	0%
66-70	1	0	0	1	3%
71-75	0	0	0	0	0%
>75	0	0	0	0	0%
Total	19	13	1	33	100%

5.3.4 Collision type by year of Airport Intersection

Among all the collision type in Airport Intersection pedestrian involved for massive 56% of them. The next type is rear end accidents (20%). As the road is divided, very little percentage is head on type is caused.

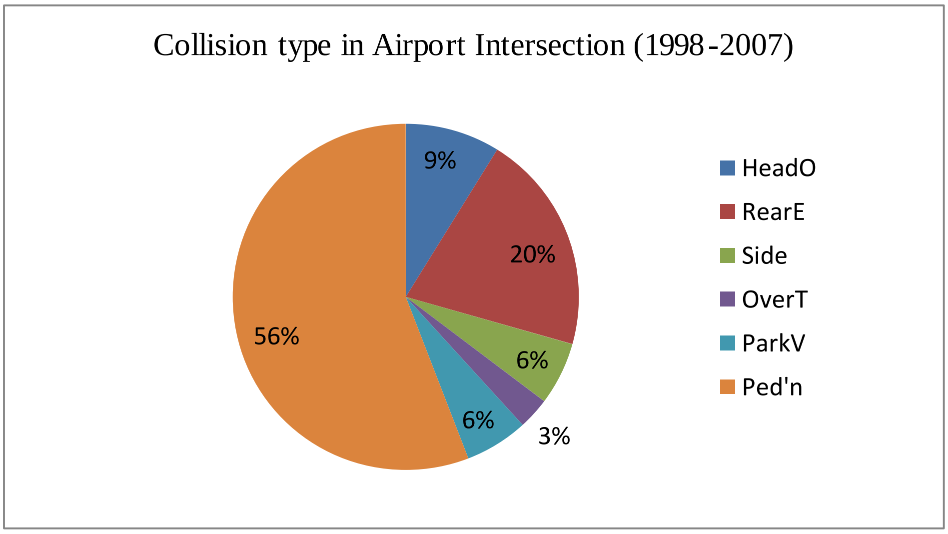


Figure 5-11 Different types of Collision at Airport Intersection (1998-2007)

5.3.5 Day of week by Year of Airport Intersection

All the accidents at this intersection are happened in quite regular interval. No particular day of the week contain very high or very low number of accidents. As this road is a part of national highway every day the pressure of the vehicles are almost same.

Table 5.6 Day wise Classification at Airport Intersection (1998-2007)

	Fatal	Grievous	Simple	Collision	Total	
Mon	2	2	0	0	4	12%
Tue	3	3	0	0	6	18%
Wed	2	0	0	0	2	6%
Thu	2	4	0	0	6	18%
Fri	3	3	1	0	7	21%
Sat	1	1	0	1	3	9%
Sun	3	2	0	1	6	18%
Total	16	15	1	2	34	100%

5.3.6 Weather conditions Vs year of Airport Intersection

During 1998-2007 all the accidents happened at this intersection were happened at fair weather. As the weather is fair in case of reasons of the accidents is not weather.

Table 5.7 Weather Condition during accidents at airport intersection (1998-2007)

	Fatal	Grievous	Simple	Collision	Total	
Fair	16	15	1	2	34	100%
Rain	0	0	0	0	0	0%
Wind	0	0	0	0	0	0%
Fog	0	0	0	0	0	0%
Total	16	15	1	2	34	100%

5.3.7 Lighting condition vs. Year of Airport Intersection

Here 65% accident has occurred in good lighted condition where 29% held at night time but light was sufficient.

Table 5.8 Lighting Condition during Accidents at Airport Intersection (1998-2007)

	Fatal	Grievous	Simple	Collision	Total	
Day	10	10	1	1	22	65%
Day-dawn	1	0	0	1	2	6%
Night-Lighted	5	5	0	0	10	29%
Night-Unlight	0	0	0	0	0	0%
Total	16	15	1	2	34	100%

5.3.8 Involvement of Different Types of Vehicles at Airport Intersection:

At this intersection for all the accidents in 1998to 2007 are mainly caused by the buses (29%) and minibuses (27%). As this is a part of national highway this is predicted, as the vehicles passes here at a very high speed.

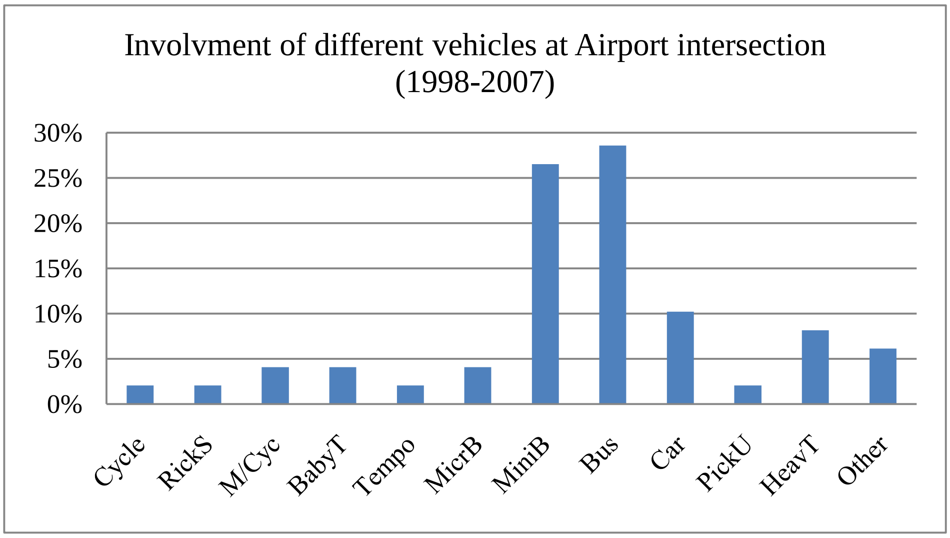


Figure 5-12 Involvement of Different Types of Vehicles at Airport Intersection (1998-2007)

5.4 Detailed analysis of the Shamoly -Technical in Mirpur road

In case of Mirpur road Shamoly to Technical Linked road is considered to be the most vulnerable during 2005-2007. In fact it is the longest link of this road. It is divided road but at many places the divider is cut down for u turn facilities of the vehicles.

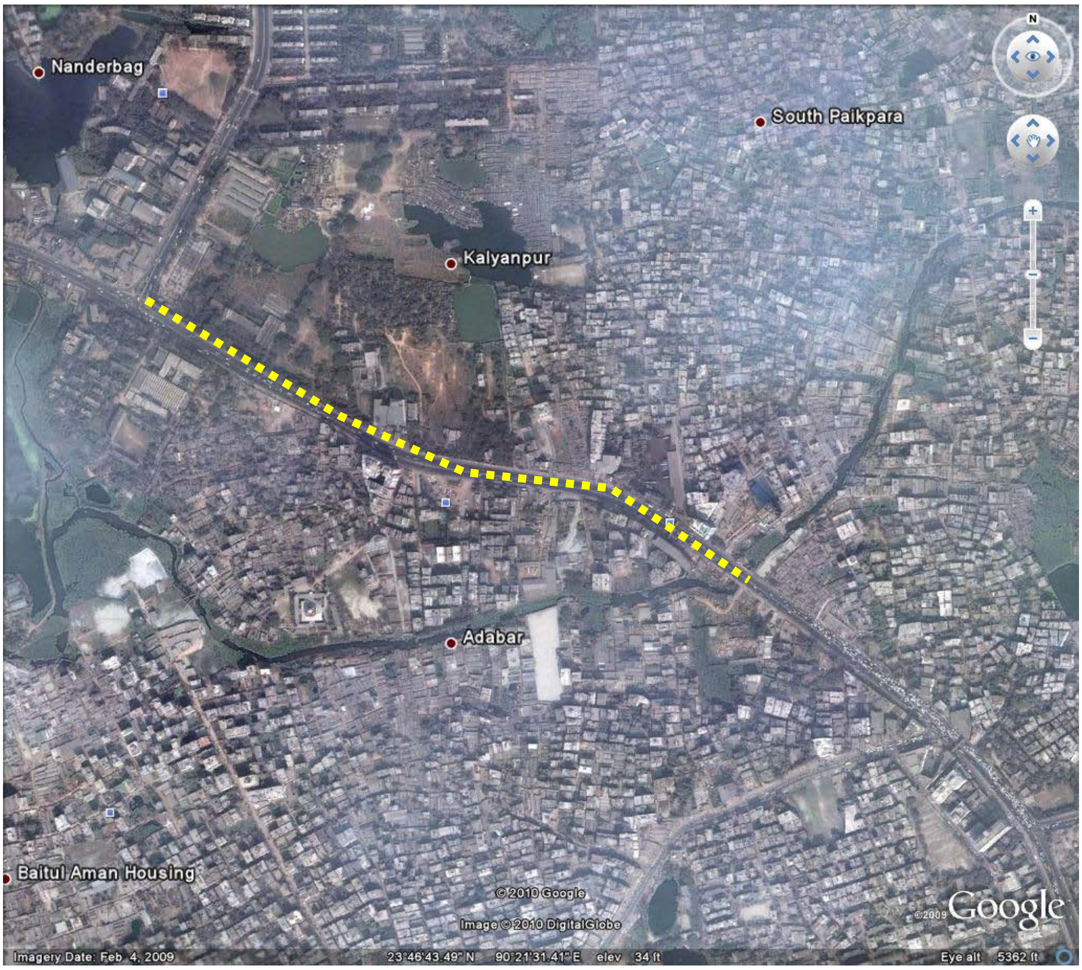


Figure 5-13 Shamoly to Technical Road section at Google map

5.4.1 Present condition of Shamoly to Technical

At this time period (1998-2007), most (55%) of the accidents happened at this linked road are fatal. There is also a huge percentage (27%) of accidents held which are considered as Grievous. So this linked road is really a horrible one.

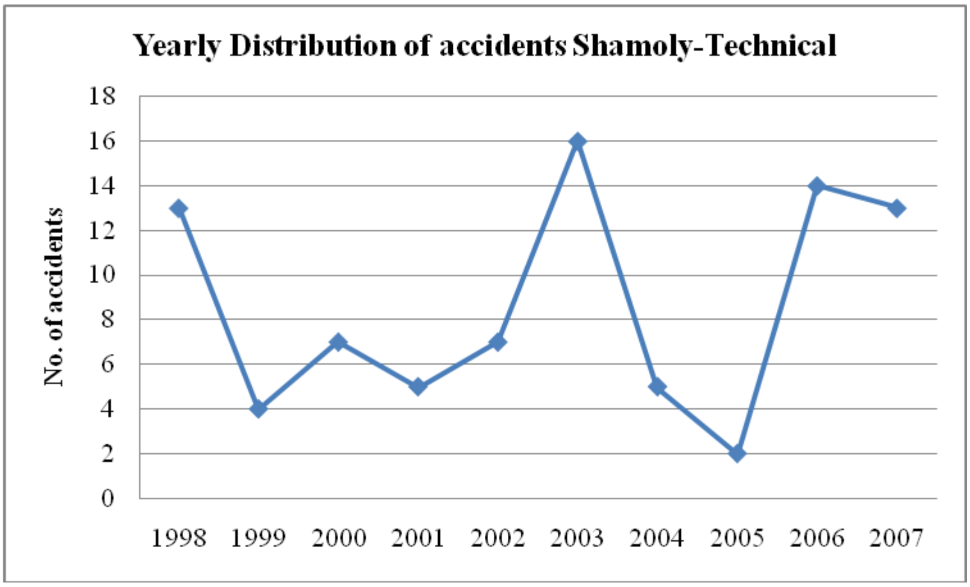


Figure 5-14 Yearly Distribution of accidents Shamoly-Technical (1998-2007)

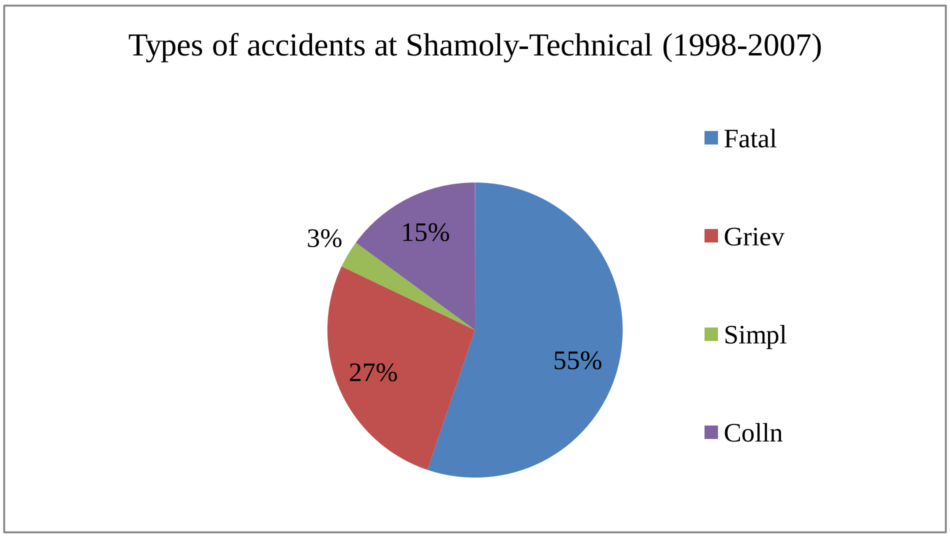


Figure 5-15 Different types of accidents at Shamoly- Technical road section (1998-2007)

5.4.2 Casualty class of Shamoly- Technical

For this link, pedestrian are the main class who are the victim of the accidents. It can be seen from the following Figure that in case of 61%of the accidents pedestrians are the victims.

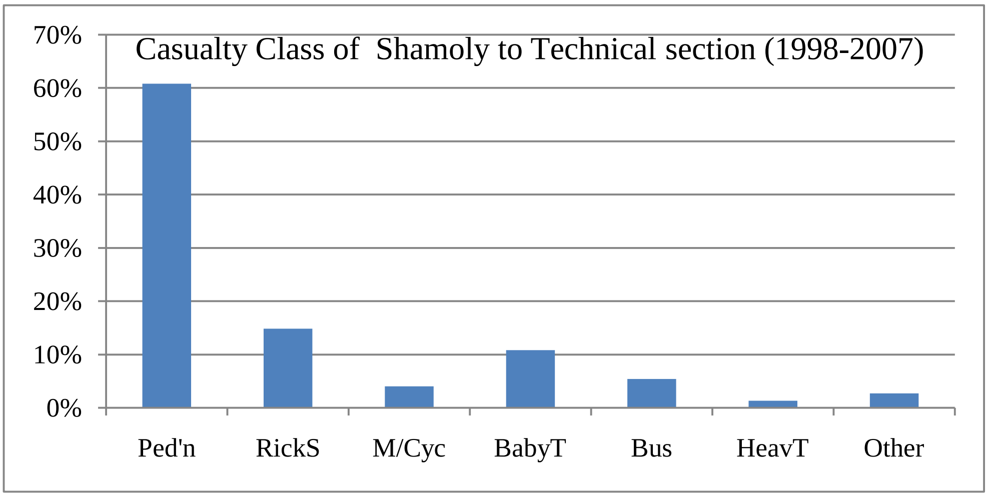


Figure 5-16 Casualty Class of accidents at Shamoly-Technical road section (1998-2007)

5.4.3 Age category of casualties of Shamoly- Technical

If the age category is analyzed 21-30 years of the people are the main victims of road traffic accidents at this linked road. So for this age category special care is needed for this section.

Table 5.9 Different age classes at Shamoly-Technical road section (1998-2007)

	Fatal	Grievous	Simple	Total	
0-5	1	0	0	1	1%
6-10	0	0	0	0	0%
11-15	0	0	0	0	0%
16-20	2	2	0	4	6%
21-25	10	5	0	15	22%
26-30	11	7	1	19	28%
31-35	3	5	0	8	12%
36-40	6	1	1	8	12%
41-45	5	1	0	6	9%
46-50	3	0	0	3	4%
51-55	1	0	0	1	1%
56-60	0	1	0	1	1%
61-65	0	1	0	1	1%
66-70	2	0	0	2	3%
71-75	0	0	0	0	0%
>75	0	0	0	0	0%
Total	44	23	2	69	100%

5.4.4 Collision type by year of Shamoly- Technical:

If the collision type chart is analyzed it is clear that most (58%) of them are with pedestrian. As like other linked road and intersection of Dhaka city here also special care is much more needed for this vulnerable road user.

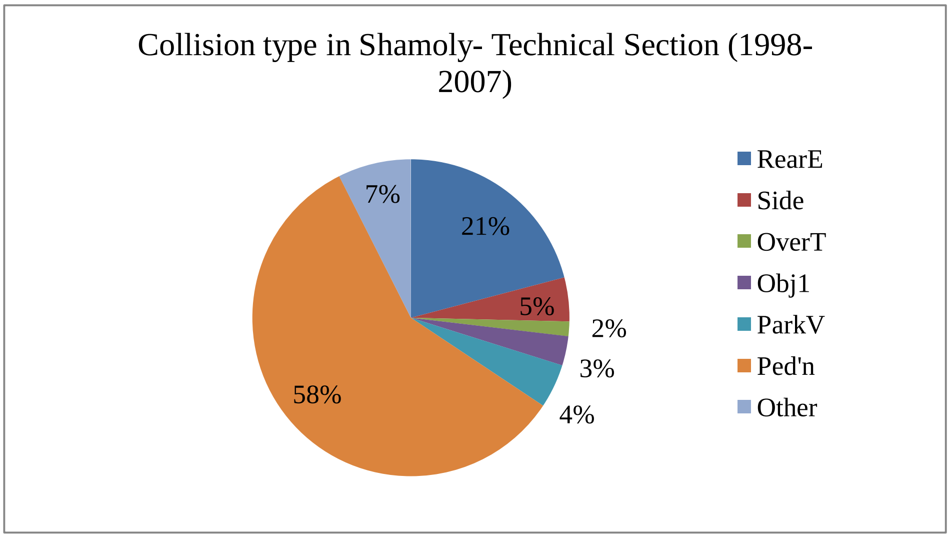


Figure 5-17 Different types of Collision at Shamoly to Technical Section (1998-2007)

5.4.5 Day of week by Year of Shamoly- Technical

For this linked road there is no particular day of attack. Except Saturday, every day some accidents held during 1998-2007. This shows that no particular day is very much commanding in case accident occurrence.

Table 5.10 Day wise Classification at Shamoly- Technical Road Section (1998-2007)

	Fatal	Grievous	Simple	Collusion	Total	
Mon	9	2	0	0	11	16%
Tue	3	4	0	1	8	12%
Wed	6	1	1	2	10	15%
Thu	2	3	0	2	7	10%
Fri	6	2	1	2	11	16%
Sat	3	1	0	2	6	9%
Sun	8	5	0	1	14	21%
Total	37	18	2	10	67	100%

5.4.6 Lighting conditions Vs year of Shamoly- Technical:

Most of the accidents held at this linked road are in good lighting condition irrespective of day or night. This is not a good message as it clearly shows that lighting condition was good which means there were some other factors in most of the cases which were responsible for the accident.

Table 5.11 Lighting condition at Shamoly- Technical road section (1998-2007

	Fatal	Grievous	Simple	Collusion	Total	
Day	18	12	1	8	39	58%
Day-dawn	5	2	0	1	8	12%
Night-Lighted	13	4	1	1	19	28%
Night-Unlighted	1	0	0	0	1	1%
Total	37	18	2	10	67	100%

5.4.7 Weather condition vs. Year of Shamoly- Technical:

At this linked road, 100% of the accidents are held during fair weather. Here is also some other factors in most of the cases which were responsible for the accident.

Table 5.12 Weather Condition at Shamoly- Technical road section (1998-2007

	Fatal	Grievous	Simple	Collusion	Total	
Fair	37	18	2	10	67	100%
Rain	0	0	0	0	0	0%
Wind	0	0	0	0	0	0%
Fog	0	0	0	0	0	0%
Total	37	18	2	10	67	100%

5.4.8 Involvement of Different Types of Vehicles at Shamoly- Technical:

In case of vehicle involvement at this linked road from the following table it is clearly visible that trucks and buses are the main culprit.

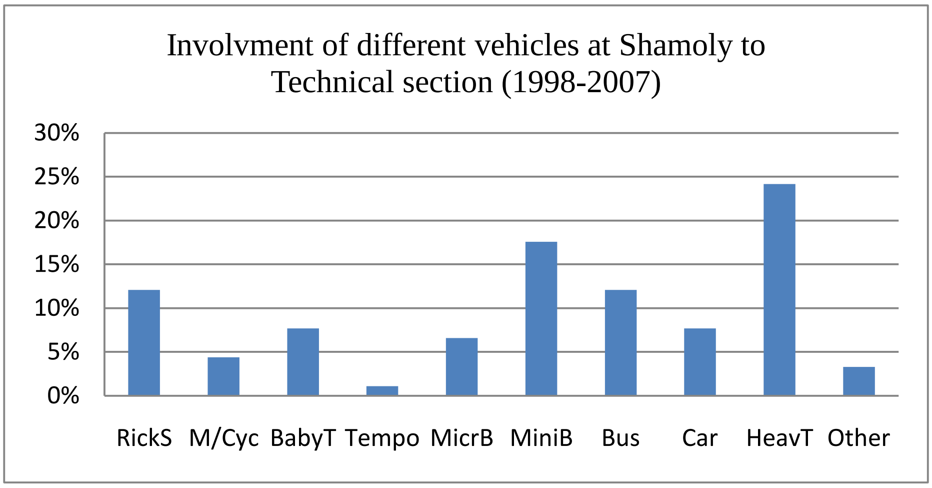


Figure 5-18 Involvement of Different Types of Vehicles at Shamoly- Technical (1998-2007)

5.5 Detailed analysis of the Banani1-Banani11 in Airport road:

Banani 1 intersection to Banani 11 intersection is this mid block. It is located at Airport Road. And as this is a part of Dhaka-Mymensingh Highway usually concentration of the vehicles are huge. It is may be not so long with respect to length but as it is considered to be most vulnerable during 2005-2007, of course there must be some reasons.

Figure 5-19 Banani 1 to Banani 11 Road section at Google map

5.5.1 Present condition of Banani1-Banani11:

As from the pie chart on the report it is clearly seen that 93% of the accidents during 1998-2007 are fatal. The main reason may be the high speed of the vehicles and another is very less provision for the pedestrians as the results later shows that pedestrians are the main class of casualty for this section.

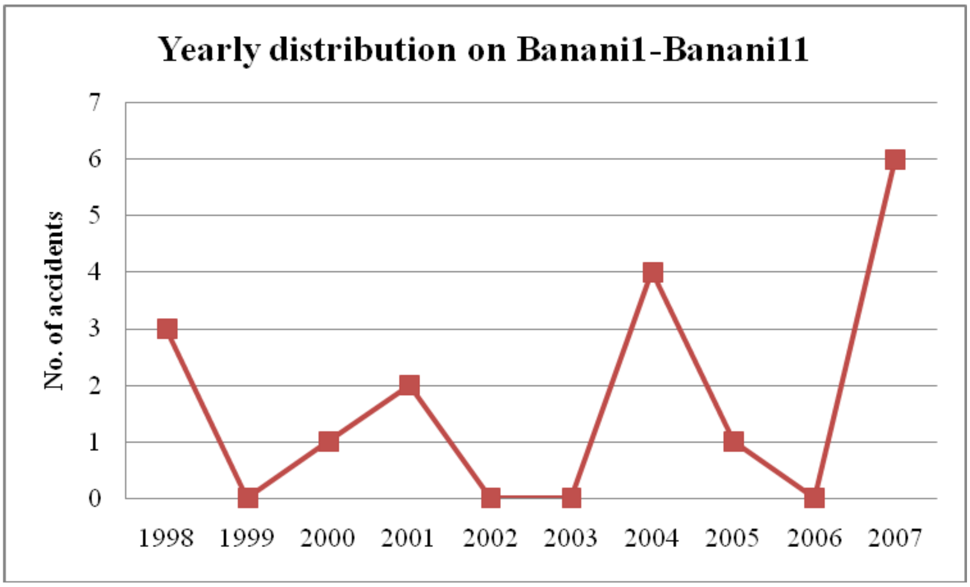


Figure5-20 Yearly distribution on Banani1-Banani11 (1998-2007)

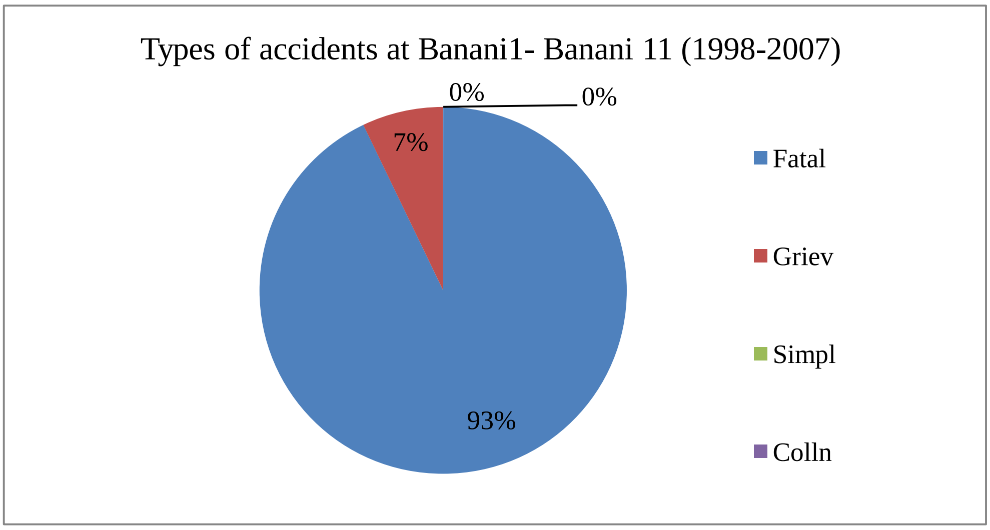


Figure 5-21 Different types of accidents at Banani 1 to Banani 11 road section (1998-2007)

5.5.2 Casualty class of Banani1-Banani11:

For this link, pedestrian are the main class who are the victim of the accidents. It can be clearly visible from the following Figure that in case of more than 80% of the accidents, pedestrians are the victims.

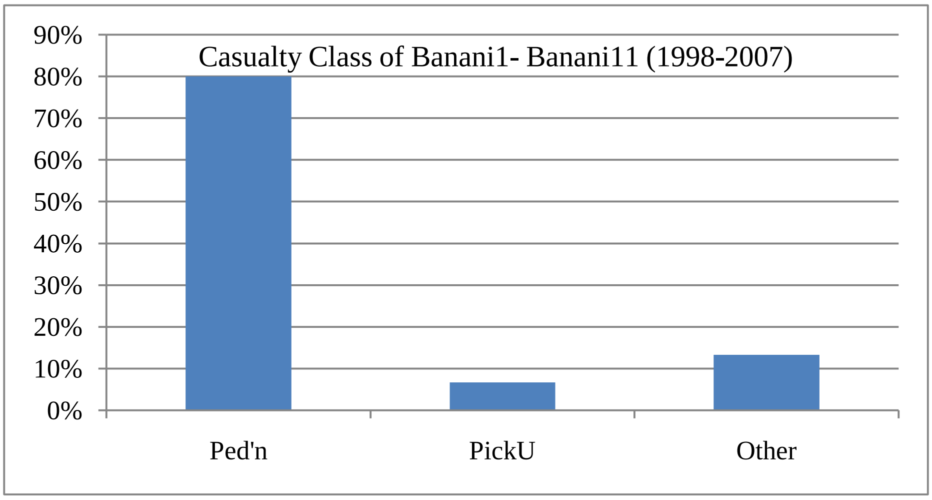


Figure 5-22 Casualty class at Banani 1 to Banani 11 road section (1998-2007)

5.5.3 Age category of casualties of Banani1-Banani11

If the age category is analyzed for this section, two age group 21-25 and 36-45 years are the main victims of road traffic accidents at this linked road. So for these age groups category special care is needed for this section.

Table 5.13 Different age classes at t Banani 1 to Banani 11 road section (1998-2007)

	Fatal	Grievous	Simple	Total	
0-5	0	0	0	0	0%
6-10	0	0	0	0	0%
11-15	0	1	0	1	8%
16-20	2	0	0	2	15%
21-25	3	0	0	3	23%
26-30	1	0	0	1	8%
31-35	0	0	0	0	0%
36-40	2	0	0	2	15%
41-45	2	0	0	2	15%
46-50	0	0	0	0	0%
51-55	1	0	0	1	8%
56-60	0	0	0	0	0%
61-65	1	0	0	1	8%
66-70	0	0	0	0	0%
71-75	0	0	0	0	0%
>75	0	0	0	0	0%
Total	12	1	0	13	100%

5.5.4 Collision type by year of Banani1-Banani11:

If the collision type chart is analyzed it is clear that tremendous percentage (86%) of them are with pedestrian. As like other linked road and intersection of Dhaka city here also special care is much more needed for this vulnerable road user.

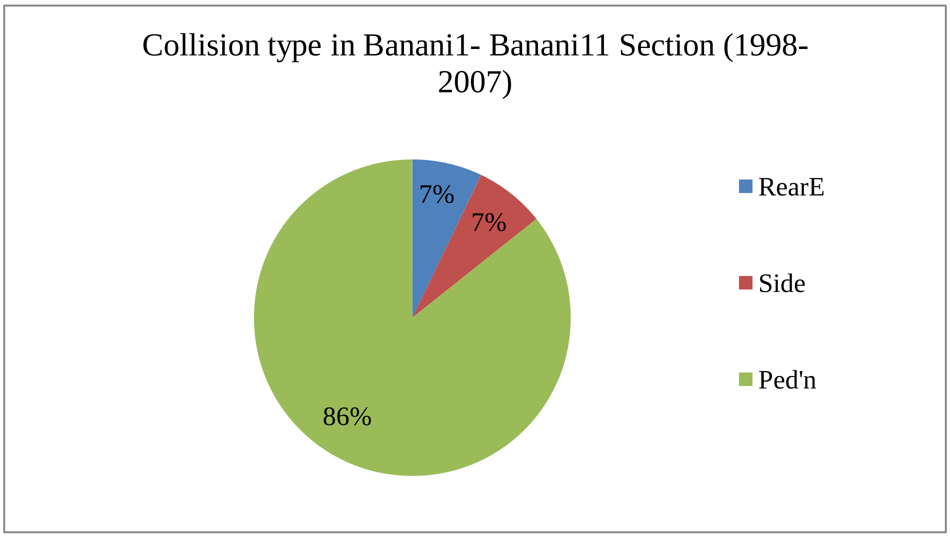


Figure 5-23 Different types of Collision at Banani1 to Banani 11 Section (1998-2007)

5.5.5 Day of week by Year of Banani1-Banani11:

At this mid block section Tuesday is the main accident prone day. In fact no specific reason can be valid for this. Special care for the traffic operation can solve the problem.

Table 5.14 Day wise Classification at Banani 1 to Banani 11 road section (1998-2007)

	Fatal	Grievous	Simple	Collusion	Total	
Mon	1	0	0	0	1	7%
Tue	4	1	0	0	5	36%
Wed	1	0	0	0	1	7%
Thu	2	0	0	0	2	14%
Fri	2	0	0	0	2	14%
Sat	2	0	0	0	2	14%
Sun	1	0	0	0	1	7%
Total	13	1	0	0	14	100%

5.5.6 Weather conditions Vs year of Banani1-Banani11:

Here only 21% of total accidents were held when the lighting condition was not so good at day time. Like other area here is also some other factors controlling the accidents.

Table5.15 Weather condition at Banani 1 to Banani 11 road section (1998-2007)

	Fatal	Grievous	Simple	Collusion	Total	
Day	9	0	0	0	9	64%
Day-dawn	2	1	0	0	3	21%
Night-Lighted	2	0	0	0	2	14%
Night-Unlight	0	0	0	0	0	0%
Total	13	1	0	0	14	100%

5.5.7 Lighting condition vs. Year of Banani1-Banani11:

At this linked road, all of the accidents are held during fair weather. Like other midblock section also some other factors were responsible for the accident.

Table 5.16 Lighting condition at Banani 1 to Banani 11 road section (1998-2007)

	Fatal	Grievous	Simple	Collusion	Total	
Fair	13	1	0	0	14	100%
Rain	0	0	0	0	0	0%
Wind	0	0	0	0	0	0%
Fog	0	0	0	0	0	0%
Total	13	1	0	0	14	100%

5.5.8 Involvement of Different Types of Vehicles at Banani 1 to Banani 11:

For this midblock section no particular vehicle in fact governing the situation. So the traffic rule s and regulation should be abide by all type of drivers can decrease the number of accident.

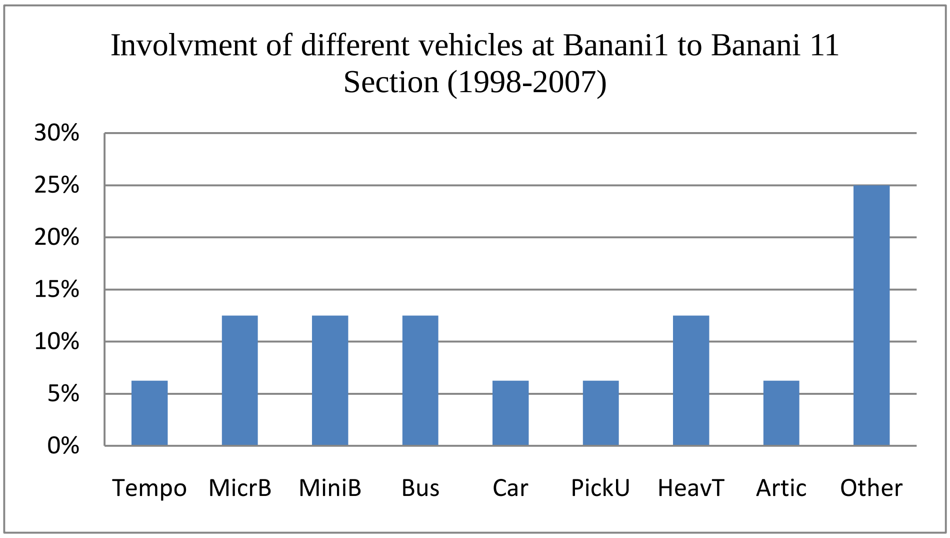


Figure 5-24 Involvement of Different Types of Vehicles at Banani 1 to Banani 11 (1998-2007)

5.6 Findings from the field survey

The findings from the field survey are summarized at this chapter one by one. For different perspective the data are collected from the field such as road condition, provision of smooth traffic operation, pedestrian facilities, passenger's facility and vehicle condition etc.

5.6.1 Field Observations at Shamoly Intersection:

Overview of the Shamoly intersection is provided below:

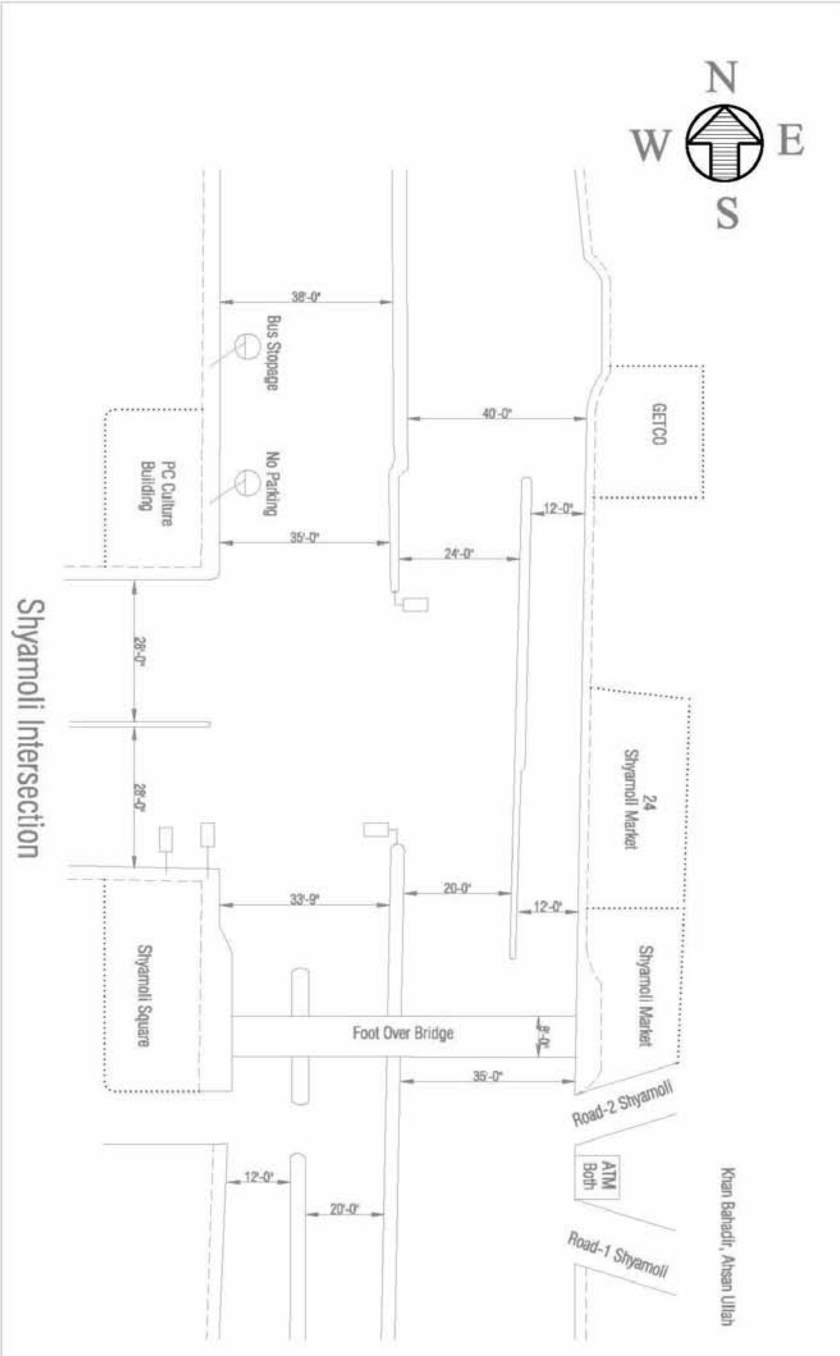


Figure 5-25 Observation of Physical Features of Shamoly Intersection

Table 5.17 Observations from the Field visit at Shamoly Intersection

Check list	Comment from field Survey
Road Condition	
Road Surface Condition	Very poor surface. At some spots there is wave of bitumen. Path holes and drainage line cover stand over the road surface.
Drainage Facilities	Poor drainage condition.
Road side Parking	No space for emergency parking
Road Markings	No road marking was visible
Road Signs	Only one road sign was present and it is also destroyed due to un careful operation of people
Road divider	Road divider is present all the three legs. But no barrier at the middle. So anybody can pass anytime.
Provision of smooth Traffic	
Traffic Controlling	At this intersection traffic is controlled by automated signal. But traffic police has to present to make these effective for the drivers.
Passing Sight distance	Passing sight distance in case of turning is good.
Stopping Sight Distance	Stopping sight distance is also good. From a long distance signals are visible and easy to understand.
Number of lanes	At the main approachesthere are 3 lanes where as the sub road has two lanes.
Lighting condition at night	Good.
Pedestrian	
Pedestrian Walking Facilities	Very poor. Shops and hawkers are occupying the space for most of the cases.
Pedestrian Crossing Facilities	Though a foot over bridge stands there pedestrians are not using that for many reasons.
Barrier for pedestrians	No barrier is provided at foot path or medians.
Passengers	
Bus bay	At one side only there is a bus bay. But many buses are not following that one.
Vehicle	
Vehicle Composition Type	Here at day time no non motorized vehicles are allowed to run. But at night rickshaws entered into this road.

So from the field visit the main reasons for the accident occurrence are as follow:

- Very poor facilities for the pedestrian movement along or crossing the road
- Signal is not well followed by the drivers, pedestrians and passengers
- Very poor condition at the road surface and turns
- Lack of road signing and marking at the intersection

5.6.2 Field Observations at Airport Intersection:

Overview of the Airport Intersection is provided below:

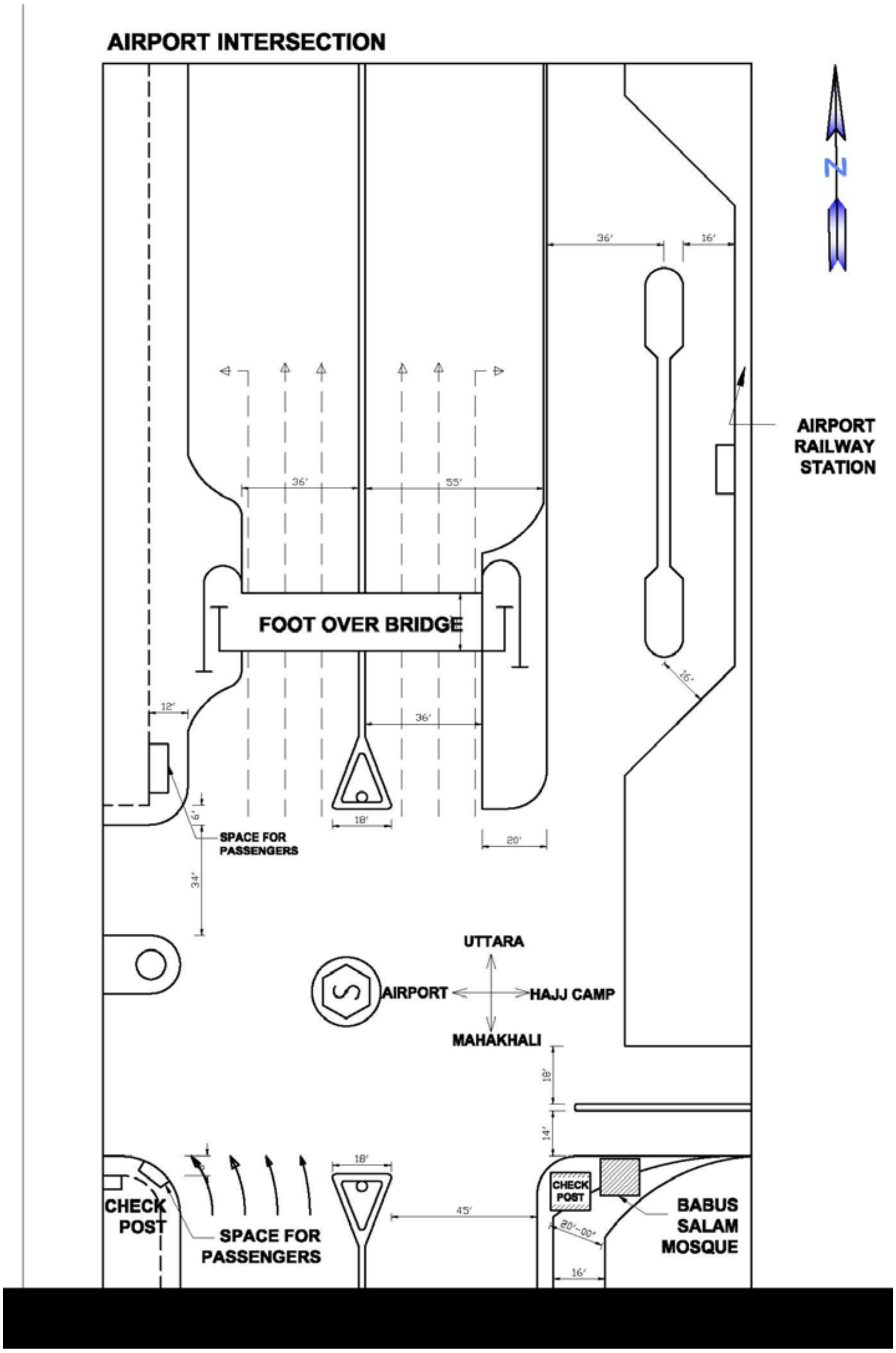


Figure 5-26 Observation of Physical Features of Airport Intersection

Table 5.18 Observations from the Field visit at Airport Intersection

Check list	Comment from field Survey
Road Condition	
Road Surface Condition	Very poor surface. At many spots there is wave of bitumen. Very interestingly the problems are concentrated at the heart of the intersections.
Drainage Facilities	Poor drainage condition.
Road side Parking	No space for emergency parking at any side
Road Markings	Road marking was visible but at many places fade out.
Road Signs	No road sign was found though there is a big roundabout at the

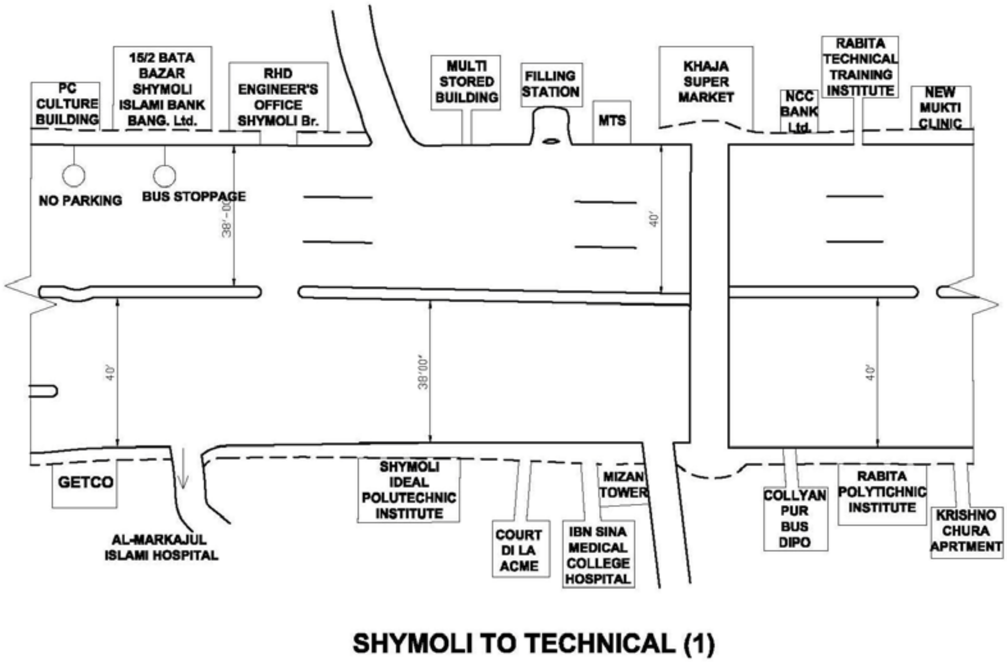
	center and many vehicles are crossing the intersection.
Road divider	Road divider is present all the four legs. But no barrier at the middle. So anybody can pass anytime.
Provision of smooth Traffic	
Traffic Controlling	At this intersection traffic is controlled by manually traffic police.
Passing Sight distance	Passing sight distance in case of turning is good.
Stopping Sight Distance	Stopping sight distance is also good. From a long distance signals (in this case policeman’s hand) are visible and easy to understand.
Number of lanes	At the main approaches there are 4 lanes where as the minor roads has two lanes.
Lighting condition at night	Not so good as many lights are destroyed.
Pedestrian	
Pedestrian Walking Facilities	Very poor. Shops and hawkers are occupying the space for most of the cases. Even the foot over bridge also reserved by the hawkers.
Pedestrian Crossing Facilities	There is a foot over bridge and pedestrians are using this very much. But the problem is it very far from other three sides so people using it to cross only one side.
Barrier for pedestrians	Barriers are provided at foot path or medians.
Passengers	
Bus bay	At one side only there is a bus bay. But many buses are not following that one. Especially the local buses are using the approach of intersection to take the passengers.
Vehicle	
Vehicle Composition Type	Here at day time no non motorized vehicles are allowed to run. And trucks are prohibited during day time.

So from the field visit the main reasons for the accident occurrence are as follow:

- Very poor facilities for the pedestrian movement along or crossing the road. Especially the footpath is totally occupied by the hawkers.
- Very poor condition at the road surface and turns: waving of the bitumins at many spots.
- Poor road signing and marking at the intersection

5.6.3 Field Observations at Shamoly to Technical section:

Overview of the Shamoly to Technical connecting road is provided below:



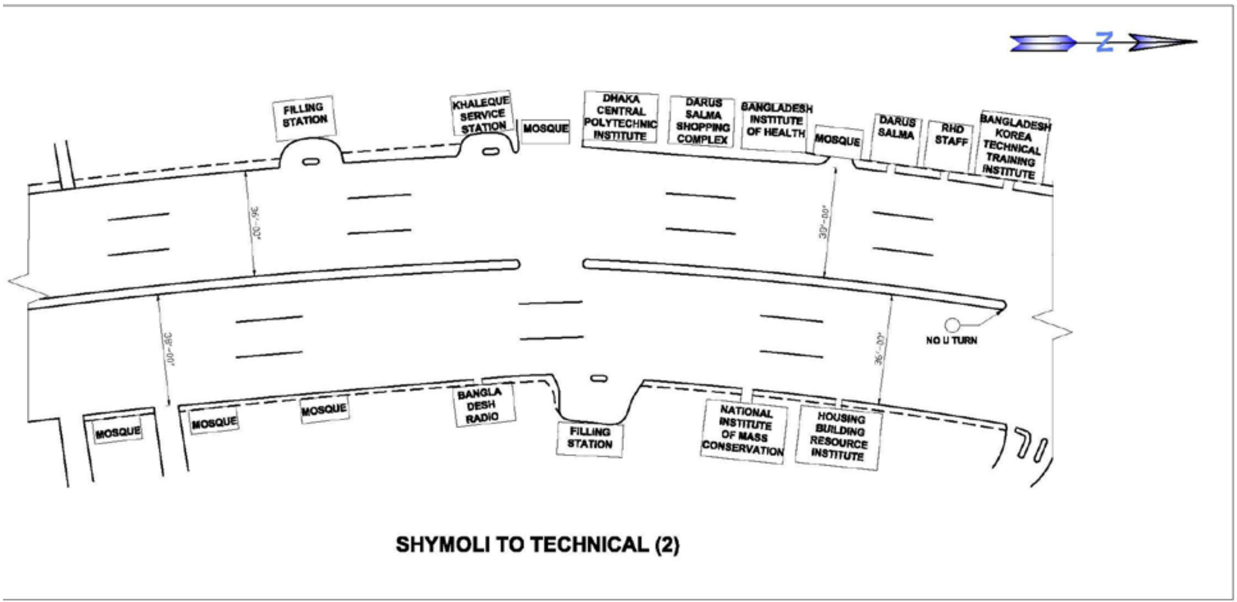


Figure 5-27 Observation of Physical Features of Shamoly to Technical Midblock

Table 5.19 Observations from the Field visit at Shamoly to Technical section

Check list	Comment from field Survey
Road Condition	
Road Surface Condition	Very poor surface. At some spots there is wave of bitumen. Path holes and drainage line cover stand over the road surface. As this link is very long many places the poor condition of road surface is found during field study.
Drainage Facilities	Very poor drainage condition. At some places no drain was found.
Road side Parking	No space for emergency parking. But as this link is very long

	illegally vehicles are parked.
Road Markings	No road marking was visible at all though it is considered a VIP road.
Road Signs	At this long section not a single road signage board seen
Road divider	Road divider is absent all along.
Provision of smooth Traffic	
Traffic Controlling	No traffic control for u turn.
Passing Sight distance	Passing sight distance is good.
Stopping Sight Distance	Stopping sight distance is also good. From a long distance signals are visible and easy to understand.
Number of lanes	At the main approachesthere are 3 lanes where as at some cases 4 lanes were found.
Lighting condition at night	Good.
Pedestrian	
Pedestrian Walking Facilities	Very poor. Shops and hawkers are occupying the space for most of the cases.
Pedestrian Crossing Facilities	A foot over bridge stands at kallayanpur, But pedestrians cannot use properly as for hawkers
Barrier for pedestrians	No barrier is provided at foot path or medians.
Passengers	
Bus bay	No bus bay found at __ long midblock section.
Vehicle	
Vehicle Composition Type	Here at day time no non motorized vehicles are allowed to run. But at night rickshaws entered into this road.

So from the field visit the main reasons for the accident occurrence are as follow:

- Very poor facilities for the pedestrian movement along or crossing the road. Especially at many places there is no walkway for the pedestrians.
- Very poor condition at the road surface and turns
- Poor road signing and marking throughout the route.

5.6.4 Field Observations at Banani 1 to Banani 11:

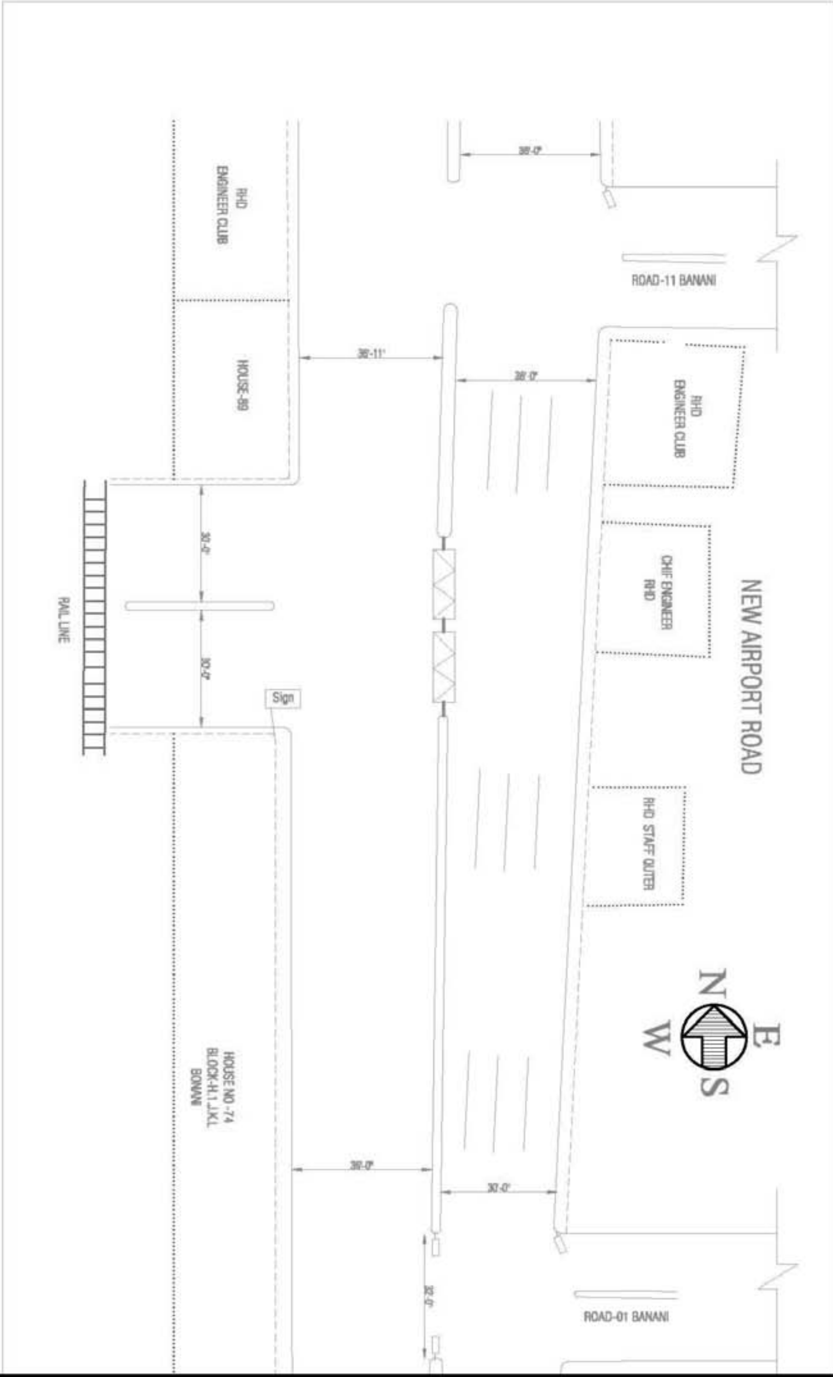


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Figure 5-28 Observation of Physical Features of Banani 1 to Banani 11 Section

Table 5.20 Observations from the Field visit at Banani 1 to Banani 11 Section

Check list	Comment from field Survey
Road Condition	
Road Surface Condition	Very poor surface. At some spots there is wave of bitumen. Path holes and drainage line cover stand over the road surface.
Drainage Facilities	Poor drainage condition.

Road side Parking	No space for emergency parking
Road Markings	At many places marking fade out.
Road Signs	No road signage seen at this intersection
Road divider	Road divider is absent all the section through.
Provision of smooth Traffic	
Traffic Controlling	No traffic control for u turn.
Passing Sight distance	Passing sight distance in case of turning is good.
Stopping Sight Distance	Stopping sight distance is also good. From a long distance signals are visible and easy to understand.
Number of lanes	At approach each side contains 3 lanes.
Lighting condition at night	Good.
Pedestrian	
Pedestrian Walking Facilities	Very poor. Shops and hawkers are occupying the space for most of the cases. Here some Aluminum shops used the footpath as storage place.
Pedestrian Crossing Facilities	No crossing facility throughout the section. At the intersection of both eand there was crossing facilities but vehicles are too much rush on to the approach.
Barrier for pedestrians	No barrier is provided at foot path or medians.
Passengers	
Bus bay	No bus bay.
Vehicle	
Vehicle Composition Type	Here at day time no non motorized vehicles are allowed to run. But at night rickshaws entered into this road.

So from the field visit the main reasons for the accident occurrence are as follow:

- Very poor facilities for the pedestrian movement along or crossing the road. Especially the vehicles are not obeying the pedestrians.
- Signal is not well followed by the drivers, pedestrians and passengers
- Very poor condition at the road surface and turns
- Poor road signing and marking throughout the route.

CHAPTER 6

CONCLUSION AND RECOMMENDATIONS

At this chapter the recommendations are summarized according to selected intersection and midblock. At last some outline of the future study is provided.

6.1 Conclusion

From the study it is very clear that this type of identification is very much necessary to improve the situation. The main thing is it is every people's right to move from one place to another place safely. To ensure this the developed world now is looking forward to vision zero. But as like other developing countries we are still quite far. As we have not so much financial and technical limitation surely we should find some cost effective way to reduce the number of accidents. As other countries are much more ahead for this process for our country we should develop some applicable process in any way. After study so many process at this study we have described a procedure which is in fact a combined process. At this process for the two major urban arterials by analyzing all the intersection and midblock some are identified as most vulnerable. In case of Mirpur road the intersection is Shamoly and the mid block is Shamoly to Technical. In case of Airport Road the intersection is Airport and the midblock is Banani 1 to Banani 11. Whenever all of these intersections and midblock are analyzed in detail it is seen that pedestrians are the most vulnerable user for all the cases. At the time of field visit also the inadequate facilities for the pedestrians are come out in reality. If someone can go through the original statistics of this ten years data it is easily seen that pedestrians are in great danger all time. Another interesting point which is very common for all the intersection and midblock is that most of the cases the accidents were happened in good lighting condition and at fair weather. Overall, this type of study will increase the capability of accident reduction for the policy makers, if the recommendations are properly maintained.

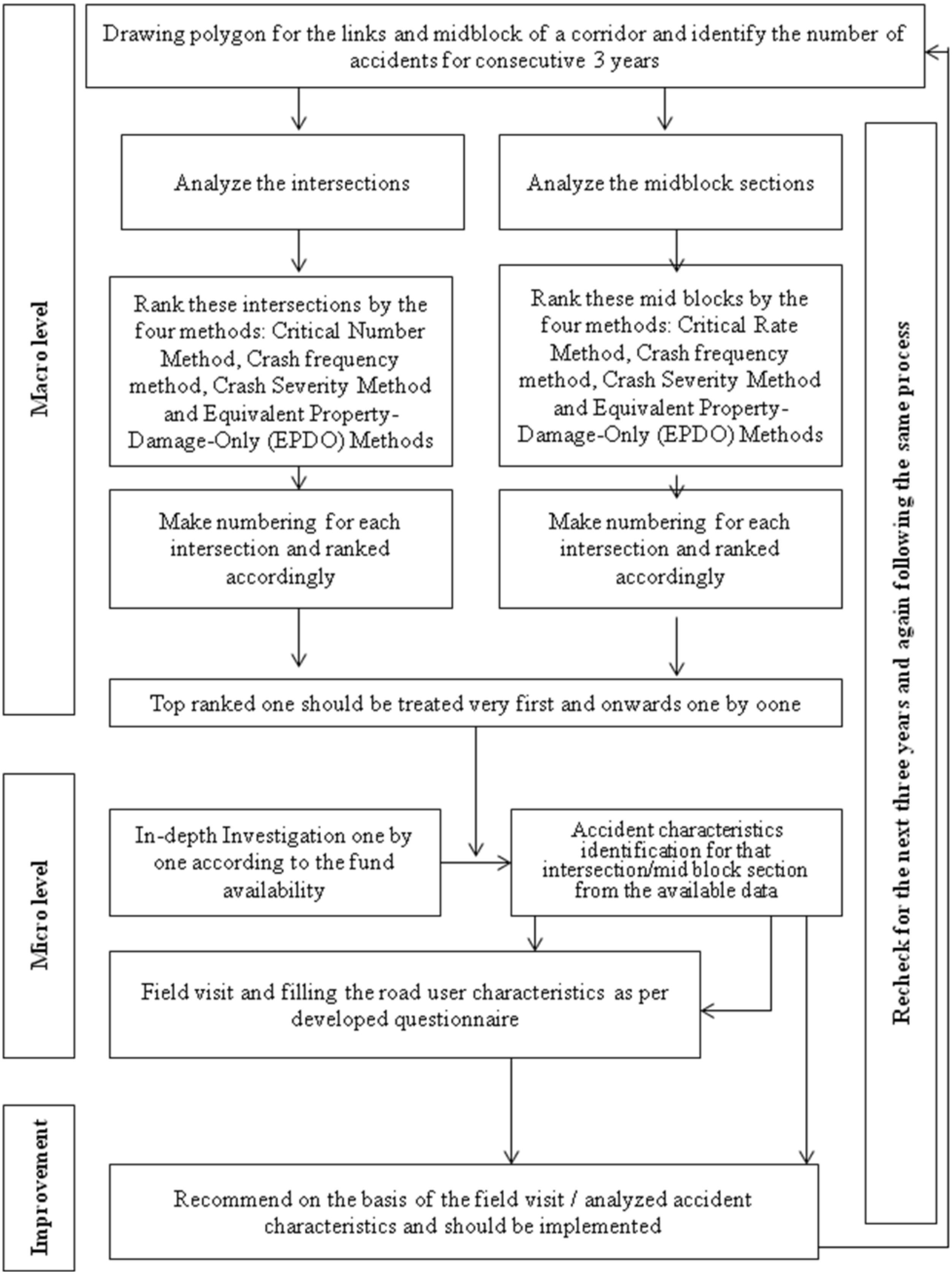
6.2 Major findings of the study:

The main findings of the study are as follow:

- A suitable method for identifying the hazardous road locations (HRL) for intersections and midblock sections of urban roads in Dhaka Metropolitan City is finalized. In this case the combined method is selected which is the combination of four different types of process.

- Then by using the method some hazardous intersections and mid block sections for two major arterial of Dhaka metropolitan city are identified. In case of Mirpur road the intersection is Shamoly and the mid block is Shamoly to Technical. In case of Airport Road the intersection is Airport and the midblock is Banani 1 to Banani 11.
- Using the MAAP5 software the feature of the identified intersection and midblock accident are analyzed for the following cases:
  1. Accident severity
  2. Collision type
  3. Casualty class analysis
  4. Age of the casualty class
  5. Weather condition
  6. Lighting condition
  7. Involvement of Different Types of Vehicles

  For each of the intersection and mid block the reasons are already predicted by looking at the tables carefully. It was found that for many cases the accidental vulnerable class is pedestrian. And maximum of the accidents were happened during nice weather and good lighting condition. So it means that, there are some other factors involved for most of the cases except external factors.
- By field visit the current safety hazardous of the selected spots (both intersection and midblock) are identified. All the intersection and midblock are full of many difficulties especially very inadequate provision for the pedestrians. All the footpaths and foot over bridges are illegally occupied by the shopkeeper at every spot. All the spots are also lacked by the road sign and markings. Here in Bangladesh, the enforcement is not so strong that the drivers will obey the rules.
- One frame work for a whole corridor for identifying the accident black spots can be developed and it can be as followed.


Macro level
Drawing polygon for the links and midblock of a corridor and identify the number of accidents for consecutive 3 years
Analyze the intersections
Analyze the midblock sections
Rank these intersections by the four methods: Critical Number Method, Crash frequency method, Crash Severity Method and Equivalent Property-Damage-Only (EPDO) Methods
Rank these mid blocks by the four methods: Critical Rate Method, Crash frequency method, Crash Severity Method and Equivalent Property-Damage-Only (EPDO) Methods
Make numbering for each intersection and ranked accordingly
Make numbering for each intersection and ranked accordingly
Top ranked one should be treated very first and onwards one by oone
Micro level
In-depth Investigation one by one according to the fund availability
Accident characteristics identification for that intersection/mid block section from the available data
Field visit and filling the road user characteristics as per developed questionnaire
Improvement
Recommend on the basis of the field visit / analyzed accident characteristics and should be implemented
Recheck for the next three years and again following the same process

6.3 Limitations of our study

- MAAP 5 contains those data which were reported to the police. Unreported accidents, which are very common in Bangladesh, were absent. Road users are not interested to report an accident to the police even with severe fatality and vehicle damage.
- Total no of intersections can't find by the study from any database. That's why here analyze the map of the city and manually counted the number of intersection.
- For the length of the linked road the data of DTCB study is used.
- Data for all over DMP area could not be collected. So this study may contain some error.
- MAAP5 software does not have any provision for volume study, Speed study, traffic conflict study, rand roadway inventory study. So exact condition of the intersection or midblock was not available during analysis.
- As data regarding the number of vehicles passing through these intersections and midblock sections are not available some of the methods cannot be used at analyze.

6.4 Recommendations to Improve Safety at the Selected Intersections and Midblock Section:

6.4.1 Recommendations for the Shamoly Intersection:

At Shamoly intersection following methods can be applied:

- **Improvement of pedestrian facilities:**

Pedestrian facilities should be the number one improvement for this intersection. The width of the foot over bridge stair should be enlarged. Hawkers and construction materials should be removed from the footpath. At this case, DCC have some regulations so that these can be applied. High medians of minimum 3.5 feet should be made at all the approaches of this intersection. So people cannot illegally cross over the median and suddenly stop at middle of the road.

- **Installation of proper signs and road markings:**

Proper road traffic signs should be installed and road marking should be visible form very far by the drivers. The road signs and markings at different spots of Shamoly intersection can be installed are provided at the figure 6.1.

- **Ensure proper enforcement for traffic rule violation:**

Some traffic which is violating the rules during red light and buses stops without the proper indication at unauthorized place should be fined. So the law enforcement system should be applied properly specially in case of signaling, pedestrian crossing, lane maintain and illegal parking close to intersection. As for the pedestrians and for the lane maintain no rule is directly obtained in this context the rule of 140 can be applied.

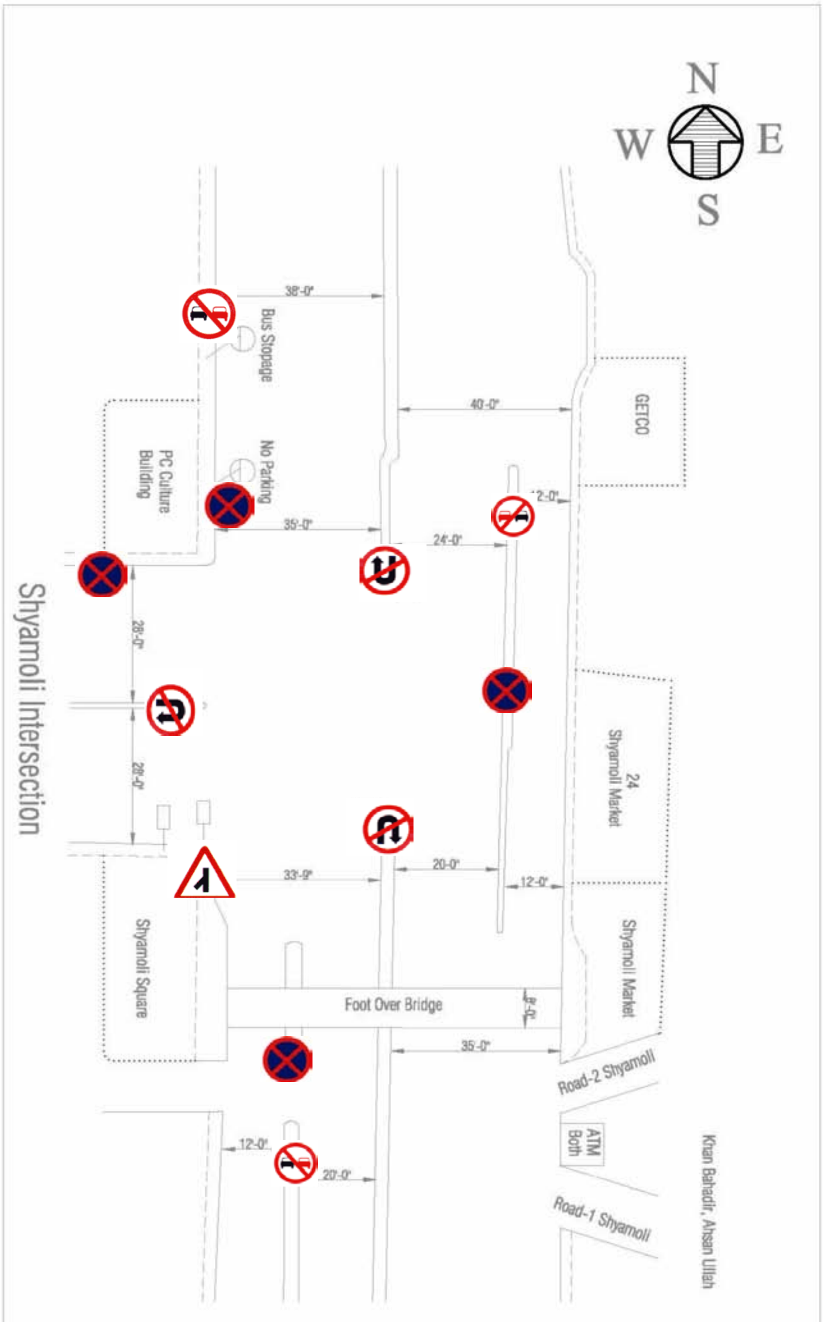


Figure 6-1 Different Types of Road Signs and Markings at Airport Intersection

6.4.2 Recommendations for the Airport Intersection:

At Airport intersection following methods can be applied:

- **Improvement of pedestrian facilities:**

Hawkers and construction materials should be removed from the footpath and the foot over bridge. The Footover Bridge should be maintained properly clean so that the pedestrians can use it with comfort. On the other side of the road there should be some type of pedestrian crossing with proper zebra crossing if possible one traffic police should be there. Because the traffic approaches at this intersection is very much high speedy and definitely too much risky.

- **Installation of proper signs and road markings:**

Proper road traffic signs should be installed and road marking should be visible form very far by the drivers. Some road signs and markings at different spots of Shamoly intersection can be installed as in figure 6.2. Road markings should be made very effectively at the approach of all the sections.

- **Ensure proper enforcement for traffic rule violation:**

Some traffic which was violating the rules without following the traffic polices instructions should be fined. The pedestrians should also be treated properly as they are causing confusion at the mind of the drives during approach to the airport intersection. As for the pedestrians and for the lane maintain no rule is directly obtained in this context the rule of 140 can be applied like before.

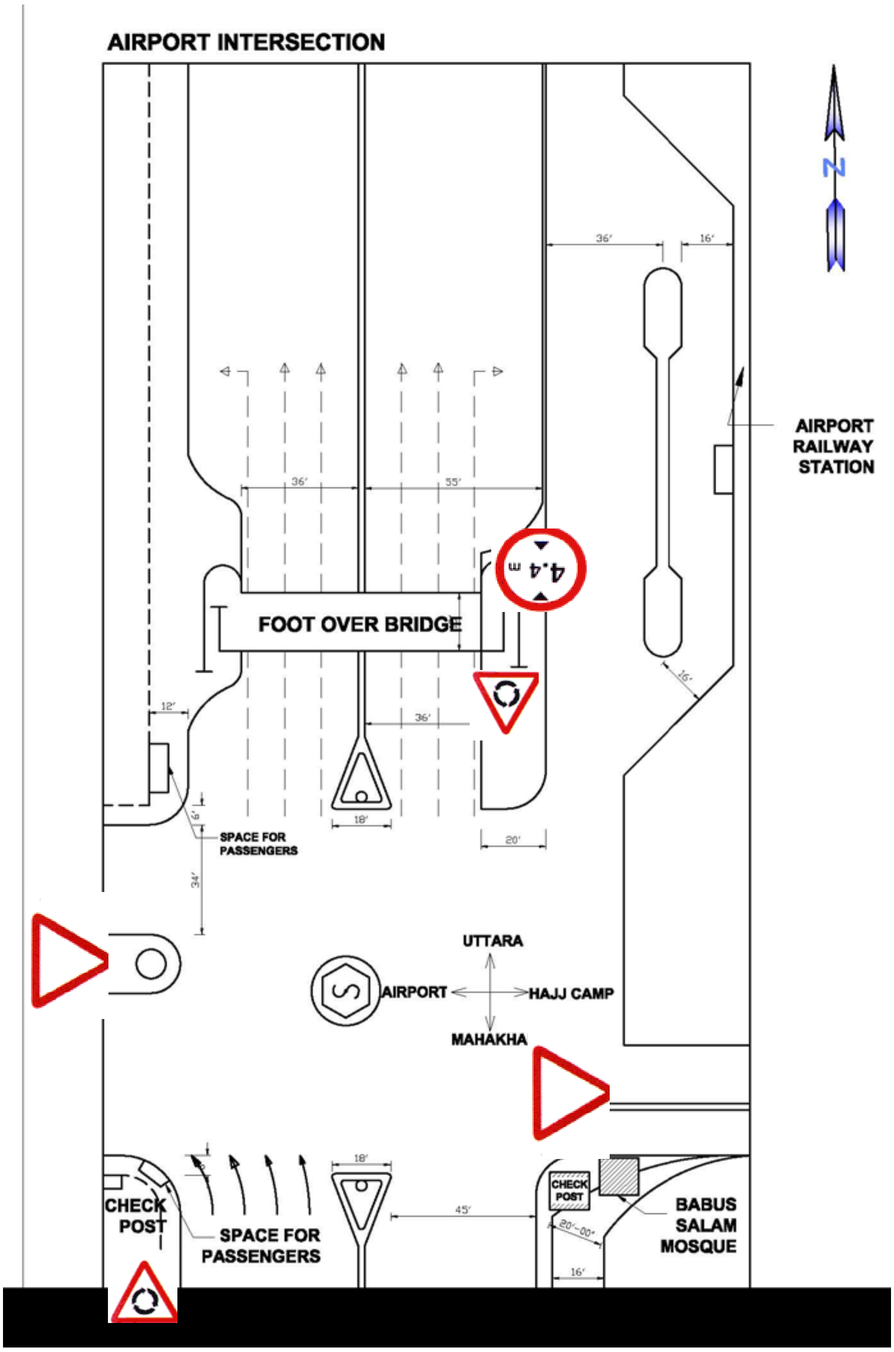


Figure 6-2 Different Types of Road Signs and Markings for Airport

6.4.3 Recommendations for the Shamoly to Technical section:

At Shamoly to Technical road section following methods can be applied:

- **Improvement of pedestrian facilities:**

Pedestrian facilities should be the number one improvement for this section. As the traffic speed and volume is at a tolerable limit at this section so that for the pedestrian some zebra crossings can be proposed specially at the section in between kallayanpur to technical.

From some portions where the footpath is faded away proper wide footpath should be installed.

- **Installation of proper signs and road markings:**

Proper road traffic signs should be installed and road marking should be visible form very far by the drivers. Some road signs and markings at different spots of Shamoly to Technical can be installed as at the figure 6.3. Road markings should be made as in the picture at many places it is faded out.

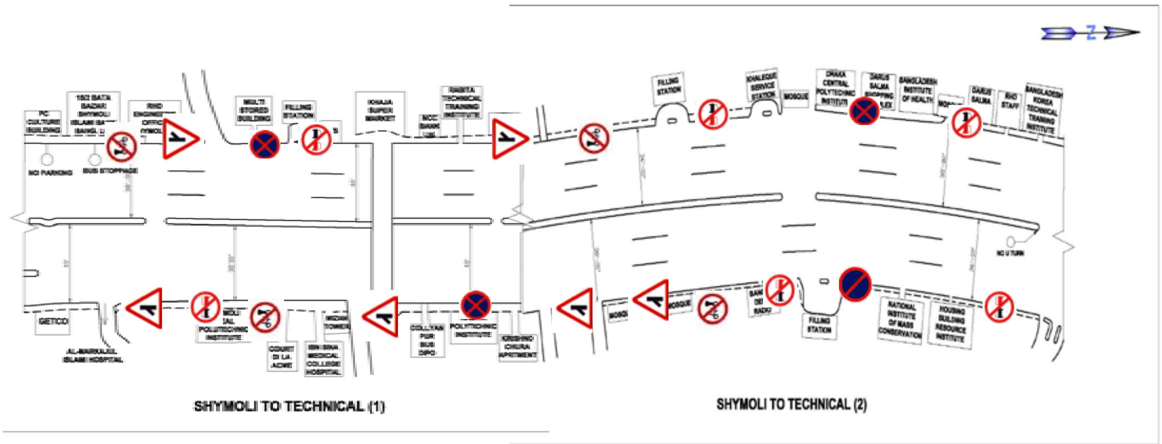


Figure 6-3 Different Types of Road Signs and Markings for Shamoly

- **Ensure proper enforcement for traffic rule violation:**

For the pedestrian crossing at particular point one traffic police can be stood. Some vehicles which are not maintain the speed limit at this section can be fined accordingly Motor Vehicle ordinance 1983. As for lane maintain no rule is directly obtained in this context the rule of 140 can be applied.

6.4.4 Recommendations for the Banani 1 to Banani 11:

At Banani 1 to Banani 11 road section following methods can be applied:

- **Improvement of pedestrian facilities:**

Hawkers, business person's materials and loading unloading of the materials from footpath should be banded. Proper crossing facilities should be designed for the pedestrians. Especially at this portion one foot over bridge should be constructed at the intersection of cantonment. Because many pedestrians who are garment workers are used to cross this road very often. The speed of the vehicles should be at a tolerable limit as per time and pedestrian concentration.

- **Installation of proper signs and road markings:**

Proper road traffic signs should be installed and road marking should be visible form very far by the drivers. Some road signs and markings at different spots of Banani 1 to Banani 11 can be installed as in figure 6.4.

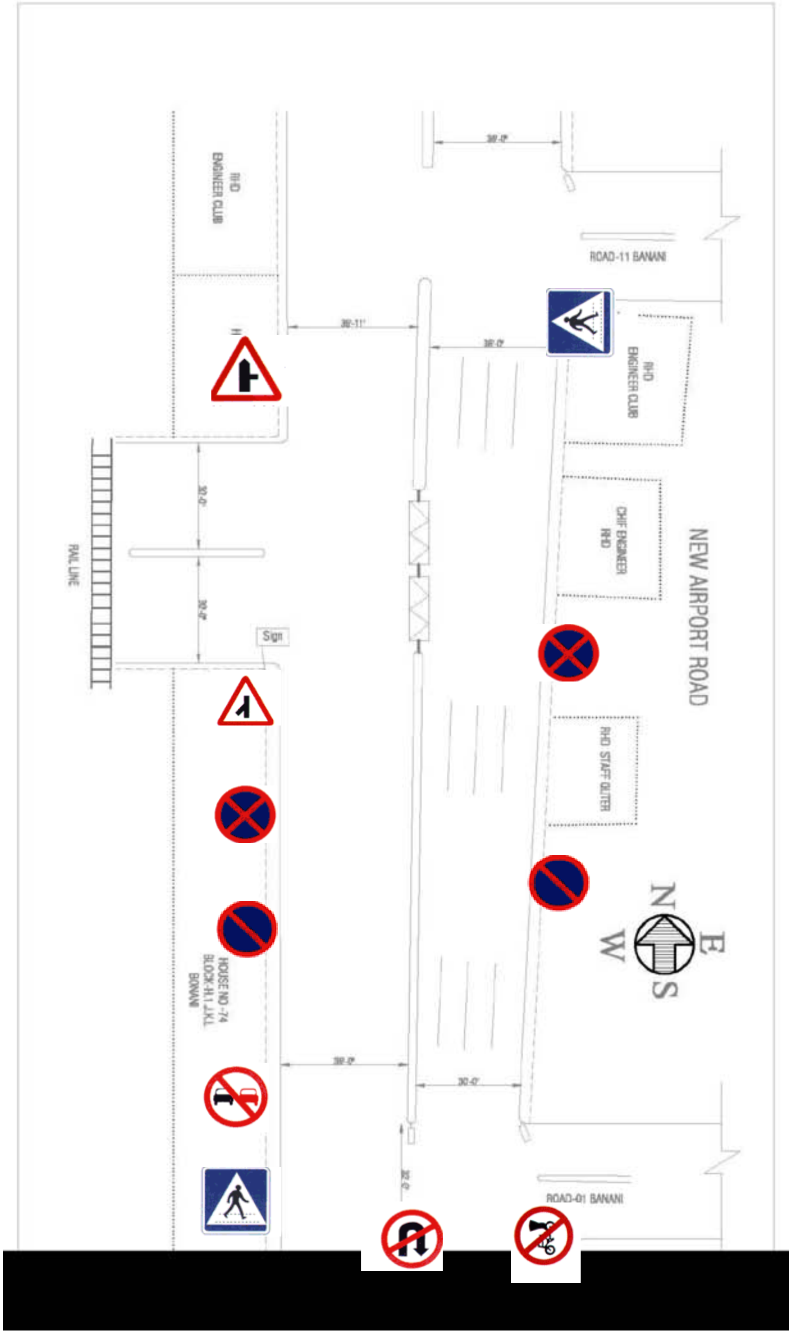


Figure 6-4 Different Types of Road Signs and Markings for Banani

- **Ensure proper enforcement for traffic rule violation:**

Some traffic which is violating the rules during red light and buses stops without the proper indication at unauthorized place should be fined. So the law enforcement system should be applied at this particular point and the pedestrians should also abide by the laws during crossing. As for the pedestrians and for the lane maintain no rule is directly obtained in this context the rule of 140 can be applied.

6.5 Recommendations for further study

To find out the actual conditions of the intersection and midblock some further study can be done to carry out improved result in future

- Traffic volume study should be done all of the intersections. Then a logical comparison may be done about safety of all types of intersections.
- Pedestrian volume study may be an important tool in finding out the lacking of the facilities especially in those intersections where pedestrian related accident is higher.
- Other studies like Capacity study and Travel time and delay study can be done which will help in assessing the real causes of intersection accidents
- Speed study should be done to comparative study of some intersection and midblock

REFERENCES:

1. Ahsan M. S. (2005), *"Comparative Accident- Study on three selected National Highways in Bangladesh"*, Thesis submitted to the Department of Civil Engineering, BUET.

2. Alam Md. Sarwar (1997) *"Performance Evaluation of Selected Signalized Intersections in Dhaka City"*, Thesis submitted to the Department of Civil Engineering, BUET.

3. Bangladesh Road Transport Authority (BRTA), (2008) *Vehicle data* *http://www.brta.gov.bd/pdf/vehicles-registered-bd-19-11-08.pdf*

4. Bangladesh Road Transport Authority (BRTA), (2008) *the motor vehicles ordinance 1983*

5. Bruce F. C.,Charles A., Foong C.W. (1900), *"Evaluation Of Accident Black Spot Treatments"*

6. Hekmat I. (1994) *"The Identification of midblock Black Spots"*, The University of New South Wales, Australia.

7. Hoque, M.M., (1981) *"Traffic Accidents in Dhaka, A Study on Roadway Safety"*, Bangladesh University of Engineering & Technology, Dhaka, Department of Civil Engineering.

8. Hoque M. M (2005) Presentation "*Road Safety Audit Case Studies*", National Workshop cum Training Course "Road Safety Audit", BUET, 16-18 March 2005

9. Houqe M. M., Debnath P**.,** Alam D., Ahmed S. N. D., (2006)"*Metropolitan Street Accidents: The Case of Dhaka"* Proceedings of the International Conference on "Road Safety in Developing Countries", Dhaka, Bangladesh, 22-24 August, 2006 (page 293-300)

10. K.Geurts, G.Wets (2003), *"Black Spot Analysis Methods: Literature Review "*

11. Michael D. P. (2007), Iowa Department of Transportation, Highway Division, Engineering Bureau, Office of Traffic and Safety, *"Safety Improvement Candidate Location (SICL) Methods"*

12. Peden, M., (2004) *"World Report on Road Traffic Injury Prevention"*, Geneva, World Health Organization.

13. RACV Consultants (1985) ; For Federal Office Of Road Safety in Australia "*Identification Of Hazardous Road Locations : Procedural Guidelines"*

14. Sayer, I. A. (1994), Paper presented to the International Course on, Prevention and Control of Traffic Accidents and Injuries. "*Accident Blackspot Investigation*"

15. Sohadi, R U R and C J Baguley. (1993) "*The identification, prioritising and analysis of accident blackspots in Malaysia"*

16. Wright P.H. *Highway Engineering* (1996) John Wiley & Sons,Inc.

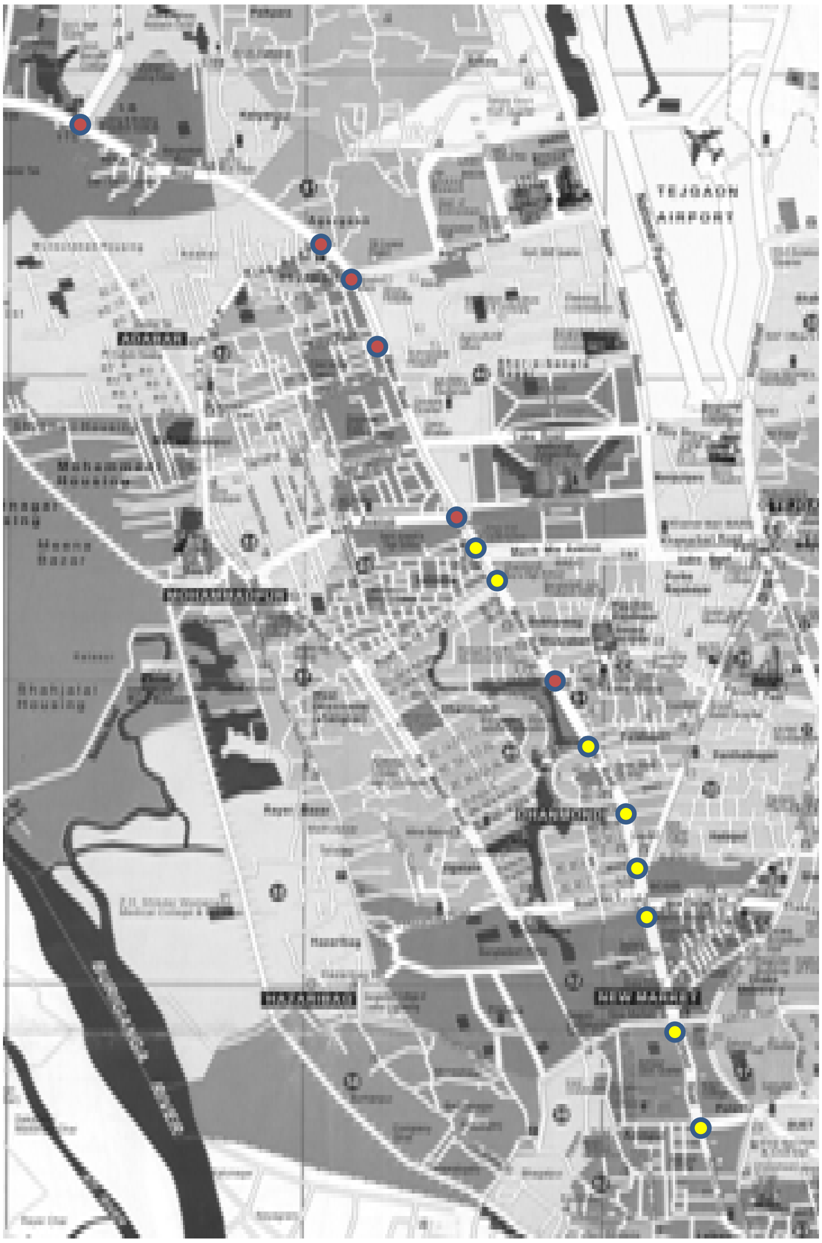
Appendices

APPENDIX I: MAPS OF THE INTERSECTIONS AND MIDBLOCK AT DIFFERENT TIME PERIOD

Intersection Analysis (2005-2007)

Mirpur Road (Azimpur – Technical)

Method 1: Critical Number Method



Mirpur Road (Azimpur – Technical)

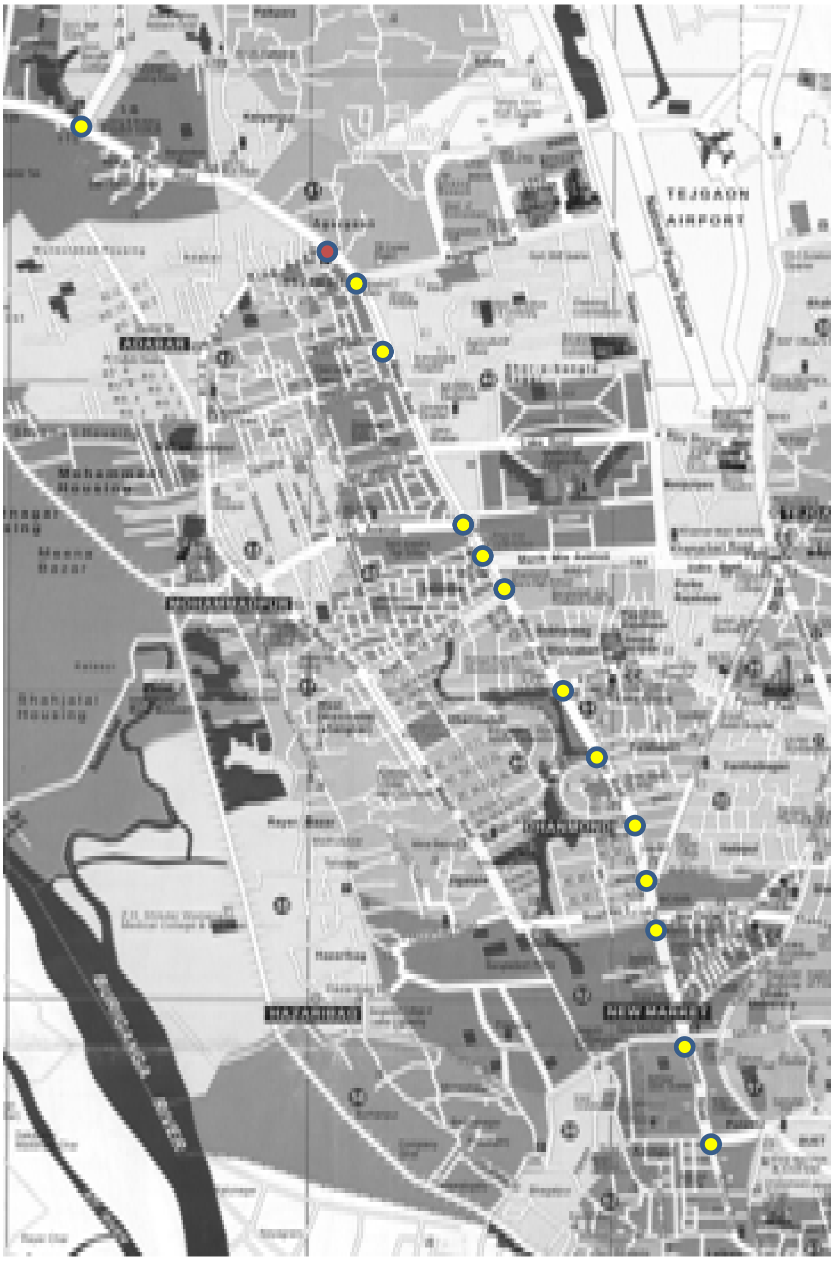
Method 2: Crash Frequency Method

Mirpur Road (Azimpur – Technical)

Method 3: Crash Severity Method

Mirpur Road (Azimpur – Technical)

Method 4: EPDO Method



Airport Road (Mohakhali-House building)

Method 1: Critical Number Method

Airport Road (Mohakhali-House building)

Method 2: Crash Frequency Method

Airport Road (Mohakhali-House building)

Method 3: Crash Severity Method

Airport Road (Mohakhali-House building)

Method 4: EPDO Method

Midblock Analysis (2005-2007)

Mirpur Road (Azimpur – Technical)

Method 1: Critical Rate Method

Mirpur Road (Azimpur – Technical)

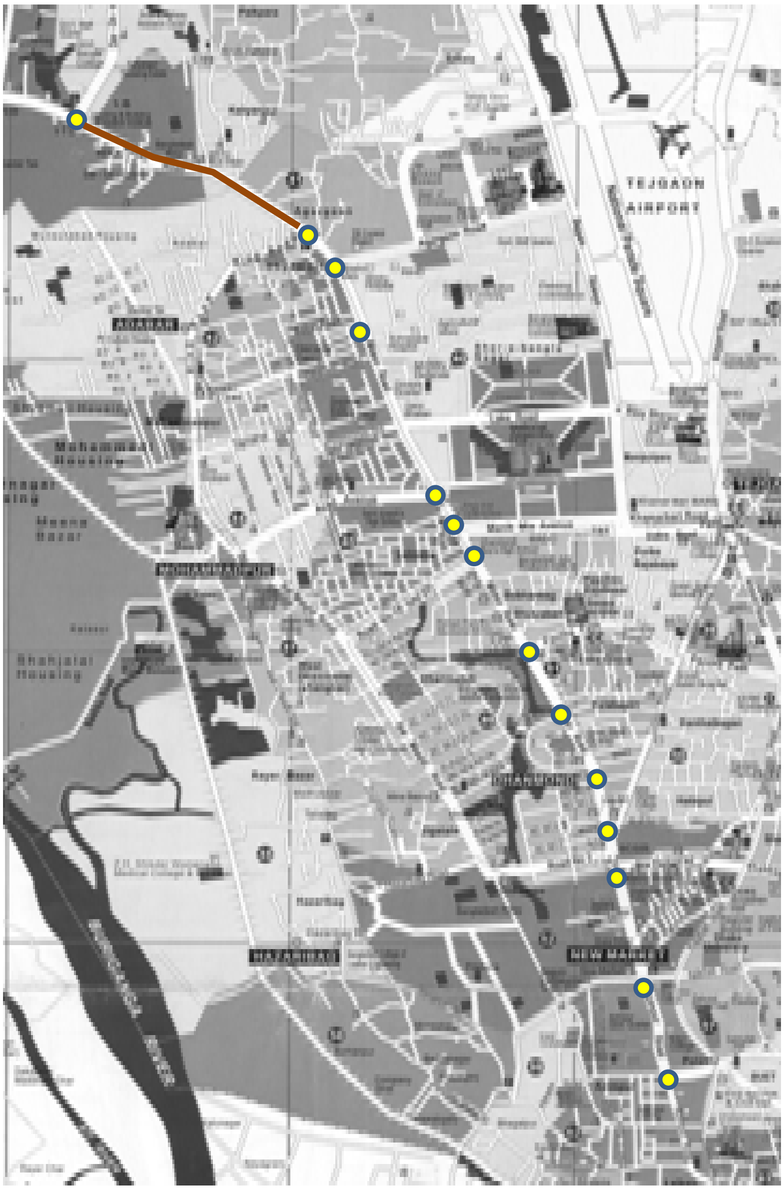
Method 2: Crash Frequency Method

Mirpur Road (Azimpur – Technical)

Method 3: Crash Severity Method

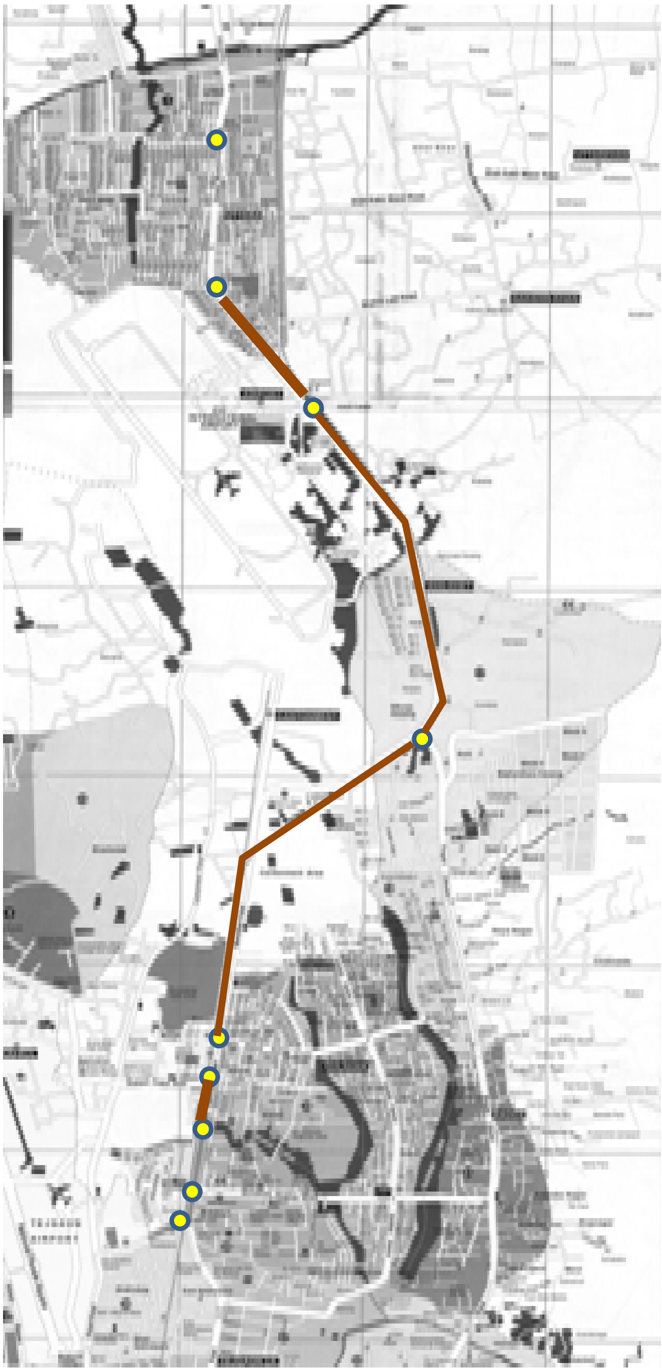
Mirpur Road (Azimpur – Technical)

Method 4: EPDO Method



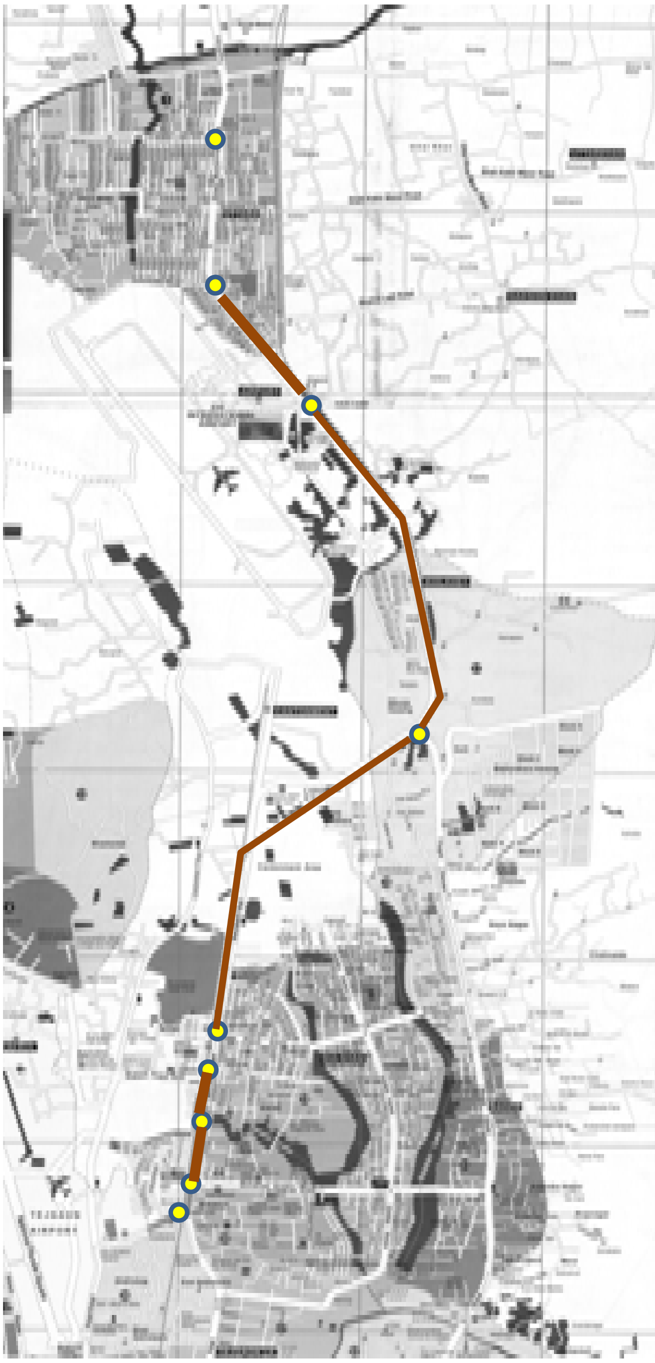
Airport Road (Mohakhali-House building)

Method 1: Critical Rate Method



Airport Road (Mohakhali-House building)

Method 2: Crash Frequency Method



Airport Road (Mohakhali-House building)

Method 3: Crash Severity Method

Airport Road (Mohakhali-House building)

Method 4: EPDO Method

APPENDIX II: FIELD SURVEY REPORT OF DIFFERENT LOCATIONS

Airport Intersection:

I. Intersection location and design:

1. Provision of the stopping sight distance to the rear of turning vehicles:

Stopping sight distance at all the approaches are sufficient. But as the roundabout is placed not exactly the middle for all the legs, sometimes some obstruction created for the maneuver of the turning vehicles.

2. Provision of areas where needed in relation to width of the carriageway to cross and traffic volumes and speeds.

At all the approachesof this intersection, traffic can enter with sufficient speed and capacity of the intersection is well enough. But due to the standing of the roundabout some speed may reduce in case of the vehicles run towards main road.

3. Provision of turning vehicles conflicting with opposite vehicle flows (right turn if traffic is on the left and vice versa) in relation to traffic volume and speeds.

In case of U turn at the main stream all the vehicles have to face difficulties. As this intersection has very less number of u turning vehicles in fact this is not a practical problem for Airport intersection.

4. Is the intersection layout is obvious to all road users?

Yes, this intersection is obvious for all the road users. Here also pedestrians have separate way to cross (foot over bridge).

5. Provision of clear and protected areas for vulnerable road users at crossing.

There are not sufficient clear and protected areas for the pedestrians at many spots. At many places of Footpath business persons are selling their products. They also illegally occupied the passenger shade and nobody is caring for that. At this intersection many people are using foot over bridge due to the barrier beside the footpath.

II. Surface of carriageways and roadsides

1. Road surface of the intersection approach road is Ok or not?

At most of the cases, road surface is too bad. The entering approaches of the intersection are very much unsmooth and many places bitumen is took away. At the leg from Uttara to Banani the carriageway contains some uneven dilation.

2. Type of the surface used by the pedestrians:

The type of surface used by the pedestrian is very much uneven. Most of the cases, the bricks are coming out. Though the width of the footpath is sufficient and at that path some persons are gathering their products and sell. The surface of the foot over bridge is also very much uneven and the rise of the stairs is broken. Street lights are not sufficient for the pedestrian to pass over the over bridge at night.

III. Signing, Marking and Equipment

1. Sight distance of the signals from the approach road is adequate or not?

For looking at the signal of the traffic, there are enough sight distance from all the legs.

2. Signing and marking is proper or not?

There no sign of the roundabout ahead or drive slowly or bus bay ahead. So signing is totally ignored during the improvement work. Though the road markings were provided now it is faded out at many places.

3. Lane markings are proper or not?

In case of the lane marking of this intersection, most of them are faded out. So for lane driving it is a big problem. Even the stopping marking was not been present properly there.

4. Provision of appropriate road lighting or not?

The lighting condition of the intersection is pretty bad. Most of them are broken or stolen. At night the drivers have to face difficulties to cross the intersection.

Shamoly Intersection:

I. Intersection location and design:

1. Provision of the stopping sight distance to the rear of turning vehicles:

At this intersection there is sufficient sight distance at all the legs. From all the sides signals can also be visible very well.

2. Provision of areas where needed in relation to width of the carriageway to cross and traffic volumes and speeds.

At all the approachesof this intersection, traffic can enter with sufficient speed and capacity of the intersection is well enough. In case of the leg from Dhanmondi to Shamoly: left turning vehicles have faced some difficulties to enter.

3. Provision of turning vehicles conflicting with opposite vehicle flows (right turn if traffic is on the left and vice versa) in relation to traffic volume and speeds.

In case of U turn at the main stream all the vehicles have to face difficulties. At all approaches it stops the vehicles from opposite side. So it reduces the effectively of the traffic signal.

4. Is the intersection layout is obvious to all road users?

Yes, this intersection is obvious for all the road users. The pedestrians have separate way to cross (foot over bridge).

5. Provision of clear and protected areas for vulnerable road users at crossing.

There are not sufficient clear and protected areas for the pedestrians. Even at one leg buses are loading passengers on the run. Some people also did not use the foot over bridge. Its effective width is very less, so people may not feel comfortable to use this. Beside footpath is mainly used by the business persons to sell their product.

II. Surface of carriageways and roadsides

1. Road surface of the intersection approach road is Ok or not?

At most of the cases, road surface is too bad. The entering approaches of the intersection are very much unsmooth and many places bitumen is took away. There are some path holes, WASA slab which eventually make the surface uneven.

2. Type of the surface used by the pedestrians:

The type of surface used by the pedestrian is very much uneven. Most of the cases, the bricks are coming out. Also the width of the footpath is very small and at that path some persons are gathering their products and sell. The surface of the foot over bridge is also very much uneven and the rise of the stairs is pretty high. The medians of the road are also very much bad in condition. The barriers are stolen, so the pedestrian liked to go over this.

III. Signing, Marking and Equipment

1. Sight distance of the signals from the approach road is adequate or not?

For looking at the signal lights; there are enough sight distance from all the legs.

2. Signing and marking is proper or not?

Only at one place there was a sign and it was not properly seen also. There could be many other signings. So no proper signing at the intersection was found.

3. Lane markings are proper or not?

In case of the lane marking of this intersection, there was nothing. So for lane driving it is a big problem. Even the stopping marking was not been present there.

4. Provision of appropriate road lighting or not?

The lighting condition of the intersection is pretty good.

Banani 1 to Banani 11 road section:

I. Alignment and Cross section:

1. Provision of the stopping sight distance; Is the alignment of roadway cleared defined?

Roadway alignment is clearly defined. In case of stopping sight distance this midblock is very good.

2. Variation of cross section requiring sudden change of speed (narrowing of carriageway, change in number of lanes)

At this mid block there is certain variation of carriageway but it is not very much. So the lane number was same all the way through.

3. Provision of proper drainage facilities?

Drainage facility is a problem. Though it was not rainy season it was observed that water is gathered at the drains.

4. Is there space allocation for vulnerable road users: is it adequate in size and structure?

There is not proper space for the pedestrian crossings. At both side there are zebra crossings for the pedestrians. But vehicles are not following the rule to stop at that. The footpath width is sufficiently wide but occupied by other.

5. Opportunities of safe overtaking (frequency and length of road sections with good sight distance of oncoming or crossing traffic, additional lanes)

At this mid block, there is sufficient space for safe overtaking. As this road has not any curves so overtaking is rather easier for the vehicles. Though this road is designated for lane driving in practical drivers do not follow the rules. At this midblock vehicles are coming very frequently from all the sides. So the volume of the vehicles is very high.

6. Provision for crossings by vulnerable road users where justified by the road environment safe design and practicability

For the crossing of the pedestrians there is no provision for safe crossing. Vehicles are coming at high speed at the zebra crossings. So it can be said that for the pedestrian this mid block is very much hazardous.

7. Provision of safe emergency parking

There is no such emergency parking facilities for the vehicles. There are some spaces where the vehicles are waiting for the loading of materials at the foot paths.

8. Provision of regular parking and bus stops off the main traffic lanes in areas where roadside activities require it.

There was no provision of parking and bus stops at this particular section.

9. Any speed humps or not?

There were no speed humps and even no sign for pedestrian crossings.

II. Surface of carriageways and roadsides

1. Is the road surfacing free of defects which could result in loss of steering control (excessive roughness, potholes, loose chippings, areas with possible accumulation or sheet flow of rain water)?

The road surface is uneven at some places. Though it is a part of a major road in Dhaka city it has some difficulties. There are some path holes and pontoons beside the road. These can be very much dangerous in case of speedy vehicles. Also at this road section motorcycles can be very much vulnerable.

2. Quality of surface of path used by the pedestrians, of routes

The foot way used by the pedestrians is very bad in condition. Most of the cases it is occupied by the materials, vehicles and also some electric materials which in fact reduces the spaces of them. At some places there were many concrete slabs over the drain, but the slabs are broken and can be dangerous for the pedestrians. At some places people throw the wastes just beside the foot path it can irritate the pedestrians very much.

III. Signing, Marking and Equipment

1. Delineation of road bends. Visibility in all conditions (night and day, rain etc.)?

There is no sharp road bends and at this road section vehicles can be well seen both at day and night.

2. Advance warning Signing and marking is propoer or not?

There is no advance warning signs and at some cases marking is also faded out.

3. Lane markings is proper or not?

Lane marking is not proper. As the marking was done some years ago, it is faded out at many locations.

4. Provision of appropriate road lighting or not?

There is enough road lighting and vehicles can be visible at day and night properly.

Shamoly to Technical Road Section:

I. Alignment and Cross section:

1. Provision of the stopping sight distance; Is the alignment of roadway cleared defined?

Roadway alignment is clearly defined. But in some cases there are turning facilities but very difficult to trace. In case of stopping sight distance this midblock is not so bad.

2. Variation of cross section requiring sudden change of speed (narrowing of carriageway, change in number of lanes)

At this mid block there is certain variation of carriageway but it is not very much. So the lane number was same all the way through.

3. Provision of proper drainage facilities?

Drainage facility is a problem. Though it was not rainy season it was observed that water is gathered at the drains. At some places no drain at all.

4. Is there space allocation for vulnerable road users: is it adequate in size and structure?

There is not proper space for the pedestrian crossings. There is one foot over bridge at kallayanpur at the total road section. This road section is very big and pedestrian have to pass at many sections but even though there is no proper provision for crossing.

5. Opportunities of safe overtaking (frequency and length of road sections with good sight distance of oncoming or crossing traffic, additional lanes)

At this mid block, there is sufficient space for safe overtaking. As this road section there are some curves so overtaking should be carefully done. Though this road is designated for lane driving in practical drivers do not follow the rules.

6. Provision for crossings by vulnerable road users where justified by the road environment safe design and practicability

For the crossing of the pedestrians there is no provision for safe crossing. Only one foot over bridge located at kallayanpur.

7. Provision of safe emergency parking?

There is enough emergency parking facilities for the vehicles. As this is very long section the load of the traffic is sustainable at day time. At night time due to the entry of the vehicles of the intercity it becomes crowded.

8. Provision of regular parking and bus stops off the main traffic lanes in areas where roadside activities require it.

There is provision of parking and bus stops at this particular section. But not properly designed.

9. Any speed humps or not?

There were no speed humps and even no sign for pedestrian crossings.

II. Surface of carriageways and roadsides

1. Is the road surfacing free of defects which could result in loss of steering control (excessive roughness, potholes, and loose chippings, areas with possible accumulation or sheet flow of rain water)?

Though it is a part of a major road in Dhaka city it has some difficulties. The road surface is uneven at many places. There are some path holes and pontoons beside the road. These can be very much dangerous in case of speedy vehicles. For this road section motorcycles can be very much vulnerable.

2. Quality of surface of path used by the pedestrians, of routes

The foot way used by the pedestrians is very bad in condition. Most of the cases it is occupied by the materials, vehicles and also some electric materials which in fact reduces the spaces of them. At some places people throw the wastes just beside the foot path it can irritate the pedestrians very much. At some places it is observed that footpath finished and no provision for them to walk.

III. Signing, Marking and Equipment

1. Delineation of road bends. Visibility in all conditions (night and day, rain etc.)?

There is some sharp road bends and at this road section but vehicles can be well seen both at day and night.

2. Advance warning Signing and marking is proper or not?

There is no advance warning signs and no road marking at all.

3. Lane markings is proper or not?

Lane marking is not proper at all.

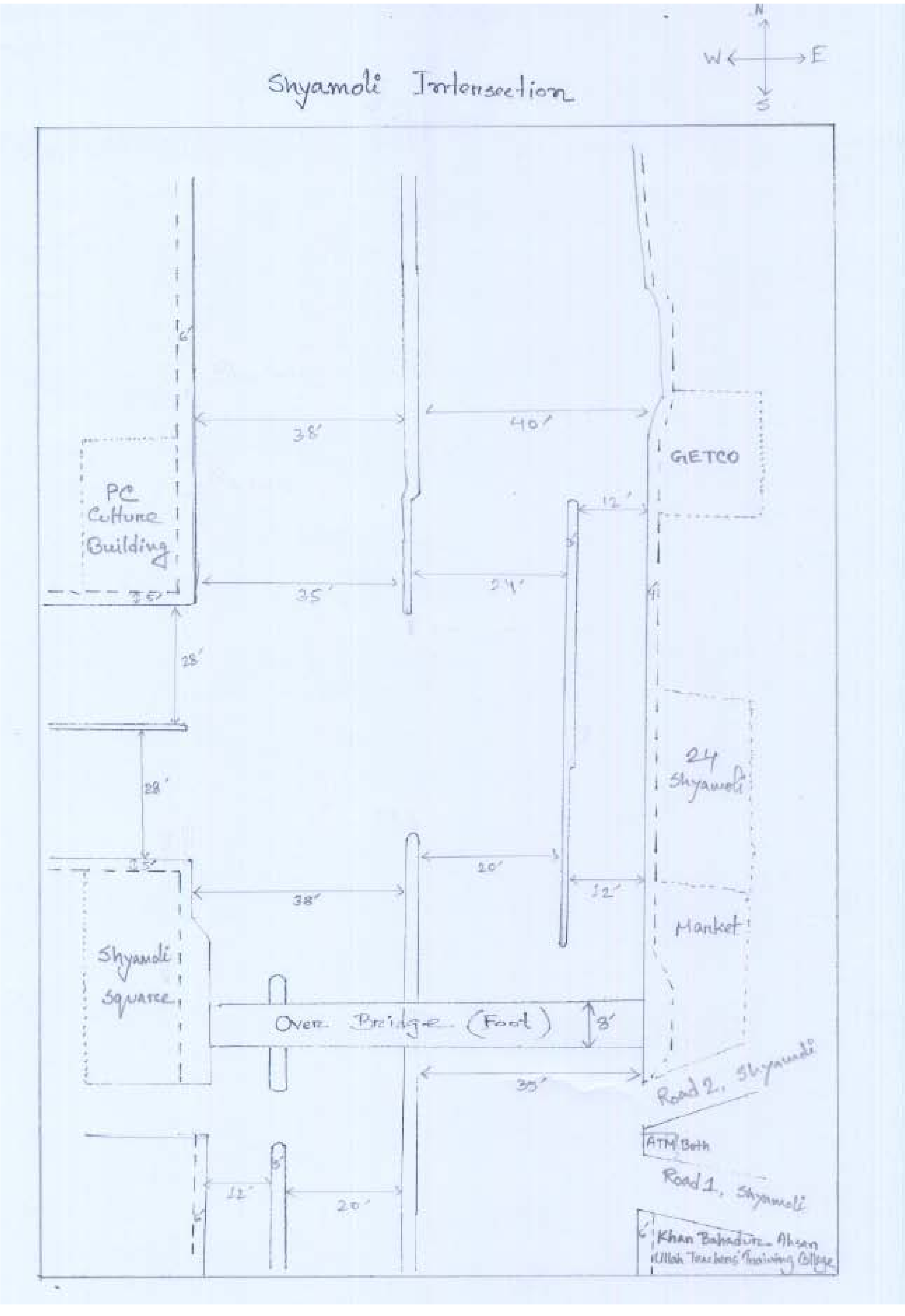
4. Provision of appropriate road lighting or not?

There is enough road lighting and vehicles can be visible at day and night properly.

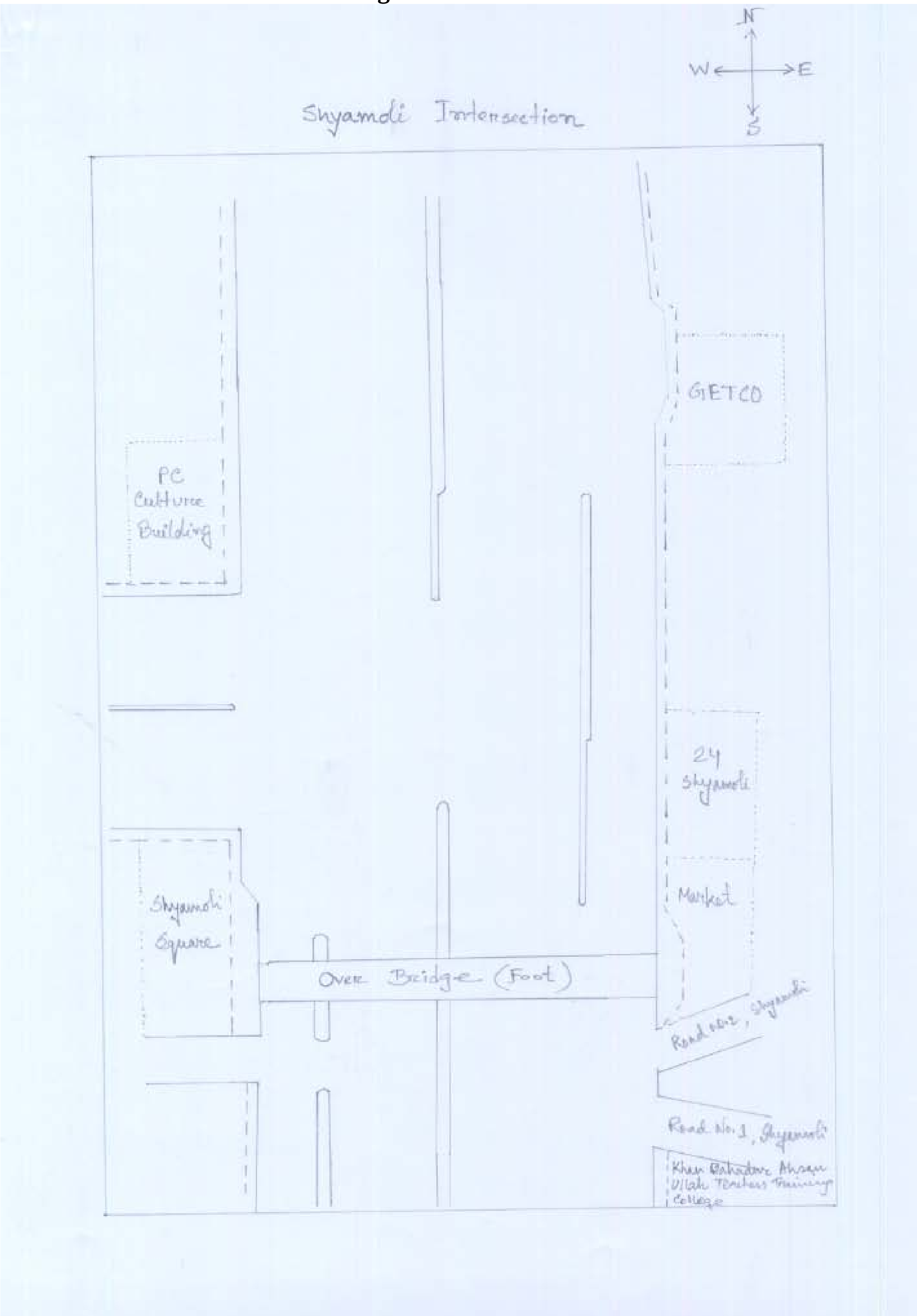
APPENDIX III: PHYSICAL FEATURES OF THE BLACK SPOTS

Physical Features of the Shamoly Intersection

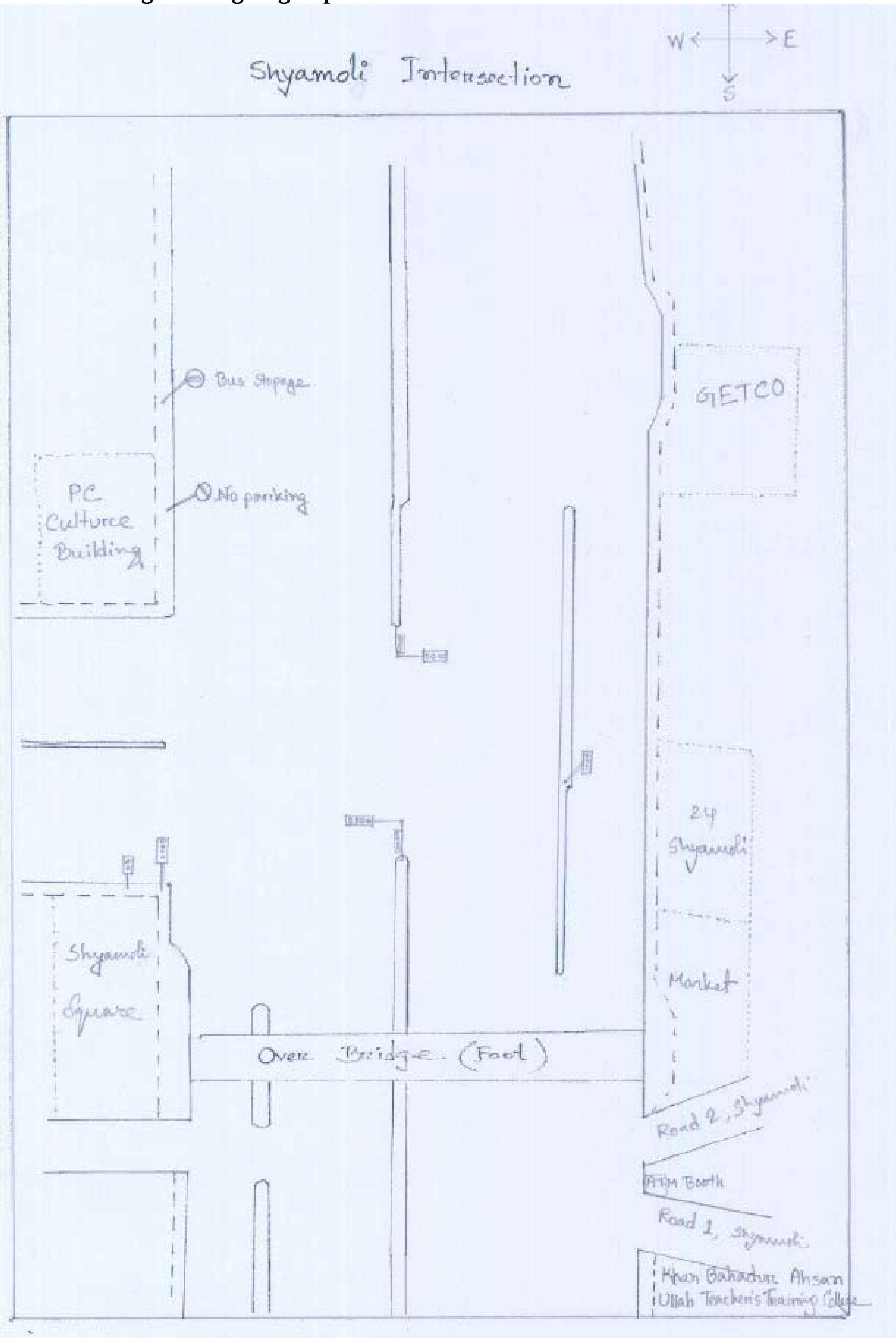
Dimension of different dimension at intersection


Shyamoli Intersection
N
W
E
S
6'
38'
40'
GETCO
PC Culture Building
12'
35'
24'
5'
28'
24 Shyamoli
28'
20'
38'
12'
Market
Shyamoli Square
Over Bridge (Foot)
8'
35'
Road 2, Shyamoli
ATM Both
Road 1, Shyamoli
12'
20'
Khan Bahadur Ahsan Ullah Teachers' Training College

Location of the intersection showing land use

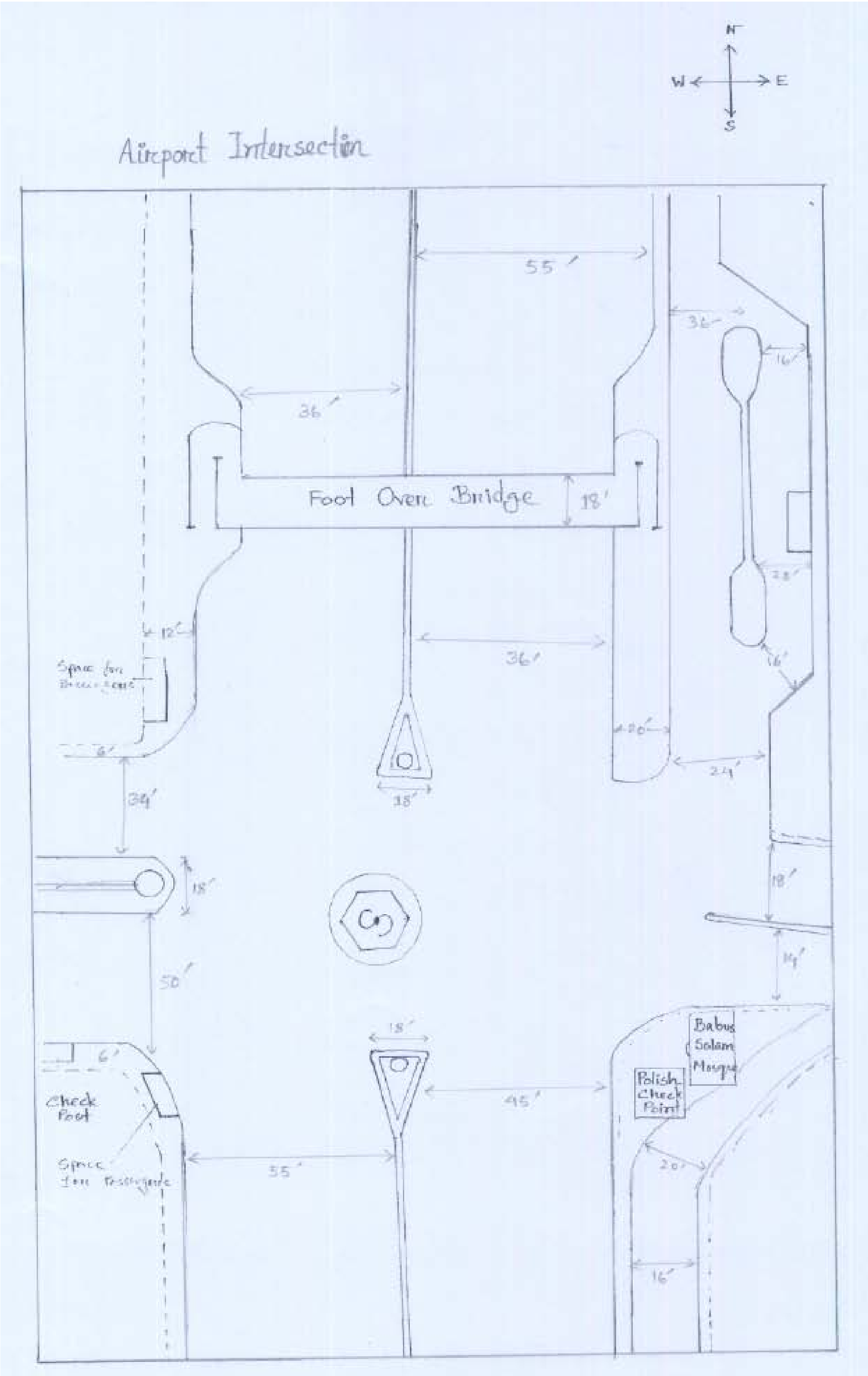


Road markings and signing at present

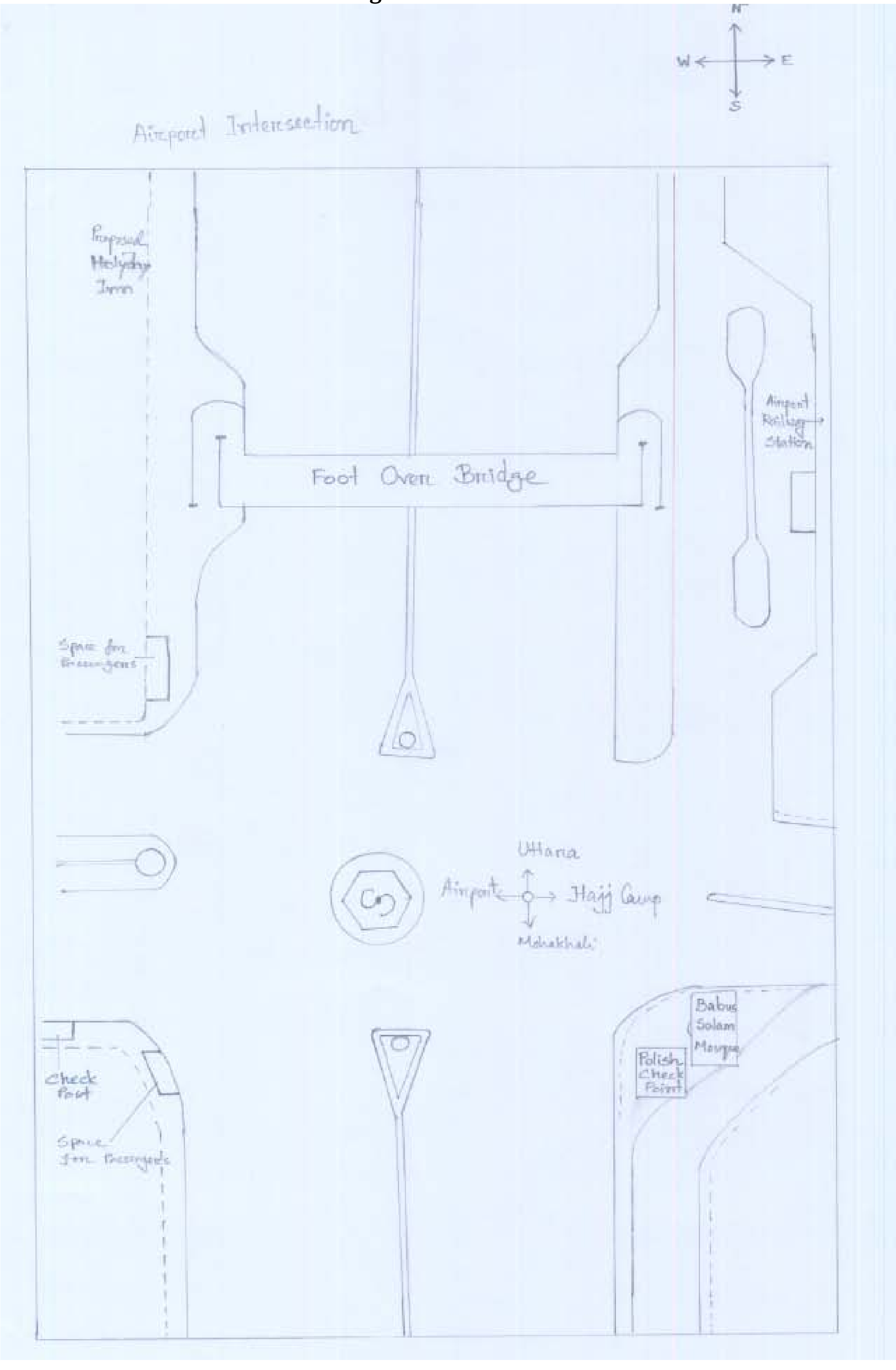


Physical Features of the Airport Intersection

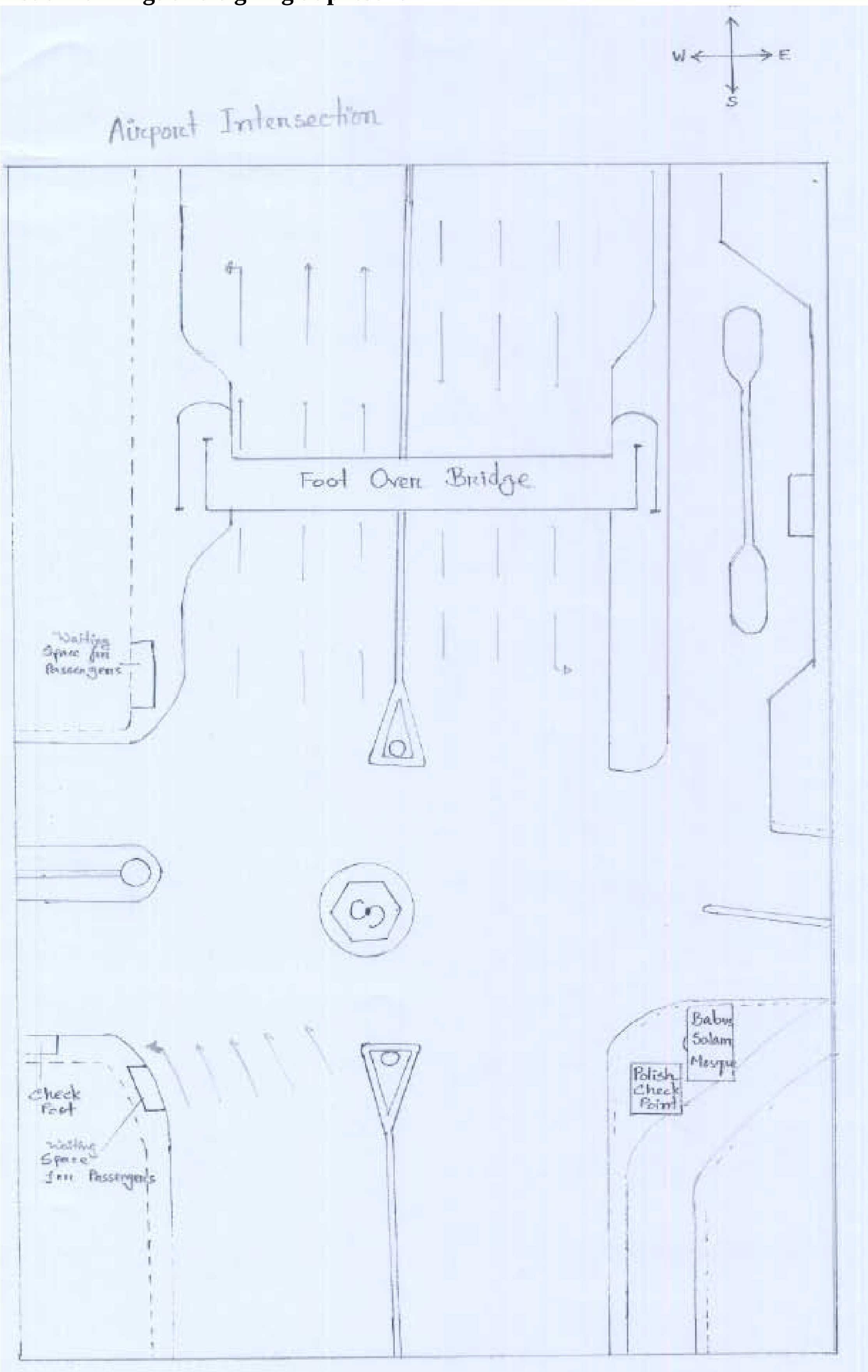
Dimension of different dimension at intersection



Location of the intersection showing land use

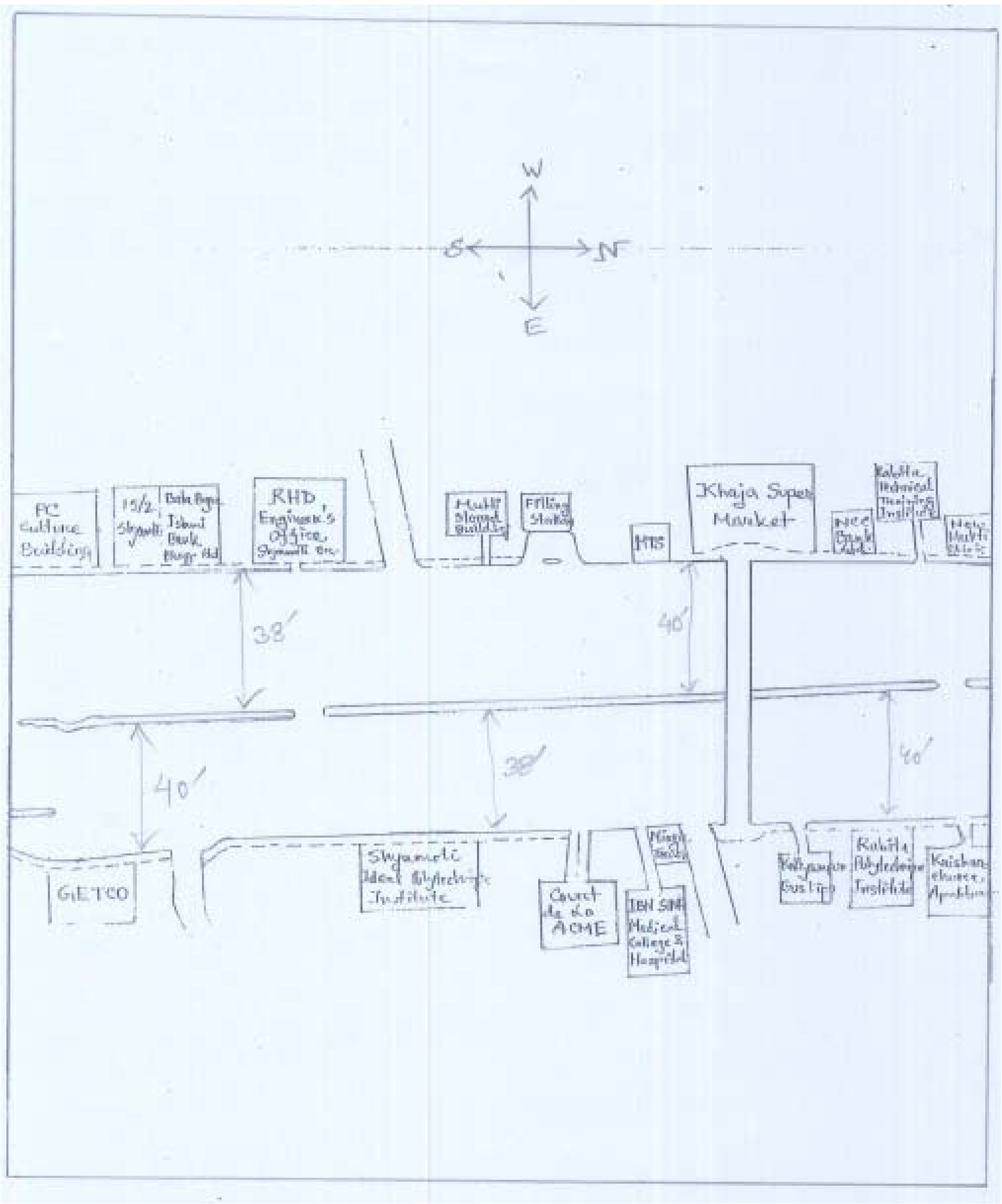


Road markings and signing at present

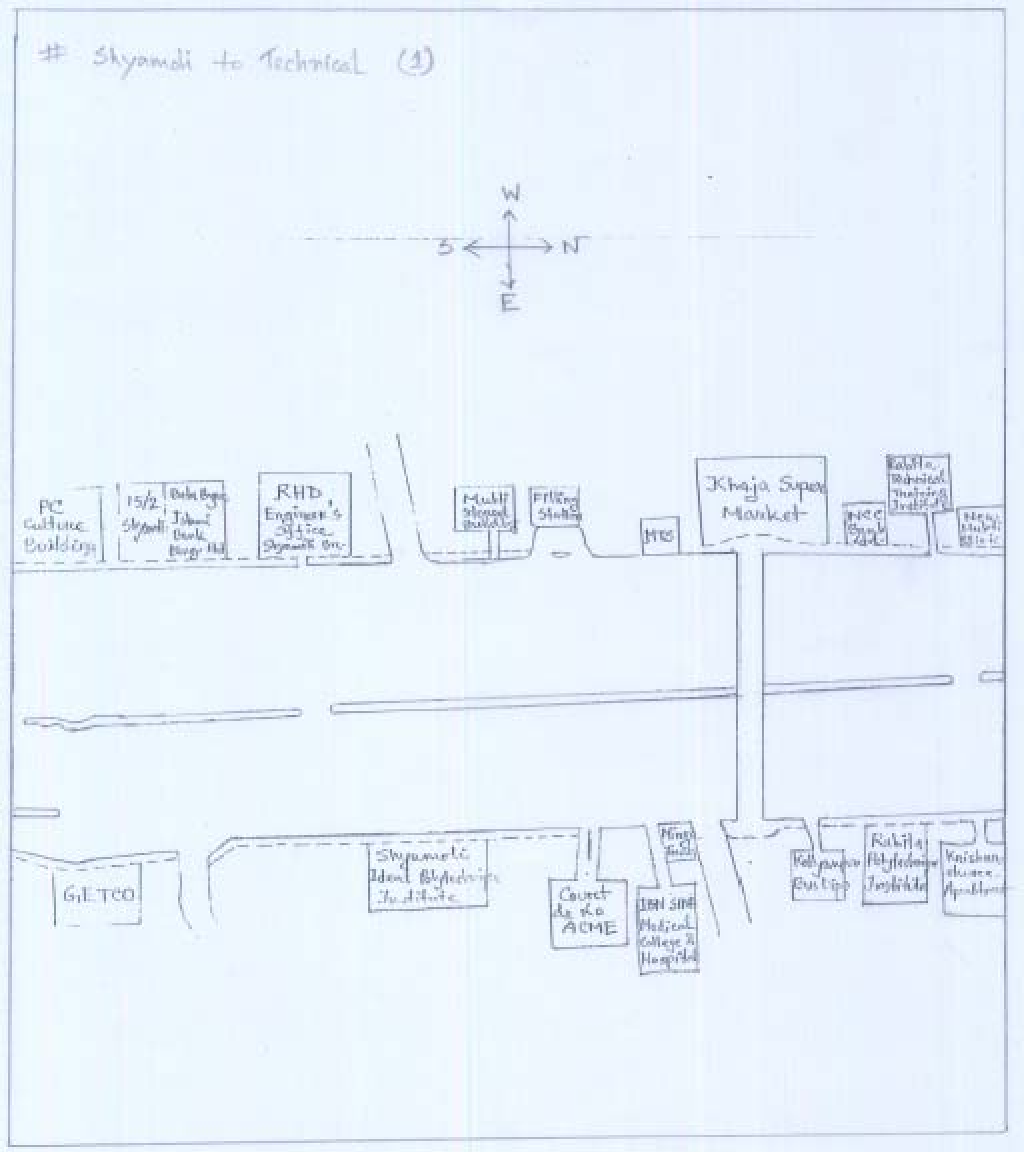


Physical Features of the Shamoly to Technical Section (Phase I)

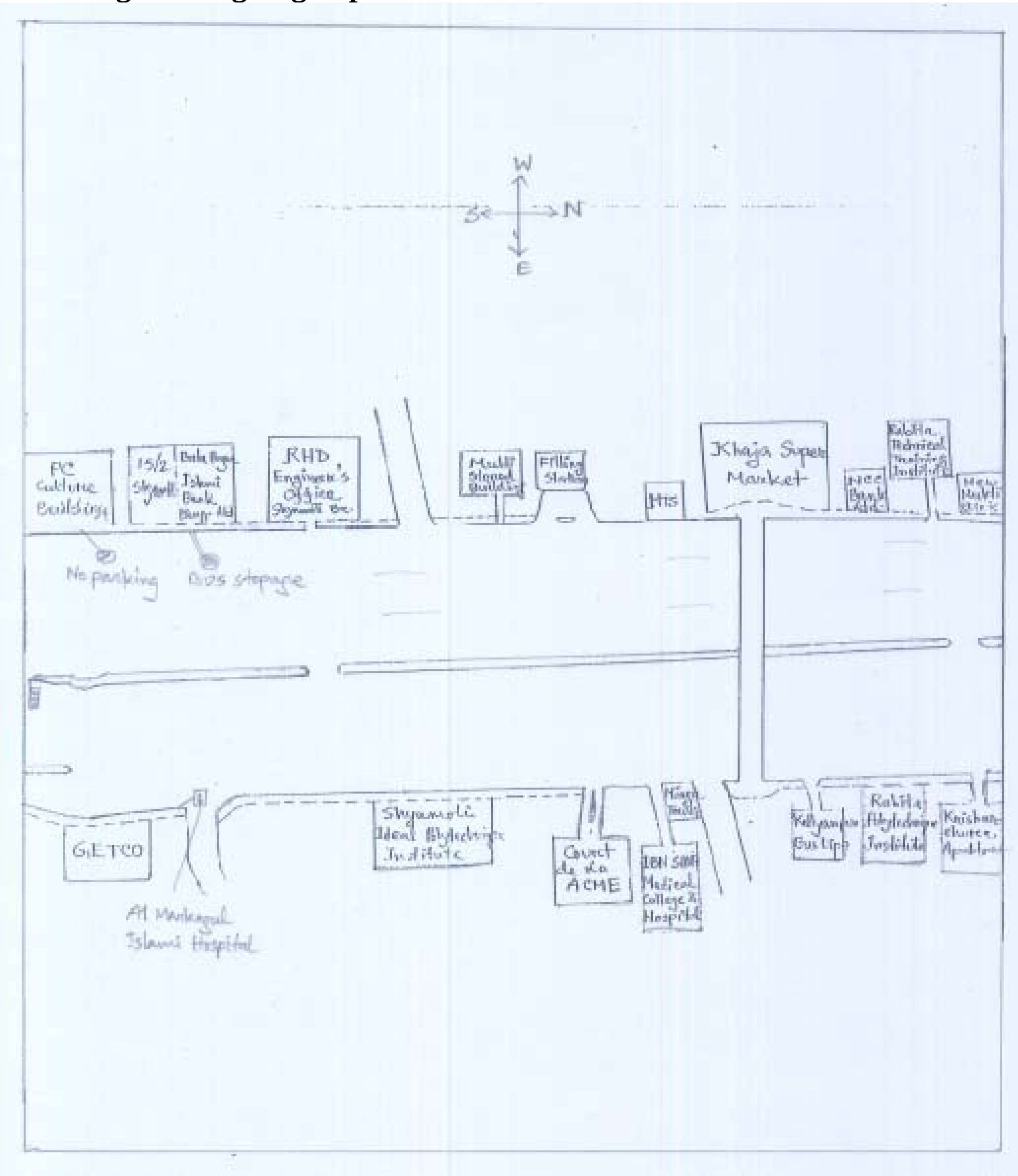
Dimension of different dimension at intersection



Location of the intersection showing land use

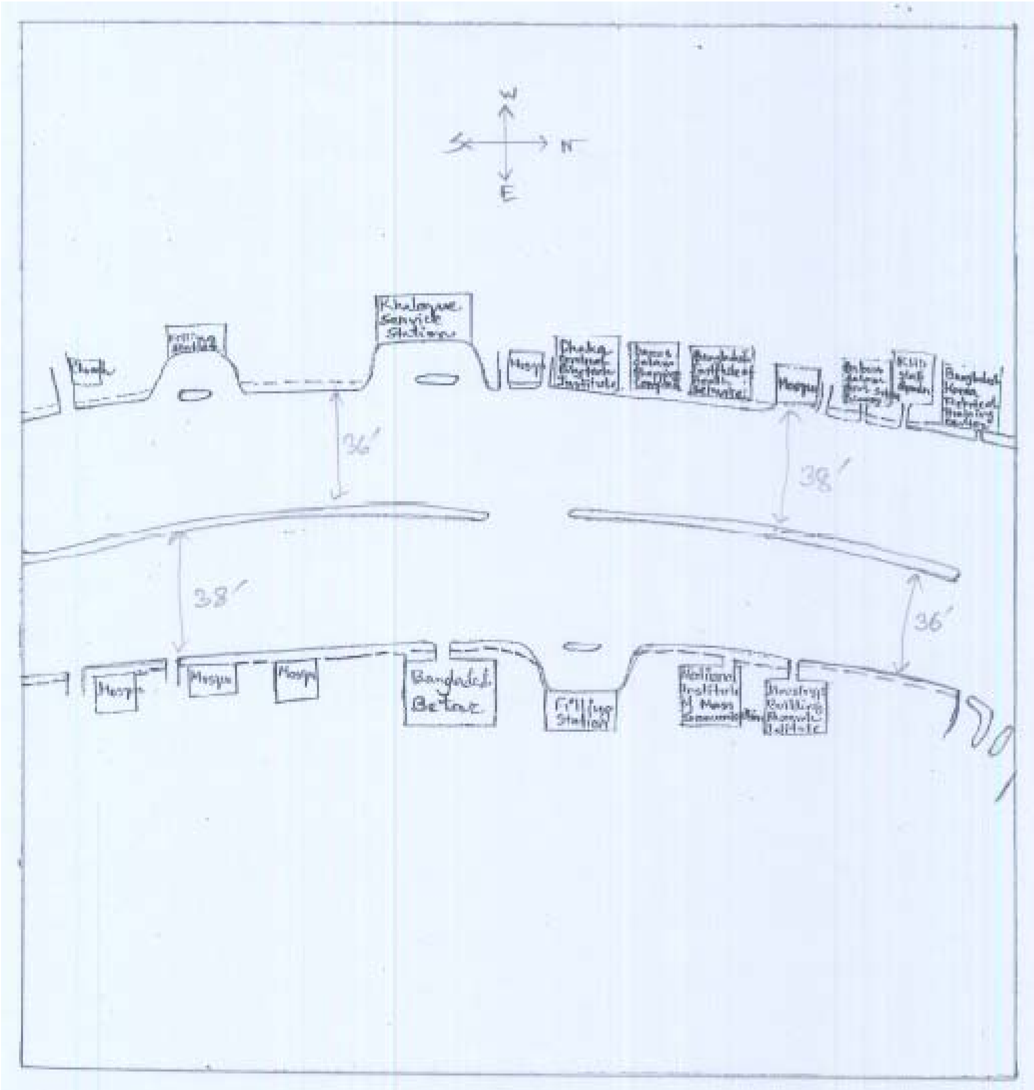


Road markings and signing at present

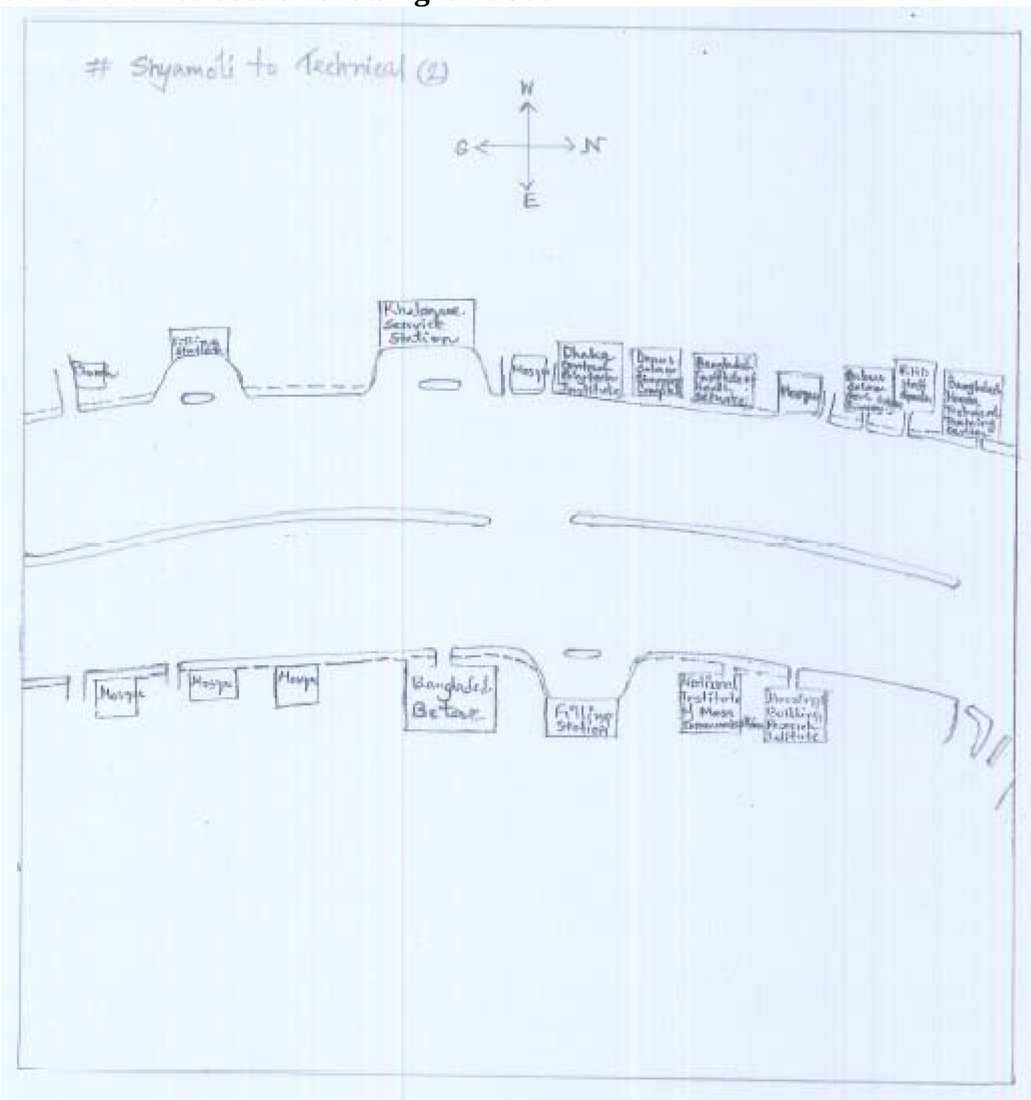


Physical Features of the Shamoly to Technical Section (Phase II)

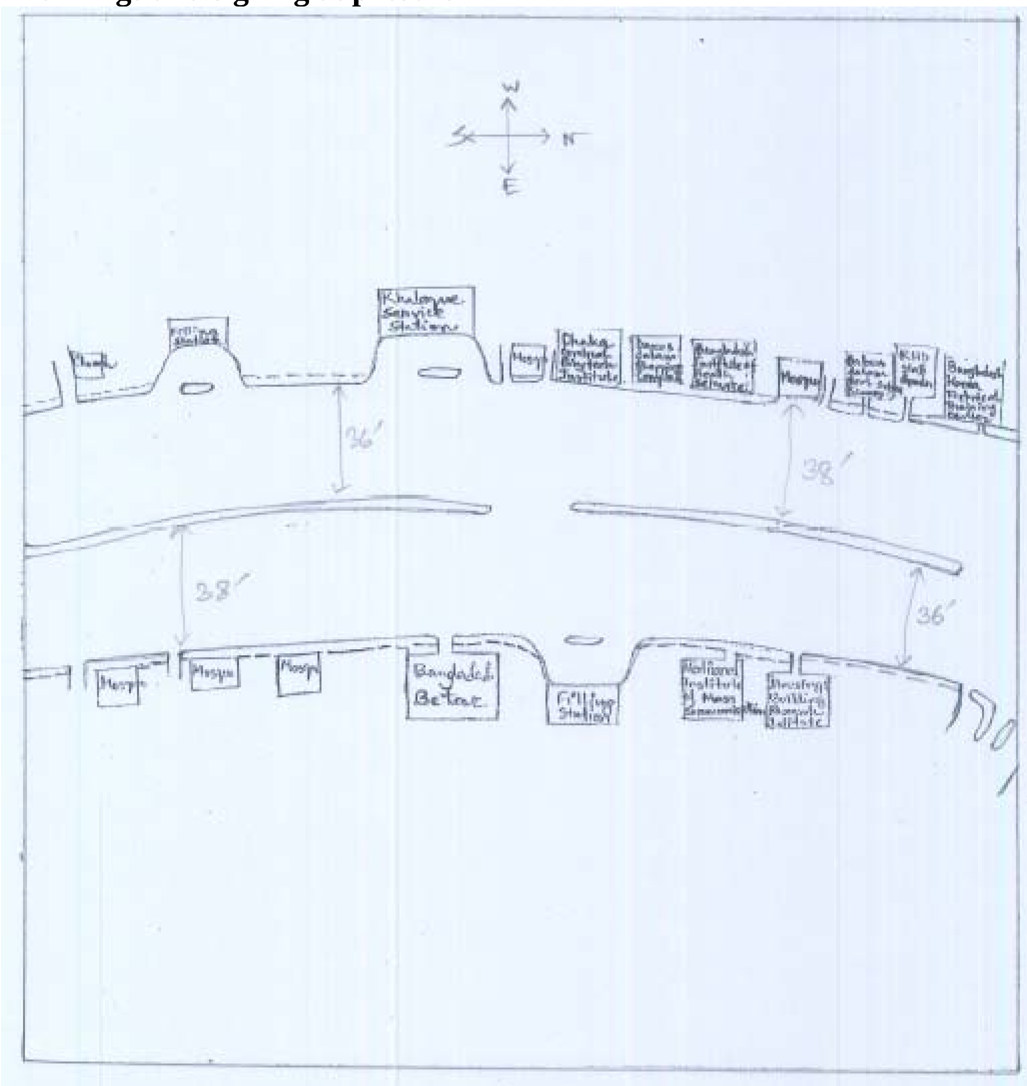
Dimension of different dimension at intersection



Location of the intersection showing land use

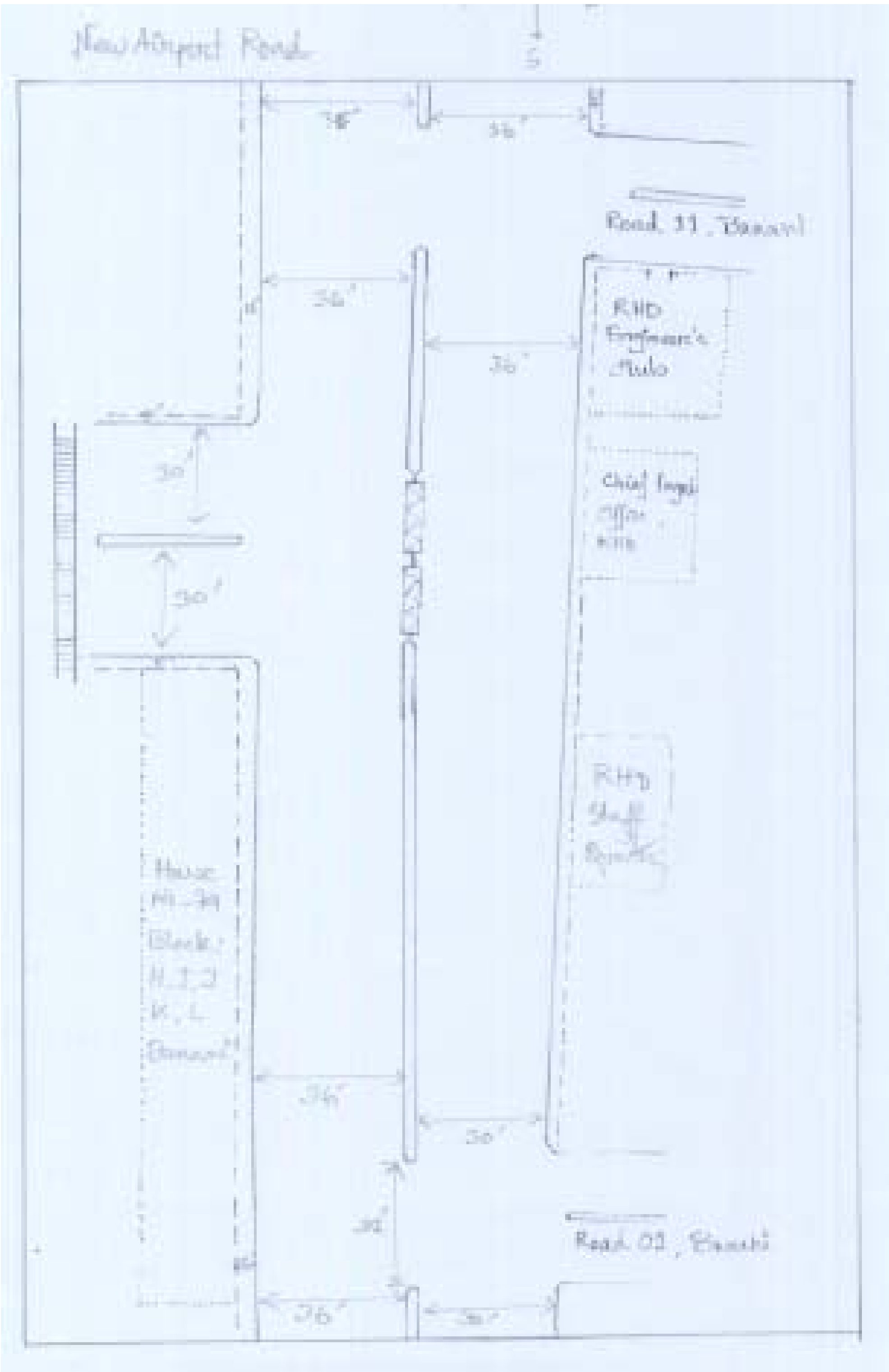


Road markings and signing at present

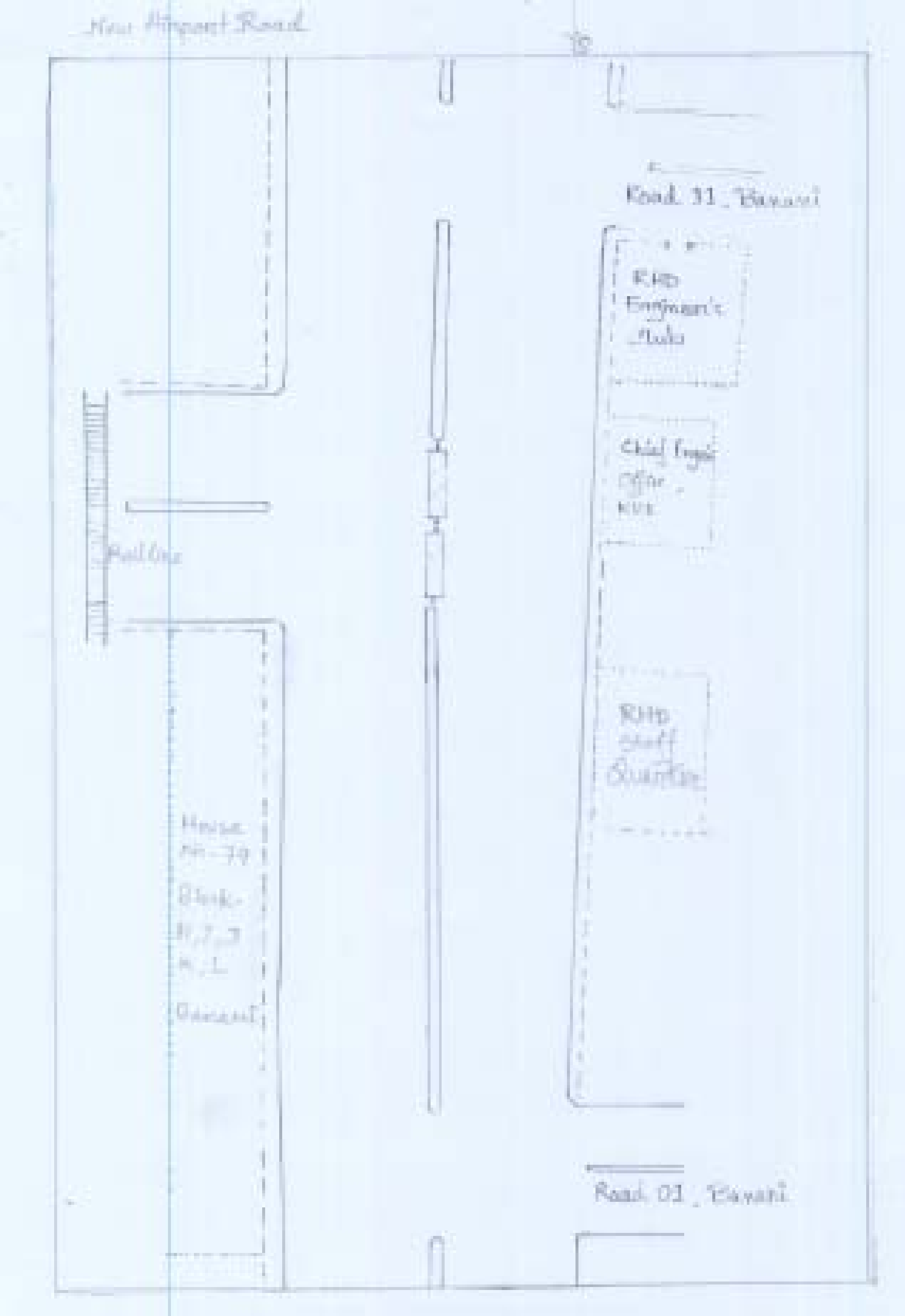


Physical Features of the Banani 1 to Banani 11

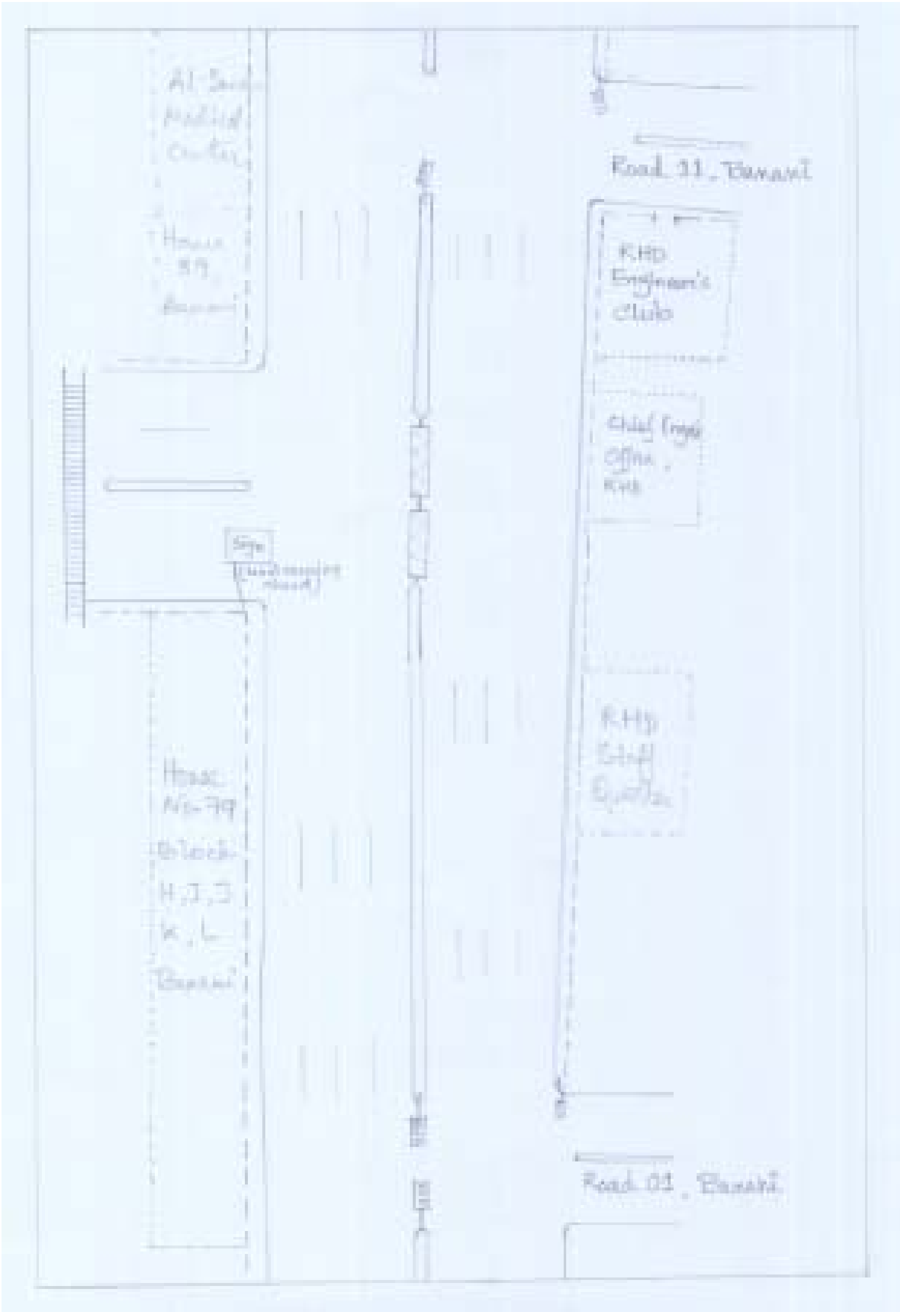
Dimension of different dimension at intersection



Location of the intersection showing land use



Road markings and signing at present



APPENDIX IV: PICTURES OF THE IDENTIFIED PROBLEMS

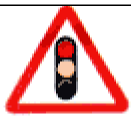
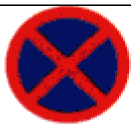
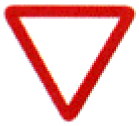
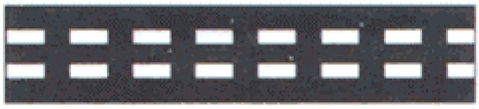
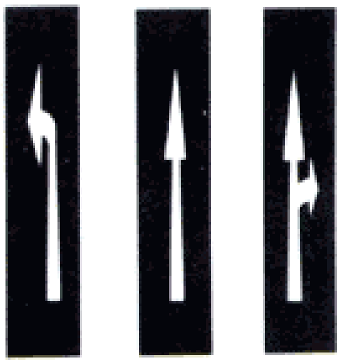
Feature of the Pavements and Foot paths at Airport intersection	
	
Footpath occupied by the hawkers	Bricks are come out from the Footpath
	
Bad drainage facilities at intersection	Footpath occupied by bus ticket counters
	
Holes at the pavement	Fade out road marking
	
Deviation of carrigeway at intersection	Street lights are broken at many locations

Feature of the Pavements and Foot paths at Shamoly intersection	
	
Footpath occupied by the hawkers	Destructed Footpath
	
Bad drainage facilities at intersection	Median is occupied by materials
	
Bad raise of the footover bridge	Very narrow stair to overbridge
	
Deviation of carrigeway at intersection	Some deviated establishment at carrigeway

<table>
<tr><th colspan="2">Feature of the Pavements and Foot paths at Banana 1- Banani11</th></tr>
<tr><td></td><td></td></tr>
<tr><td>Footpath occupied by the vehicles</td><td>Bricks are come out from the Footpath</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Bad drainage facilities</td><td>Footpath occupied by the aluminum</td></tr>
<tr><td></td><td></td></tr>
<tr><td>WASA Poltoon at the pavement</td><td>Fade out road marking</td></tr>
<tr><td></td><td></td></tr>
<tr><td>Footpath is occuoied by electric boards</td><td>Pavement is uneven</td></tr>
</table>

Feature of the Pavements and Foot paths at Shamoly to Technical	
	
Footpath occupied by the bus counters	Illegal occupancy over Footpath
	
Bad drainage facilities at carriageway	Discontinuation of the footpath
	
No lane marking	Inconsistent deviation on the carrigeway
	
Deviation of carrigeway	Pedestrians facilities are ignored all the way

APPENDIX V: SIGNS USED FOR DIFFERENT LOCATIONS

<table>
<tr>
<td>
No rickshaws</td>
<td>
No cycles</td>
<td>
No parking</td>
<td>
Roundabout</td>
</tr>
<tr>
<td>
No overtaking</td>
<td>
Traffic signals</td>
<td>
No pedestrians</td>
<td>
Ahead only</td>
</tr>
<tr>
<td>
Pedestrian crossing</td>
<td>
No stopping</td>
<td>
No vehicles over height shown</td>
<td>
Give way to traffic on major road or roundabout</td>
</tr>
<tr>
<td colspan="2">
Vehicles must stop and give way to traffic on the major road. At traffic signals vehicle must stop unless the signals allow them to proceed.

Vehicles must give way to traffic on the major road or rounabout</td>
<td colspan="2">
Traffic lane arrows</td>
</tr>
</table>