JIMMA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

JIMMA INSTITUTE OF TECHNOLOGY

SCHOOL OF CIVIL & ENVIRONMENTAL ENGINEERING

CONSTRUCTION ENGINEEING AND MANAGEMENT STREAM

AN OVERVIEW OF ROAD SAFETY MANAGEMENT IN THE CITY OF ADDIS ABABA

(CASE STUDY AT BLACK SPOT SECTIONS AND REVIEW OF TRAFFIC POLICE ACCIDENT RECORD)

A Thesis submitted to the School of Graduate Studies of Jimma University in Partial fulfillment of the Requirements for the Degree of Master of Science in Civil Engineering (Construction Engineering and Management).

BY:

Endale Berhanu

December, 2015

Jimma, Ethiopia

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Endale Berhanu

Advisor: Esayas Alemayehu (Dr. Ing.)
Co-Advisor: Mamuye Busier (MSc).

DECLARATION

I, hereby declare that this thesis work entitled "An Overview of Road Safety Management in the City of Addis Ababa: Case study at Black Spot Sections and Review of Traffic Police Accident Record" is my original work and has not been presented by any other person for an award of a degree in this or any other University.

Name	**Signature**	**Date**
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This thesis has been submitted for examination with my approval as university supervisor

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(External Examiner)		

Abstract

Unless Road Safe Management System at Road Traffic Accident Black Spot sections of the road in terms of black spot treatment or intervention is undertaken, identification of road traffic accident black-spots (RTABSs) in the City of Addis Ababa is either negligible or only a general attempt made for the city as a whole without interventions at the most severe section or spots of the road in the reduction or prevention of injuries of road crashes. The main aim of this study was, therefore, to characterize road traffic accidents in the sub-city of Addis Ababa. For this purpose, secondary data obtained from Addis Ababa traffic police office was employed. The findings of the study revealed that road fatalities (334 -374), serious injuries (2,205 – 2,869) and property damages in Birr (20,365,227 – 72,687,411) are increasing in the study period from 2003-2013. Among the most vulnerable group of road users, pedestrian group cumulative fatality and injury accounts (3,531 – 18,951) which is the most affected groups, followed by passengers (322 – 3,841), and drivers (165 - 949) between the same study periods. Along with group of transport system causing injuries constitute motor/bicycle 2%, automobile 26%, trucks 39%, taxi 19%, public transport 10% and others 3% in the intended periods.

Next to characterizations of accident, the main objectives of the study was to see the safe road management interventions at the most severe identified black spot section of the road through observational check list with the local traffic police officers namely Kirkos Sub City, Arada Sub City and Bole Sub City. The main causes of accidents at black spots were not intervened as required: - unavailability of proper pedestrian facilities, high volume of pedestrian traffic, drivers' fatigue, and lack of awareness of traffic rules and regulations, and violation of speed limit, inadequate sight distances at curves, no proper traffic signs, and faded road markings are usually the most common causes of accidents.

The study also reveals that although one of the most venerable group of road users are pedestrian which accounts 3,531 (88%) fatality in the study period, the laxity in the provisions or interventions of safe road management system at RTABSs of road by the concerned agency like AACRA, in using low cost engineering counter measures are not capable and coordinated, consequently, the probability of other potential hazardous and black spot sections occurrences could be high and the traffic injuries is expected to become worsen and worsen.

As a final point, low cost engineering measures are recommended to reduce the number of road accidents at identified black spots and other sections. However, the effect should be evaluated with appropriate safety auditing procedures for reduction and prevention of accident, and barriers for an intervention of road safe management among institution should be studied in future incorporating: institutional capacity, political commitment, funding, implementation, monitoring, and evaluation and research requirements.

ACKNOWLEDGEMENT

I would like to acknowledge the efforts, support, guidance, cooperation and encouragement of numerous people who have made it possible for me to undertake this study.

I wish to express my sincere gratitude to my advisor, Dr. (Ing) Esayas Alemayehu (JU) and Ing. Mamuye Busier (JU) their patience, guidance, encouragement and support in shaping the outlook of this thesis. They provided invaluable insights that have guided my thinking and understanding.

I am grateful to Mr. Endalkachew Geremew (LLB and LLM) Attorney and Consultant at Law, and all other member of staff at the School of Civil and Environmental Engineering of Jimma University, for support, encouragement and facilitation.

I would also like to thank Addis Ababa Traffic Police officers, all the respondents and key informants for answering my questions and enabling me to complete this study.

I am also greatly indebted to Ethiopian Road Authority for providing me full sponsorship to undertake my Masters' study.

Last but not least, my appreciation goes to Ms. Fitsum Asrat for her help in secretarial work of this study.

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Acronyms

- AA – Addis Ababa
- AACRA – Addis Ababa City Road Authority
- AATPO – Addis Ababa Traffic Police Office
- AM – Anti Meridian
- BS – Black Spot
- CRBC – China Road and Bridge Corporation
- DALYs – Disability Adjusted Life Years
- ECA – Economic Commission for Africa
- ERA – Ethiopian Road Authority
- EPHA – Ethiopian Public Health Association
- FASC – Federation of African Society of Chemistry
- FDRE – Federal Democratic Republic of Ethiopia
- FTP – Federal Traffic Police
- GDP – Gross Domestic Product
- HAPI – Horn of Africa Press Institute
- HC – Human Capital
- JU – Jimma University
- KM – Kilo Meter
- LMICs- Low-and Middle Income Countries
- OAU – Organization of African Unity

- PCS – Population Census Commission
- PM – Post Meridian
- RSDP- Road Safer Development Program
- RSMS – Road Safe Management System
- RTA – Road Traffic Accident
- RTABSs – Road Traffic Accident Black Spot section
- UN- United Nation
- UNECA - United Nations Economic Commission for Africa
- VSM – Variable Message Signs
- WHO – World Health Organization
- WTP – Willingness To Pay
- YLL – Years life Lost
- YLD – Years Living with a Disability

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Glossary/Technical Terms

- **Road safe management System**: - Process to reduce the harm (deaths, injuries, and property damage) that result from vehicle crashes on public roads.
- **Road (Crashes) Traffic Accident:** is collision between vehicles; between vehicles and pedestrian; between vehicles and animals; or between vehicles and fixed obstacles", are a major global public health challenges.
- **Black spots:** is an engineering term to denote the section of a road network where traffic accidents usually occur.
- **Disability adjusted life years*;*** The years lost by an individual because he or she is disabled as a result of being involved in a traffic accident.
- **Injuries;** Number of persons who sustain tissue damage which may be slight or serious in a motor vehicle crash.
- **Health risk;** A term that express the relationship between accidents and population. It is measured as the number of persons killed or injured in a geographical area in a year divided by 100,000 populations in that geographical area.
- **System risk;** A term that express the relationship between accidents and motor vehicles. It is measured as the number of persons killed or injured in a geographical area a year divided by 100,000 vehicles in that geographical area in the year.

CHAPTER ONE

1.1. Back Ground of the Study

Low- and middle-income countries (LMICs) account for 90 percent of fatalities in road crashes [1]. More than 1.3 million people die in road crashes, and between 20 and 50 million are injured, many of whom suffer a permanent disability [2]. The socioeconomic costs of these injuries are estimated at between 1 and 7 percent of the GDP in LMICs [3] Like the actual and projected rates of motorization in these countries, the accompanying annual increase in road traffic injuries is unprecedented, involving premature death and disability, as noted, in catastrophic numbers, pre- dominantly among vulnerable road users and economically active males [5].

Without new initiatives of road safety management, more than 50 million deaths and 500 million serious injuries on the world's roads can be anticipated with some certainty by 2050 [7]. Nearly 60 percent of the preventable loss will occur in the World Bank's East Asia and Pacific and South Asia regions alone and a further 18 percent in Sub-Saharan Africa [4, 5, and 6].

Addis Ababa, which is the capital city of Ethiopia and the seat of many international organizations with more than 100 embassies, has now become one of the fastest growing and largest emerging market economics in the sub Saharan Africa. The population of the city is estimated to be 2.8 Million with an average growth rate of 2.1% [8]. Following the current economic development in the country, Addis Ababa has become the economic hub of the nation due its geographical as well as political significance. Such rapid socio-economic development in the city creates a huge demand for transportation and the passenger-Km travel is increasing. The Urban Transport study report of Addis Ababa estimates that the travel demand of Addis Ababa will be doubled in 2020 and the daily trip will become 7.7 Million trips per day from 3.6 Million in 2004 [9], and From the vital events indicators and cause of death reports (EPHA September 2013) among the top 15 leading specific causes of deaths, traffic accident is the 10^{th} stage [10]

Accordingly, official evidences show that the associated transportation problems in the city; namely, traffic congestion and traffic accident rate are becoming worse and worse.

According to a report by the Ethiopian government Federal Police Commission in the year 2007/08[11], for instance, one could easily notice that there were about 1802 traffic accident fatalities, 2156 serious injuries, 2123 slight injuries and 9005 property damage. With the expected considerable underreporting, the road traffic hazard is believed to be much higher than indicated by such statistics. Compared with international figures, the country is one of the worst examples in terms of fatality rate per vehicle which was 94.4 fatalities per 10,000 vehicles in 2009/10[11].

As it has been recognized by many international organizations, such as the United Nations and the World Health Organization, this development calls for effective road-safety measures [3]. It is not enough to implement measures that improve legislation, roads, vehicles, road-user behavior, and post crash response; one of the key activities is to organize effective and efficient road-safety management [12].

In this respect, road safety management is a "systems approach" to road safety that examines the components of the system (infrastructure, vehicle, and road user) in developing strategies for prevention of traffic congestion and traffic accident [3]. Furthermore, the following point of view will be assessed in this thesis: (1) assess the problem, policies, and institutional settings relating to road-traffic injury and the capacity for road-traffic-injury prevention in the city; (2) identify and observe the preventive measures of lead agency in government and others for the national road-safety effort.

1.2. Statement of the problem

The rate of traffic accidents in the city of Addis Ababa goes up together with the increase in the total number of motor vehicles in use and rapid growth rate in the population size. The ever increasing rise in the number of automobile ownership together with the poor condition of the existing functional public roads has factually resulted in causing the high level of safety problems. Hence, upon taking seriously such general trends of the city it evidently calls for an overwhelming policy attention that must be paid regarding these critical issues. In fact among the major issues to make an overall inquiry at this juncture would be specific and comprehensive target assessment if there is a lack of governmental leadership and capacity for road safety across key agencies at Addis Ababa in general and sub city level in particular.

Therefore it is inevitable that assessing the safe road management system/practice in relation with traffic injury at black spot would appear extremely important to highlight the alleged/purported seriousness of the problem as observed in the city could mainly be due to the gap in the road traffic injury prevention of the traffic management system. Taking into account such general understanding/perspective the study will examine the status of road safety management system of Addis Ababa at key governmental agencies directly in charge of road safety, road safety programs, and influential organizations outside the government, key research institutes, and it will identify the major barrier to improvement and forward low cost engineering counter measures that can improve traffics safety and reduce injuries and fatalities in targeted areas.

1.3. Significance of the Study

The study will add knowledge on understanding what engineering and other risk factors contribute to the occurrence of road traffic accidents and related injuries in the city of AA. The data obtained in this study, can be used by the transport authorities, traffic police commissions, road authority, road safety authorities for planning and evaluating road safety measures. The data can also be utilized by the AA road authority for planning and intervention using low cost engineering measures mainly at black spot section of the road. The recommendations will be forwarded to benefit the public at large on prevention of road accidents. The data can also be utilized as a baseline data in future related researches.

1.4. Objective

1.4.1. General Objective

The main objective of the research is to Overview Road Safety Management in the City Addis Ababa.

1.4.2. Specific objectives:

I. To review the magnitude of road traffic injuries and fatalities in AA as a public health and economic problem in the period of 2004 to 2013.

II. To assess engineering and other contributing risk factors for traffic injury at black spot road sections.

III. To spot the lead agency in the government to see the national safety effort, capacity and institutional setting for road traffic injury prevention.

IV. To propose short term engineering counter measures for identified high risk black spot road sections.

1.4. Research Questions

I. What kind of traffic injuries occurred in the city of AA in a period of 2004 and 2013?

II. What type of engineering measures/factors observed/lacked at black spot sections of the road to tackle the overall traffic accident problems of the city of AA?

III. What kind of safety measure have been taken or implemented in the city of AA by the lead governmental agent and other stakeholders?

IV. What short term engineering measure is going to be implemented in the city of AA mainly at black spot sections in particular?

1.5. Scope and Limitation

As the road safe management system in relation with traffic injury is apparently wide and touches lots of areas, it appears quite necessary to define the scope of the study with the belief that untreated topics could be left out and filled by other researchers. Accordingly, since the study uses purposive sampling, the scope is limited to the most serious black spots of road sections in Addis Ababa city

The other aspect of limitation of these non experimental studies is that, it cannot rule out extraneous variables: behavior of drivers, service year of vehicles, educational back ground etc… as the cause of what is being observed

1.6. Structure of the thesis

The report is organized in five chapters that are linked to the issues in relation to the study: it also includes information from various sources relating to the study. Chapter one gives the background of the study, problem statement and states the main objective of the study.

Chapter two characterizes road traffic injuries and safe road management system on the system theory as a base of knowledge of this study. Chapter three reviews the methodology used in the study, it elaborates the qualitative and quantitative methods used types of data collected.

Chapter four presents the findings using descriptive epidemiology of road traffic injuries and the findings on safety measures undertaken by local government authority at black spot sections of the road.

Chapter five presents the final discussion, conclusions and recommendations.

CHAPTER TWO

2. Literature Review

2.1. Introduction

Road Safety is a multi-sectoral and multidimensional issue. It incorporates the development and management of road infrastructure, provision of safer vehicles, legislation and law enforcement, mobility planning, provision of health and hospital services, child safety, urban land use planning etc. In other words, its ambit spans engineering aspects of both, roads and vehicles on one hand and the provision of health and hospital services for trauma cases (in post-crash scenario) on the other. Road safety is a shared, multi-sectoral, responsibility of the government and a range of civil society stakeholders. The success of road safety strategies in all countries depends upon a broad base of support and common action from all stakeholders [18].

2.2. Characterization of Road Traffic Accidents

Road traffic accidents (RTAs) here defined as "An accident that occurred on away or street open to public traffic; resulted in one or more persons being killed or injured, and at least one moving vehicle involved. Thus, RTA is collision between vehicles; between vehicles and pedestrian; between vehicles and animals; or between vehicles and fixed obstacles", are a major global public health challenges.

Descriptive epidemiology of road traffic injuries are outlined below:

- Mortality
- Morbidity
- Disability and costs (both social and economic).

Mortality

In 1998, there was an estimated 1,170,694 road traffic injury deaths worldwide. Deaths from road traffic injuries were the 10th leading cause of death among all ages, accounting

to 2.2% of the global mortality. Road traffic injuries were the leading cause of injury-related death, accounting for 20.3% of all injury deaths. However, among females, deaths from road traffic injuries were the 2nd leading cause of injury death, following suicide. Overall, males sustained 73.0% of road traffic injury deaths. Mortality rates were 28.8 per 100,000 population for males and 10.8 for females [19].

Road traffic injury deaths were the 2nd leading cause of death among those aged 15-44 years (21.7 deaths per 100,000) and the 3rd leading cause of death among those aged 5-14 years (13.7 deaths per 100,000). Deaths from road traffic injuries were also among the 15 leading causes of death for those aged 0-4 years (13.7 deaths per 100,000) and those aged 45-59 years (22.8 deaths per 100,000).

Road traffic injuries accounted for 1,029,037 deaths in low- and middle-income countries (87.9% of global mortality from road traffic injuries) and 141,656 deaths in high-income countries. Corresponding mortality rates per 100,000 populations were 20.7 and 15.6 deaths respectively [19].

World Health Organization (WHO) strategy of 2001 reports that currently road traffic injuries are the leading cause of deaths and injuries, the 10th leading cause of all deaths and 9th leading contributor to the burden of disease worldwide based on disability adjusted life years. The numbers of deaths resulting from road traffic crashes have been projected to reach 8.4 million in the year 2020.

Road traffic accidents which are generally unintended and preventable are a common risk every day to life that can happen to almost every one, anywhere. The problem of road traffic accident is increasingly becoming a threat to public health and national development in many developing countries. Road traffic accidents contribute to poverty by causing deaths, injuries, disabilities, grief, lost of productivity and material damages.
The British Medical Journal of 11th May 2002 indicated that more people die on the road traffic accident than from malaria worldwide; and that traffic accident cause about 1.2

million deaths and injury 10 to 15 million people a year in the world. Many people do not know that road traffic accidents are preventable [20].

Road traffic accidents are the most frequent causes of injury-related deaths worldwide [21]. According to the World Report on Road Traffic Injury Prevention [22] traffic accidents account for about 3000 daily fatalities worldwide. Statistical projections show that during the period between 2000 and 2020, fatalities related to traffic accidents will decrease with about 30% in high income countries. The opposite pattern is expected in developing countries, where traffic accidents are expected to increase at a fast rate in the years to come.

Morbidity

Aggregate global and regional data sources on road traffic related morbidity per se are not routinely published or accessible. The Transport Road Laboratory's recent report produced estimates of the global incidence of non-fatal road traffic injuries, based on assumptions that about 50% of road injuries are reported, that a ratio of 100 injuries for every fatality applies in highly motorized countries and a ratio of between 20 and 30 injuries for every fatality in less motorized countries. Clearly the basis on which these assumptions have been made can be questioned, as can the robustness of the estimates that have been produced.

Within-country data on non-fatal injuries are routinely available for some countries, particularly higher income countries, where sufficient resources exist for these data to be collected and collated routinely. However, such data are not commonly available in most low- and middle-income countries. Routinely collected police and/or transport sector data provide one source of data on non-fatal road traffic injuries, although definitions and classifications of injury severity are non-standard.

The Transport Research Laboratory report estimates that in 1999 there were at least 11 million non-fatal injuries in highly motorized countries and 12–23 million in less

motorized countries. Consequently, they estimate that in 1999 there were between 23 and 34 million road crash injuries.

Disability

Aggregate global and regional data on road traffic-related disability, in terms of the prevalence of longer-term sequelae of road traffic injuries, are not routinely available. Similarly few countries, if any, routinely collect data on the prevalence of injury-related disability in the absence of any recognized recording systems for the range of disabilities that might be attributed to road traffic injuries. Both follow- up studies of injured persons and population surveys can usefully provide such estimates [23, 24].

Estimates of road traffic disability-adjusted life years lost are available from the World Health report 1999 database.(1) Disability–adjusted life years (DALYs) combine data on the number of years of life lost (YLL) from premature death with a comparatively adjusted measure of years living with a disability (YLD). The latter adjustments are based on the severity and duration of the injury-related disability, and age and sex of the individual.

In 1998, there was an estimated 38,848,625 disability-adjusted life years lost from road traffic injury worldwide. Road traffic injuries were the 9th leading cause of disability-adjusted life years lost among all ages, accounting for 2.8% of global disability.

Road traffic injuries were also the leading cause of injury related disability. Among males, road traffic injuries were the 6th leading cause of disability-adjusted life years lost, while among females they were the 15th leading cause, and were a less important cause of disability-adjusted life years lost than self-inflicted injuries which ranked as the 12th leading cause of disability-adjusted life years lost. Overall, males sustained 73.1% of road traffic injury-related disability adjusted life years lost.

Road traffic injuries were the 2nd leading cause of disability-adjusted life years lost among those aged 5- 14 years (8.7 million DALYs lost)) and the 3rd leading cause of

disability-adjusted life years lost among those aged 15-44 years (22.8 million DALYs lost). Deaths from road traffic injuries were also among the 15 leading causes of death for those aged 0-4 years (3.1 million DALYs lost) and those aged 45-59 years (3.3 million DALYs lost).

Table 2.1 Disease burden for 10 leading causes of death.

1998. Disease or Injury	**2020. Disease or Injury**
1. Lower respiratory infections	1. Ishaemic heart disease
2. HIV/AIDS	2. Unipolar Major depression
3. Perinatal Conditions	***3. Road Traffic Injuries***
4. Diarrhoeal diseases	4. Cerebrovascular disease
5. Unipolar Major depression	5. Chronic obstructive pulmonary disease
6. Ishaemic heart disease	6. Lower respiratory infections
7. Cerebrovascular disease	7. Tuberculosis
8. Malaria	8. War
9. Road Traffic Injuries	9. Diarrheal diseases
10. Chronic obstructive pulmonary disease	10. HIV/AIDS

Source WHO, Evidence, Information and Policy Report 2000

By the year 2020,it is projected that road traffic disability adjusted life years lost will move from being the 9th leading cause of disability adjusted life years lost to the 3rd leading cause.

Economic and Social Costs

Routinely collated and published reports of aggregate global and regional economic and social costs of road traffic injuries are not available. However, the Transport Research Laboratory recently produced estimates of these costs, based on a review of costing studies undertaken in a range of countries.

Various methods exist for the costing of road traffic injuries, but most countries use one of the following two methods:

- the "gross output" of "human capital" (HC) method
- the "willingness to pay" (WTP) method

The latter method has been adopted in a number of high-income countries, whereas the former method is the method favored in those low- and middle-income countries that have had the resources to undertake these costing studies. While the human capital approach has traditionally focused on the direct and indirect costs of traffic injuries, recent recommendations suggest the need to augment these costs with costs that take into account the "pain, grief and suffering" of all those involved in road crashes.

The Transport Research Laboratory report indicates that road crash costs expressed as a percentage of GNP ranged from 0.3% in Vietnam to almost 5% in the USA, Malawi and Kwa Zulu, Natal. Further the report produced a crude estimate of global and regional costs, assuming that the annual cost of road crashes is about 1% of the GNP in "developing" countries, 1.5% in "transitional" countries and 2% in "highly motorized" countries [25].

A systematic review of all the available evidence on risk factors for road traffic injuries, robust epidemiological studies and highlights in particular those factors for which there is any information from studies conducted in low-income countries.

Individual risk factors (associated with increased risks of road traffic injuries)

- Both acute alcohol consumption and regular/usual alcohol consumption [shown in low-income countries also [*26)*].
- other drugs and medications
- speeding [shown in low-income countries also [27]
- non-wearing of seat belts

- non-wearing of motorcycle and bicycle helmets [shown in low income countries also [26]
- mobile phone use
- minimal driver experience
- carriage of peer passengers (for young drivers)

Vehicle factors

- absence of seat belts
- smaller vehicle size (for vehicle occupants)
- larger vehicle size (for vulnerable road users)
- older vehicle age
- poor vehicle conspicuity (for motorcycles)

Environmental factors

- higher traffic speed and traffic density
- one way streets and multi-home driveways (for child pedestrian)

In general the importance of injury as a public health problem is not well recognized in many developing countries [28]. Road traffic injuries are a major worldwide problem. In developing countries the trend has reached an alarming state, but very little attention is paid to the problem [29].

In developing countries the proportion of serious injured and killed casualties are higher than in the developed countries. An analysis of cross sectional data on road traffic related deaths has shown that the poorest countries have highest road traffic related mortality rates [31]. In this analysis, many industrialized countries appear to have introduced interventions that reduced the incidence of road traffic injuries and improve survival of those injured [31]. In developing countries there are some peculiarities regarding the accident profiles. A study done in Calcutta India, reported that there are some host

(human) factors (such as the behavior of drivers, pedestrians and cyclist behaviors) and seasonal factors (weather and time) that contribute to fatal road traffic accidents Zhang et al [33]. Overall, most traffic accidents occurred on main roads (highways) and in the majority of cases pedestrians were found to be at fault during crossing the roads [32].

Studies done worldwide have shown that road traffic injuries are the leading causes of death of many adolescents and young adults [29]. There is evidence that using minimum safety standards, crash worthiness improvement in vehicles, seatbelts use laws and reduced alcohol use can substantially reduce deaths on the road [30].

Based on current knowledge, fatal and long term crash injury is largely predictable, largely avoidable and a problem amenable to rational analysis and remedy. Research and experience in North America, Australasia and Europe have shown that very substantial reductions in road deaths and serious injuries can be achieved against the background of increased motorization. In 2004, the World Report of Road Traffic Injury Prevention provided a global call to action and blueprint for effective intervention based on past best practice as well as innovative, ambitious 'safe system' approaches. International organizations such as the World Health Organization [34], the World Bank [35, 36] all acknowledge that the key to achieving better performance in road safety is by more effective safety management.

Thus, there is an urgent need to recognize the worsening road safety situation in order to take appropriate action. Road traffic injury prevention and mitigation should be given the same attention and scale of resources that are currently being channeled towards other predominant health issues, if increasing human loss and injury on the roads, with their devastating human impact and large economic cost to society are to be avoided.

2.3. Road Safety Management System

Introduction

This chapter depicts partially the institutional frame work of organization in tracing and interventions of road accidents in the City of AA coupled with analyses of findings on the review of AATPO data mainly on: common place road traffic accident, the magnitude of accident on hourly and week bases, and environmental conditions of the road during traffic accident in period of 2003- 2013. And finally examination of effective counter measures intervenes by Addis Ababa City Road Authority (AACRA) on the identified Road Traffic Accident Black Spot sections in the City of Addis Ababa.

Institutional Frame work

Safety is produced just like other goods and services and the production process is viewed as a management system with three levels: **institutional management** functions produce **interventions**, which in turn produce **results**. Consideration of all elements of the road safety management system and the linkages between them becomes critical for any country seeking to identify and improve its current performance level.

In line with institutional frame work, the responsibility for road safety work in the city of Addis Ababa is shared by a number of governmental organizations. These organizations involved in the road safety work reflect many aspects of this field: Engineering, Education, Enforcement, Emergency medical services, and this situation is not unique in the city.

The organizations involved in road safety activities in the city of AA are:

- *AA Traffic Police Office*, whose responsibilities are control of road traffic and interventions in case of accidents,
- *AA Education Bureau*, whose responsibilities is the education of school children in road traffic safety issues.

- *AA City Road Authority*, whose responsibilities are construction, maintenance and road traffic safety issues,
- *AA Transport Bureau*, whose responsibilities is vehicle inspection, registration, load axle control and issuing of driving license.
- *AA Health Bureau*, whose responsibilities are emergency services and medical care in hospitals of injured persons,

The coordination of all the different aspects of the road safety work between the city government bodies involved seems to be more or less a problem. There is also a certain disagreement between the organizations as to where to the main responsibility of the road safety work should be.

Common Place Trend of Traffic Accident Death in the City of Addis Ababa

The common place of trend of road traffic accidents in AA City administration had been in increase for the past eleven years (2003 to 2013). The striking thing is that it is consistently high. The contribution of this city to the total motor accidents in the country was also very high. The alarming high road accidents may be attributed to the heavy traffic on the highway caused by vehicles going and coming from neighboring regions.

Obviously the frequency of road traffic accident in Addis Ababa varies from one place to the other. This variation in the frequency and intensity of road accidents has led to the need for identification of RTABSs for taking appropriate safe road management interventions at relevant accident locations by considering each target areas. Table 5.1 below shows the common place trend of motor traffic accidents from 2003- 2013. Accordingly, Commercials area (54-53%), residential area (19-17%), market area (11-12%) were the leading common place in the frequency of road traffic accident death being 1st, 2nd and 3rd in every five years period of time 2003-2008 and 2009-2013 respectively.

Safety is produced just like other goods and services and the production process is viewed as a management system with three levels: institutional management functions produce interventions, which in turn produce results [36]. Consideration of all elements of the road safety management system and the linkages between them becomes critical for any country seeking to identify and improve its current performance level [36] [37]

The strategy incorporates the safe system approach which aims to improve road safety through four cornerstones: safe road use; safe roads and roadsides; safe speeds; and safe vehicles. The State Black Spot Program is an element of the safe road and roadsides cornerstone.

Black Spot Program

One of the most cost-effective road safety interventions is to eliminate so-called black spots, that is, to remedy accident-prone locations along the roads. This includes the following steps: identify the black spots, study the problems (diagnosis) at each spot, design suitable countermeasures, estimate their effects, set priorities, implement, and finally, follow up and evaluate the results.

Black Spot Treatment

Treatment of black spots using low cost engineering measures is one of mechanism measures that help to reduce accidents at dangerous spots. The most popular low cost engineering measures incorporates:

- road realignments
- sealing of road shoulders

- signing and delineation improvements
- installation of audio tactile edge lining
- installation of roundabouts
- installation of traffic signals
- installation of pedestrian signals
- installation of advanced amber flashing warning signals
- improvements to existing signalized intersections
- installation of splitter islands
- hazard removal and protection
- installation/upgrading of street lighting
- skid resistant surfacing
- re-aligning Y intersections
- passing lanes at T intersections
- speed control measures

2.4. Low Cost Engineering Statistical Countermeasures

Roadside delineators

Research with roadside delineators shows little or no effect on accidents and injury accidents according to [44] When studying accidents during darkness only, a Finnish study shows a tendency to an increase in injury accidents when roads with bad alignment are equipped with delineators. The increase was not statistically significant. When studying accidents in darkness and during bad surface conditions only, there was a significant accident increase.

The estimated reduction factor for roadside delineators for accidents, injury accidents and fatal accidents is ±0 %. However, delineators make driving more comfortable and can lead to increased speed.

Road markings

Analysis performed in [44] shows that the most probable reduction factor of edge markings for injury accidents is -3 %. Estimated reduction in injury accidents for centerline markings is -1 %. Neither -3 % nor -1 % is statistically significant.

In a few studies, the reduction factor has been estimated when a previously unmarked road was marked with both center and edge markings. An analysis of these studies shows a significant decrease of injury accidents by -24 %.

Two research reports compare an unmarked road with a road with center and edge markings and roadside delineators. The results show a significant decrease in injury accidents by -48 %.

It is estimated that the reduction factor for accidents of road markings is: ±0 %: -10 %. Due to increased speed it is estimated that injuries and fatalities decrease less than accidents, probably by ±0 %; -3 %.

Change of general speed limit

The reduction factors of changed speed limit depend on the decrease in speed. Average reduction factors are estimated to be -10 %; -15 % for accidents, -20 %; -30 % for fatalities and -15 %; -20 % for injuries. The reduction factors are based on such changes in speed limit that the actual average speed is decreased by 5-6 km/h.

Side area improvement

When a vehicle leaves the road it is important that it does not collide with fixed hazardous objects like trees or outcrops of rock. Steep slopes are also dangerous and will be dealt with under the guardrail section. Flattening the side to avoid vehicles from rolling over is also a safety improvement. A possible benefit with flatter sides is that a vehicle that goes off the road will have the possibility to return to the road again. The flattening, however, has become somewhat discussed during the last years. When a vehicle that has gone off tries to come back, the driver sometimes turns the steering wheel so much that when the vehicle changes direction it either rolls over or it passes

over the road towards the other ditch. The latter can cause severe accidents if there are oncoming vehicles.

It is estimated that the reduction factors for substantial side area improvements are ±0 % for accidents and -20 %; -40 % for fatalities and injuries.

Roadside guardrails

Guardrails are used to prevent a vehicle from leaving the carriageway and the shoulders. It can be used at the roadside to hinder vehicles to go off the road or in the median to prevent collisions with oncoming vehicles. Guardrails on the side are erected where it is dangerous for vehicles to leave the road. The roadsides can be dangerous because the environment is hazardous with trees, rocks or stones or because of steep and high slopes. Guardrails can also be erected where there are pedestrians and bicyclists along the road.

The reduction factors for guardrails are estimated to be approximately the same as for roadside improvements: ±0 % for accidents and -20 %; -40 % for fatalities and injuries.

Median barriers

In [45] it is estimated that median barriers reduce the number of casualties by -10 %; -15 %. Damage only accidents increase by +20 %; +25 %.

As indicated [44] that median barriers on multi-lane roads decrease the number of fatal accidents by -20 % and the number of injury accidents by -5 %. Damage only accidents increase by +25 %.

Improved signing in curves

One of the cornerstones of road safety is never to surprise a driver. If there are curves that are sharper than the drivers have reasons to expect, it is wise to have some warning for these curves. It is then advisable to put up signs that improve the driver's vision of the curve or warns for the curve. It is important that this is done in a consistent way. If other curves with the same geometry are left unattended they could be even more dangerous since drivers' expectations have changed. It is also important that the signs are visible in darkness.

The reduction factor for background marking signs in curves is estimated to be -20 %; -40 %. Advance warning for curves has been found to decrease the number of injury accidents by -10 %; -30 %. However, the estimates are uncertain. The overall estimated reduction factors are -10 %; -40 % for accidents, fatalities and injuries.

Sight distance

The reduction factor for a substantially improved sight distance is estimated to be -5 %; -15 % for accidents. Since improved sight distance increases speed, the estimates for fatalities and injuries are lower: -5 %; -10 %.

Prohibit overtaking

There are no known research results that give the reduction factor of prohibiting overtaking. It cannot be ruled out that prohibiting overtaking can have a positive effect, for instance, in hidden depressions or junctions with bad visibility or other sites with many overtaking accidents. It is important, however, to be consistent and not to use prohibit overtaking too often. Prohibit overtaking is estimated to have a lower reduction factor than a median barrier.

Since a median barrier has a reduction factor of -10 %; -15 %, it is estimated that prohibited overtaking will have a factor of -5 %; -10 %, with the same value for accidents, fatalities and injuries.

Traffic regulation and information with variable message signs (VSM)

VMS have been used at pedestrian crossings etc. and with speed recommendations and road surface and traffic information. Speed reductions by -10 % and up to -30 % decreases in accidents have been the results.

VMS with road surface information have given somewhat lower speed, corresponding to a decreased accident risk by -15 %; -20 %.

The reduction factor for effective VMSs is estimated to be -15 %; -20 % for accidents, fatalities and injuries.

Improved route guidance

There are no known research results that show the reduction factor of improved route guidance. It is quite possible that clear and unique route guidance has a positive effect on safety. It can avoid sudden brakes when the driver has to change lane or direction at the last second. It can also prevent drivers to take the wrong way, which leads to more vehicle kilometers traveled than necessary.

It is estimated that improved route guidance will have a small reduction factor, around -2 % on accidents, fatalities and injuries.

Dividing islands on the secondary road

Dividing islands on the secondary road are, especially in 4-leg junctions, successful when the visibility of the junction needs to be improved. Otherwise, it is not regarded as a measure that decreases accidents, especially not in 3-leg junctions.

One good thing with dividing islands is that it allows pedestrians and cyclists to cross the road in two steps, which increases their safety.

The reduction factors for dividing islands on the secondary road for the number of accidents, injuries and fatalities are estimated at -5 %; -10 % in 4-leg junctions and ±0 % in 3-leg junctions.

Modern roundabouts

Modern roundabouts have several advantages from a safety point of view. If correctly designed they decrease vehicle speeds, which is beneficial for safety. A roundabout also creates one-way traffic, which simplifies for the drivers. This also implies that left-turning in front of oncoming vehicles is eliminated. One-way traffic also simplifies for the approaching vehicle, since the driver only has vehicles coming from one direction to consider when entering the roundabout.

Vehicles are conflicting at small angles in a roundabout. So, if there is a collision, the collision forces are small. This means that the risk of severe accidents is low when there is an accident.

It is estimated that the reduction factors for modern roundabouts are +20 %; -70 % for accidents, -50 %; -80 % for fatalities and ±0 %; -50 % for injuries.

Signalization

Installing modern traffic signals in a junction is estimated to give an average reduction factor of -30 % for accidents, injuries and fatalities in 4-leg junctions, and -15 % in 3-leg junctions. Traffic signals can, however, increase the number of accidents if installed in junctions where the percentage of vehicles coming from the secondary road is low. It is assumed that the signal is traffic regulated. Time regulated signals are not advisable. They do normally increase the number of accidents.

Lighting in a junction

Lighting in a junction decreases the number of night-time accidents and thus all accidents. The reduction factor is higher when traffic on the secondary roads is higher. Lighting is also more necessary where there are many pedestrians.

The reduction factor for lighting in a junction is estimated to be -20 %; -40 % of night-time accidents, corresponding to -5 %; -10 % of all accidents, fatal accidents and injury accidents. Where there are many vulnerable road users, the decrease of fatalities and injuries could be higher.

Rumble strips

Rumble strips consist of a number of painted strips across the road. The aim is to create vibrations and noise so that the driver is alerted. This is also supposed to make him decrease his speed.

It is estimated that rumble strips in front of a junction decrease the number of injury accidents by -30 % (interval -40 %; -25 %) in the junction, and damage only accidents by -25 % (interval -45 %; -5 %). Fatalities are reduced more, around -40 %.

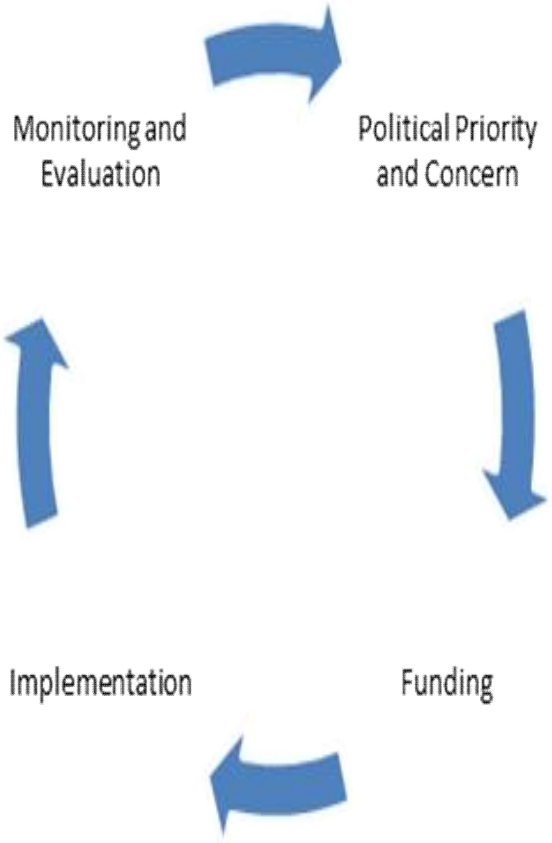
Separated bicycle and pedestrian lanes in urban areas

Pedestrian and bicycle lanes in urban areas can be separated from motor vehicle traffic by curbstones. As shown on [44] that constructing a separate pedestrian and bicycle lane in urban areas decreases the number of injury accidents.

The estimated reduction factor for separate bicycle and pedestrian lanes (in urban areas) is -4 % (interval: -7 %; -1 %) for accidents, fatalities and injuries.

Requirements to sustain reduction of road accidents

As shown in literature, there are plenty of requirements to sustain reduction of road accidents: political commitment and concern, funding, implementation, monitoring, evaluation and research [46]. As political concern is low, funding is seen as difficult problems. Thus implementation of counter measures becomes difficult, and accidents continue to increase. Outside stimulation for one or more of the above areas, could turn the vicious circle into positive one as indicated in Figure 2.1. Increased political concern can bring about organization of user fees for increased funding, which in turn will make implementation of counter measures are easier. When adequate countermeasures are implemented, the monitoring system will bring show favorable effects for road safety, and political concern will be further stimulated.



Figures 2.1. Relations between high priority areas of action.

CHAPTER THREE

3. Research Design and Methodology

3.1. Study Area

Introduction

Addis Ababa is the capital city of Ethiopia. Founded in 1886, it is the largest city in Ethiopia, with a population of 3,384,569 according to the 2007 population census with annual growth rate of 3.8%. This number has been increased from the originally published 2,738,248 figure and appears to be still largely underestimated.[47][48]

As a chartered city (ras gez astedader), Addis Ababa has the status of both a city and a state. It is where the African Union and its predecessor the OAU are based. It also hosts the headquarters of the United Nations Economic Commission for Africa (UNECA) and numerous other continental and international organizations. Addis Ababa is therefore often referred to as "the political capital of Africa" due to its historical, diplomatic and political significance for the continent.[49]

The city is populated by people from different regions of Ethiopia – the country has as many as 80 nationalities speaking 80 languages and belonging to a wide variety of religious communities. It is home to Addis Ababa University. The Federation of African Societies of Chemistry (FASC) and Horn of Africa Press Institute (HAPI) are also headquartered in Addis Ababa.[49]

Geography

Addis Ababa lies at an altitude of 2,300 metres (7,500 ft) and is a grassland biome, located at 9°1′48″N 38°44′24″E Coordinates: 9°1′48″N 38°44′24″E.[15] The city lies at the foot of Mount Entoto and forms part of the watershed for the Awash. From its lowest point, around Bole International Airport, at 2,326 metres (7,631 ft) above sea level in the southern periphery, the city rises to over 3,000 metres (9,800 ft) in the Entoto Mountains to the north.

Subdivision

Table 3.1. The city is divided into 10 boroughs named sub cities and 99 kebele, the 10 sub cities are:

Nr	Subcity	Area (km^2)	Population	Density/km2	Map
1	Addis Ketema[18]	7.41	271,644	36,659.1	
2	Akaky Kaliti[19]	118.08	195,273	1,653.7	
3	Arada[20]	9.91	225,999	23,000	
4	Bole[21]	122.08	328,900	2,694.1	
5	Gullele[22]	30.18	284,865	9,438.9	
6	Kirkos[23]	14.62	235,441	16,104	
7	Kolfe Keranio[24]	61.25	546,219	7,448.5	
8	Lideta[25]	9.18	214,769	23,000	

Nr	Subcity	Area (km^2)	Population	Density/km2	Map
9	Nifas Silk-Lafto[26]	68.30	335,740	4,915.7	
10	Yeka[27]	85.46	337,575	3950.1	

Economy

The economic activities in Addis Ababa are diverse. According to official statistics from the federal government, some 119,197 people in the city are engaged in trade and commerce; 113,977 in manufacturing and industry; 80,391 homemakers of different variety; 71,186 in civil administration; 50,538 in transport and communication; 42,514 in education, health and social services; 32,685 in hotel and catering services; and 16,602 in agriculture. In addition to the residents of rural parts of Addis Ababa, the city dwellers also participate in animal husbandry and cultivation of gardens. 677 hectares (1,670 acres) of land is irrigated annually, on which 129,880 quintals of vegetables are cultivated. The city has recently been in a construction boom with tall buildings rising in many places. Various luxury services have also become available and the construction of shopping malls has recently increased.

Transport

Public transport is through public buses from Anbessa City Bus Service Enterprise or blue and white share taxis. The taxis are usually minibuses that can seat at most twelve people. Two people are responsible for each taxi, the driver and a weyala who collects fares and calls out the taxi's destination.

Road

The construction of the Addis Ababa Ring Road was initiated in 1998 to implement the city master plan and enhance peripheral development. The Ring Road was divided into three major phases that connect all the five main gates in and out of Addis Ababa with all other regions (Jimma, Debre Zeit, Mekelle, Gojjam and Ambo). For this project, China Road and Bridge Corporation (CRBC) was the partner of Addis Ababa City Roads Authority (AACRA).[51] The Ring Road has greatly helped to decongest and alleviate city traffic.

3.2. Study Design/Period

Although there are endless ways of classifying research design, they usually fall into one of the three general categories: Experimental, Quasi- Experimental, and Non Experimental. This classification system is based primarily on the strength of designs experimental control. Therefore in this particular thesis, since there is no extraneous variables as the cause of what is being observed, or no control over the variables and the environments that the study looking for, Non Experimental designs (i.e. descriptive and co-relational designs) is going to be used as a scientific study design [15].

This study design will provide a brief overview of the safe road management system in relation with traffic accident in the period of 2004 – 2013, through the most widely used approaches: Case study.

Case Study: involve in providing an accurate and complete description of the road traffic accident in the city of AA, using in depth review of traffic records in the specified period of time. According to Kazdin [16], the main characteristics of case studies are:

- The information is highly detailed, comprehensives, and typically reported in a narrative form as opposed to the quantified records of dependent measure.
- The information they examine is retrospective or archival.
- Is unique and valuable source of information the complements and informs theory, research, and practice kazadin [17], serving to fulfill the first goal of science, which is to identify issues and causes that can then be experimentally assessed.

Sampling

There are many different ways of to choose sample, and the method will depend on the area of research, research methodology and preference of the researcher. Basically there are two main type of sampling: probability and purposive sampling [15].

In this thesis, purposive sampling (i.e. Convenience sampling and Hand Picked sampling) is going to be under taken.

Convenience Sampling: this method of sampling usually used when there is limited time of research, limited recorded data and other resources. Hence this sampling is very helpful in the identification and assessment of black spot section or routes of the road in the city of AA.

Hand Picked Sampling: since safe road management system among key Governmental and other stakeholders are looking for expertise, cover range of possibilities, politically important cases or enhance learning by exploring the limits or boundaries of a situation or phenomenon, this method is going to be used for sampling.

Data Collection Techniques and Tools.

There are many different approaches to data collection: desk review, interviewing, global rating, observation, biological measures etc…

Among this approaches desk review techniques is used in this thesis, which it provides an accurate and complete description of the traffic accident report; type of injury, place, behavior of drivers, road environment, etc…

The second approach of this thesis is observational method of data collection, which it relies on the direct observation of the construct of interest under natural setting, which is also often used in the assessment of highly risky black spot section of the main road.

Lastly, the survey study (i.e. interviewing) through both open ended and close ended questions of measurement modalities is used under lead governmental and other stakeholders' assessment with regards to safe road management, practice and road traffic accident in the city of AA.

CHAPTER FOUR

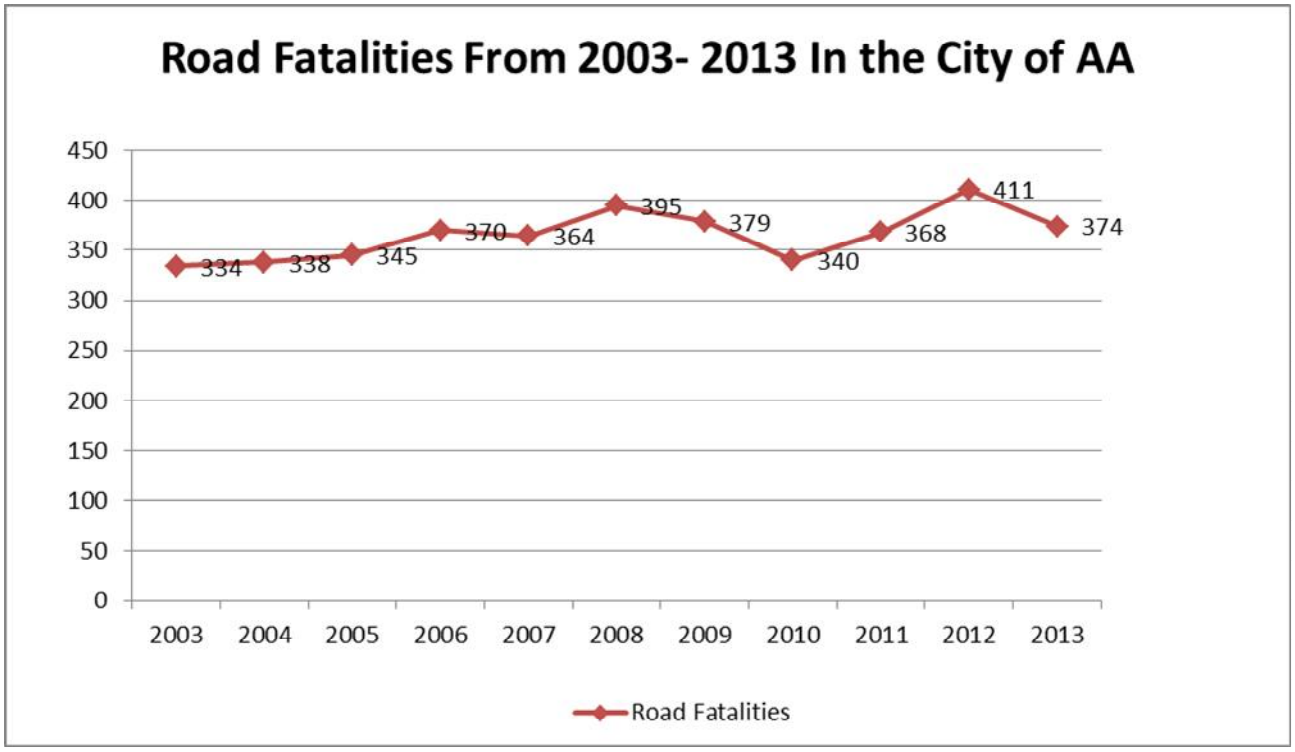
4. Result and Discussions

4.1. Traffic accidents in the city of Addis Ababa

Road Fatalities

Road traffic accidents constitute a major challenge in Addis Ababa not only in terms of health of the people but also in terms of economic loss. In 2004, 2006, 2012 the number of reported death resulting from road accidents was about 338, 370, 411 reflecting an annual growth of 1%, 7%, 12% compared to the previous year respectively (Figure 1). The corresponding economic loss which is **22,436,120 birr**, **27,300,115 birr** and **52,013,101** birr with growth of 10%, 4%, and 14% compared to the previous year respectively (Figure 2).

Figure 4.1: **Road Fatalities from 2003- 2013 in the City of AA**

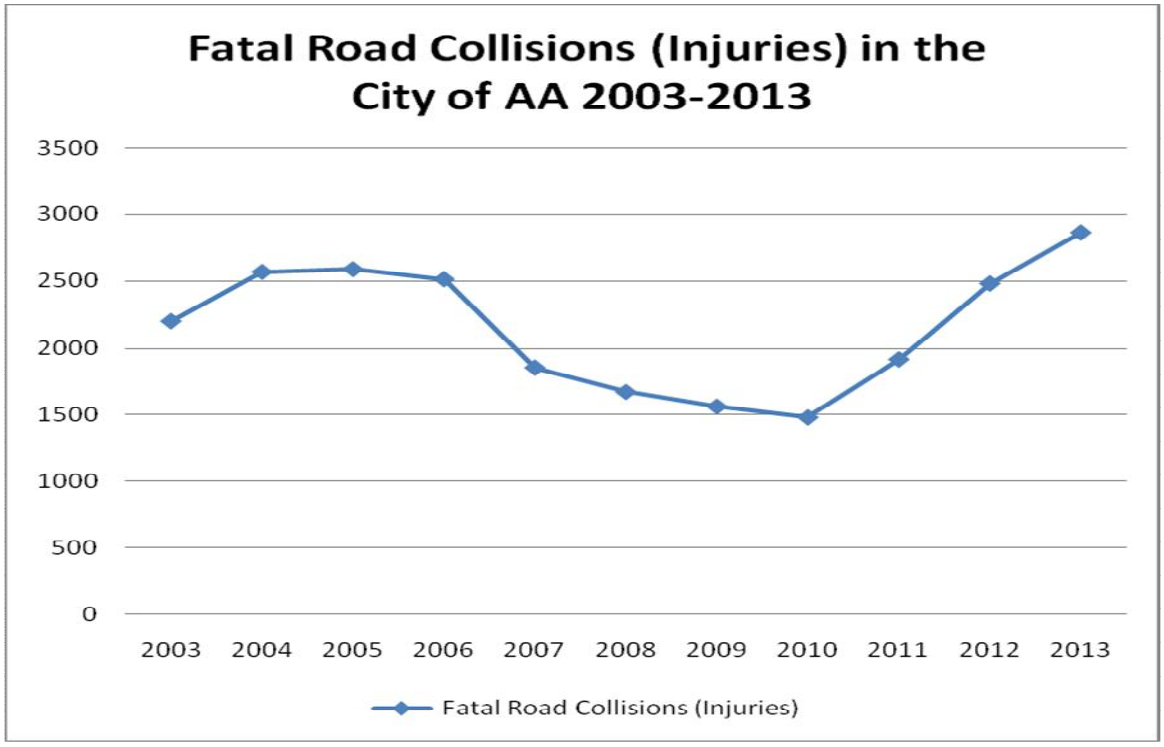


Source: Police Recorded Registration from AATPO (2003-2013)

Serious Injuries

Figure 2 depicts the trend in persons reported seriously injured between 2003 and 2013. During 2006- 2010, there was a reduction of 41% in the number of people injured. Mean while during 2010- 2013, there was an increase of 55% in the number of people injured. In addition, there is concern that some injuries go unreported. Therefore, it is important to continue to address the issue of serious injuries as they can lead to life-long disability and high costs associated with treatment and care, whilst agreeing a new way of defining a serious injury.

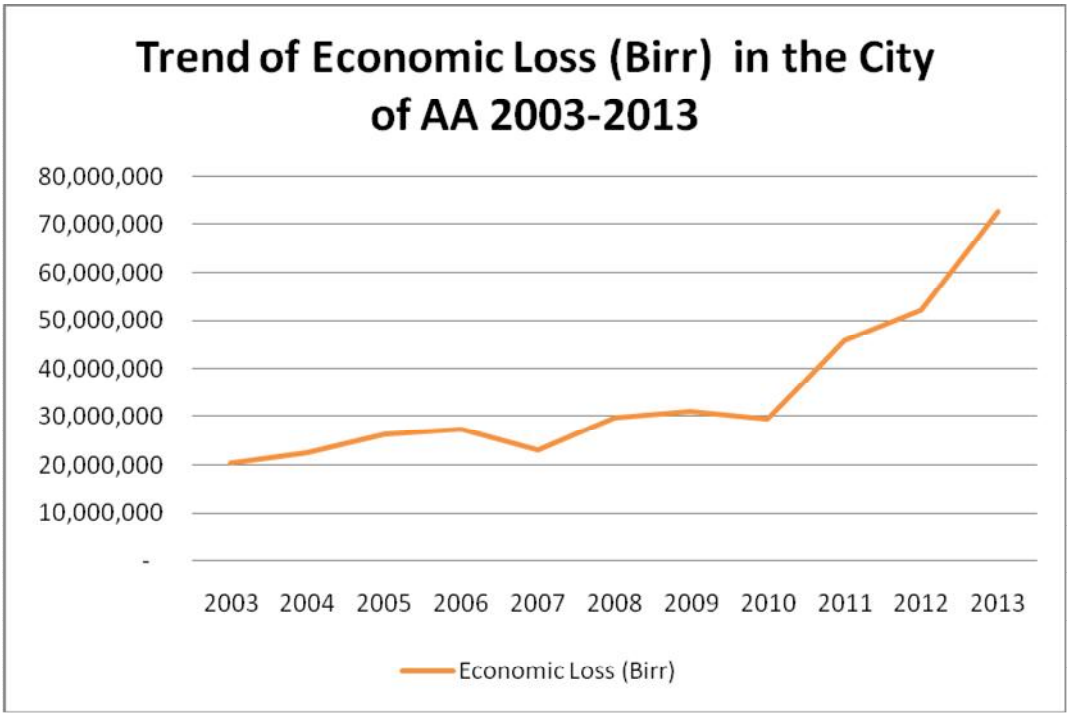
Figure 4. 2: Fatal Road Collisions (Injuries) in the City of AA 2003-2013



Source: Police Recorded Registration from AATPO (2003-2013)

Economical Loss (Property Damage)

Figure 4.3: Property Damage Loss by Road Collisions in the City of AA 2003-2013



Source: Police Recorded Registration from AATPO (2003-2013)

The rapidly increasing number of road traffic accidents has a negative impact on the economy and society of Addis Ababa. The average annual cost of Road traffic accidents for the state government about 34,537,758 million birr. The people who are affected by road traffic accidents are mostly in their most productive years (18 - 50 years). These deaths are a huge drain on the country's human resources. Also, when a head of household dies or is seriously injured in a road traffic accident, the whole family is plunged into poverty and psychological torture. Road traffic accidents are, therefore, a big problem to the government and the society of Addis Ababa.

It has been widely established that along Addis Ababa Roads the following aspects are common: inappropriate driver's behavior, lack of law enforcement, poor traffic

management, inconsistent road designs, deteriorating road conditions and inappropriate information system. All these make road safety management a very serious problem in Addis Ababa. Economic activities are accelerating while improvement and upgrading of roads is at a slow pace and road accidents are on the increase. Addis Ababa City demonstrates these characteristics and radical changes are required to safe guard the investments and development processes although there is problem in data integration in year 2003-2013 about real cause of fatality.

High Risk and Vulnerable Road Users

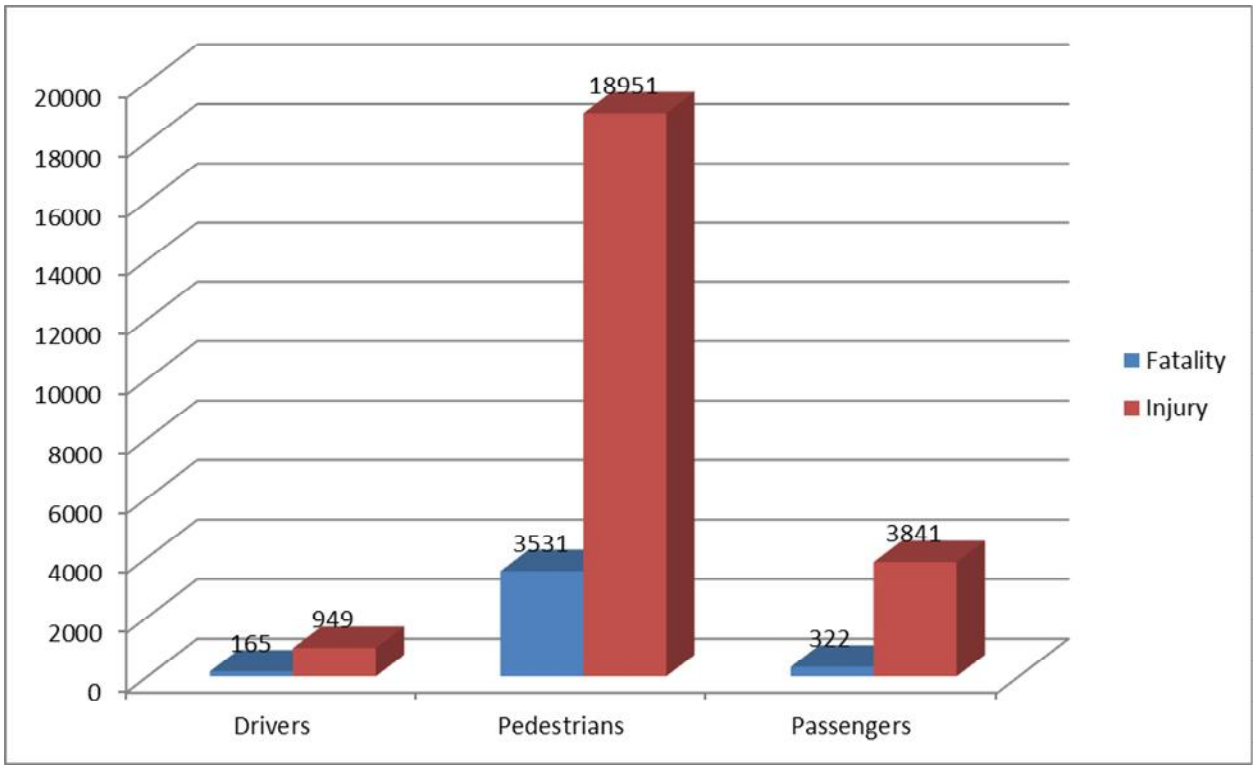
To throw forward in terms of incidences of road traffic accidents, Addis Ababa was labeled one of the most unsafe cities in Africa. Between 2003 and 2013, the number of killed persons in road traffic accidents increased from 334 to 4,078 persons. In the same year interval, 23,741 people were collectively injured (seriously-slight) in road traffic accidents in the city. The statistics on road traffic accidents in the city show that 53 %, 17%, 12%, 12%, and 7% all road traffic accident took place in the office/commercial areas, residential areas, public areas (i.e.: church, mosque, school, hospital and other public), market areas, and recreational areas respectively. The statistics also show further that pedestrians and passengers constituted 96% and driver constituted 4% of all fatal road traffic injuries in the city. The number of fatalities and serious injures was expected to rise from 15 percent (2004) to 28 percent in 2013

Table 4.1: Annual Average Injuries by Road User Type in the city of AA 2003-2013

Road User By Type	2004-2008	2009-2013	% Change over The period
Bicycle/ Motor Cycle	271	344	27%
Automobile	2820	3702	31%
Truck	5980	3891	-35%
Taxi	2681	1955	-27%
Public Transport Bus	1113	1562	40%
Others	160	741	363%
Total	13025	12195	-6%

Source: Police Recorded Registration from AATPO (2003-2013)

Figure 4.4. High Risk and Vulnerable Road Users in the City of AA 2003-2013



Source: Police Recorded Registration from AATPO (2003-2013)

The analysis of these Statistical Data indicates that pedestrian group is the most affected in terms of fatalities followed by passengers, and drivers. Among group of transport system causing injuries in 2003- 2013 constitute motor/bicycle 2%, automobile 26%, trucks 39%, taxi 19%, public transport 10% and others 3%.

However, road traffic accidents are made. at the same time as defective vehicles and bad roads account 26.0 Percent of all road traffic accidents, the human factor (dangerous driving and excessive speeding) accounts for 74.0 percent of all the road traffic accidents (URT, 2005). Dangerous driving and excessive speeding are sustained by the transformation of the built environment from a habitat for cars. The traffic conflicts of the motorized and the no motorized in the urban built environment are, probably, the single most important explanation of road traffic accidents in the country. Banyikwa (1988).

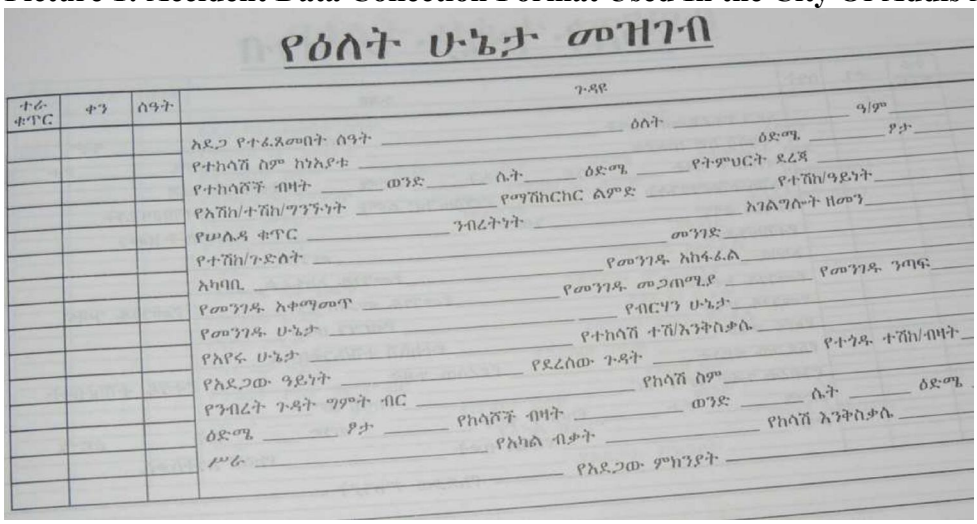
In Addis Ababa road, safety is one of the burning issues in the management of the road transport sub sector. The number of road accidents reported in the media day after another, coupled with the statistics release by the traffic department of the police force plainly leads credence to the existing problem. The statistics have all along demonstrated that the rate of accidents has kept on increasing annually and this trend is unlikely to be reversed particularly with the increase of motor vehicles on our roads without provision of safe road management system.

Generally as indicated in number of thesis, Addis Ababa, as a capital city of the country, is characterized by the largest share of road traffic flow, congestion and accidents. The causes are diverse and dynamic, and are both spatially and temporally significant (See Birhanu, 2000; Bitew, 2002; Fanueal, 2006; Tewolde, 2007 and others). These can be identified as human behavioral related and non-human behavior related causes. While factors related to drivers, passengers and pedestrian behaviors are human related causes, those factors related to weather conditions, road network situations and vehicle technical problems can be grouped under non-human behavior related causes of road crashes. According to Birhanu (2000), pedestrian are the most victims of road car accidents. For example, 56 % of the fatalities during the period 1987/8-1996/7 were pedestrians in Ethiopia which is higher than the corresponding average for African countries (40%) and the average for some developed countries (20%) in the period (ibid). In contrast, the pedestrian fatalities in Addis Ababa were much higher, 88 % of all fatalities in 1987/8-1993/4 (Birhanu, 2000).

Main Finding

Pedestrians are likely to remain the main victim groups for the long period time (2003-2013).

Picture 1: Accident Data Collection Format Used In the City Of Addis Ababa



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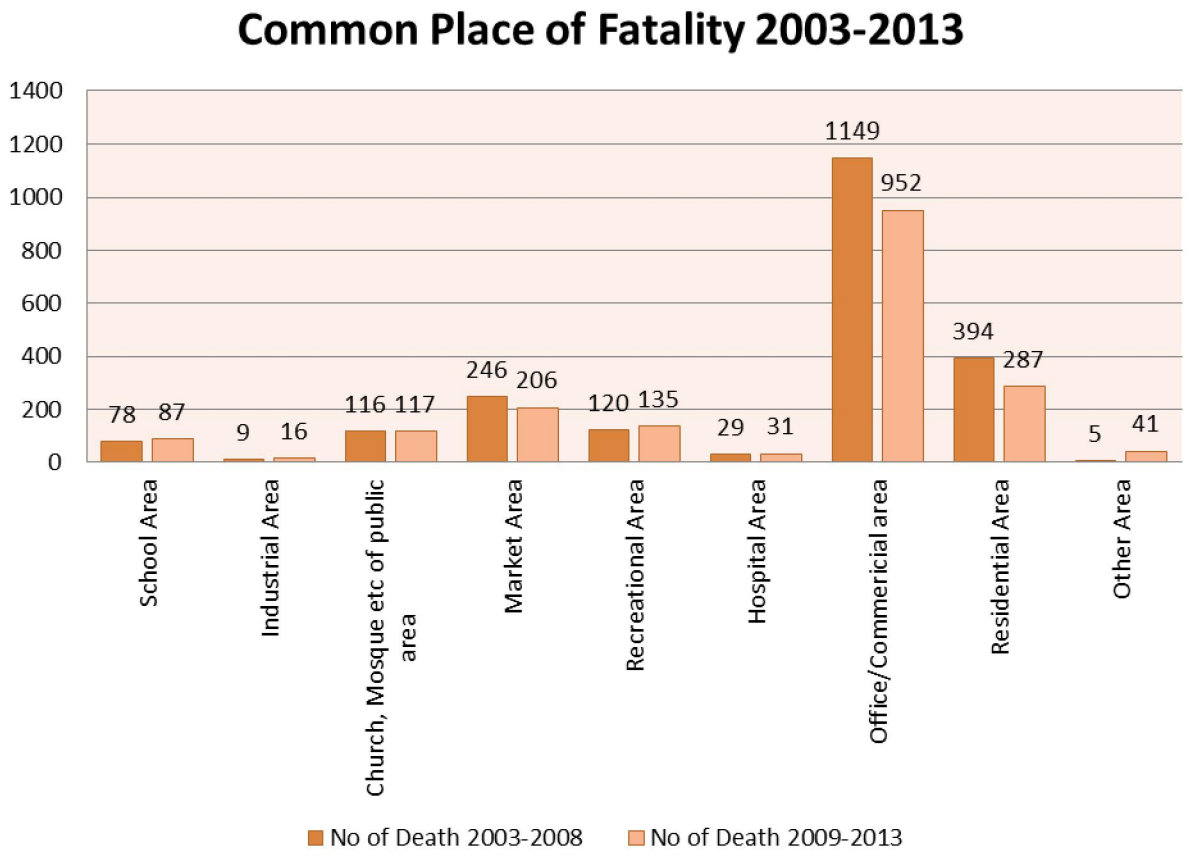
			አደጋ የተፈጸመበት ሰዓት ዕለት ዓ/ም የተከሳሽ ስም ከነአያቱ ዕድሜ ያታ የተከሳሾች ብዛት ወንድ ሴት ዕድሜ የትምህርት ደረጃ የአሽከ/ተሽከ/ግንኙነት የማሽከርከር ልምድ የተሽከ/ዓይነት የሠሌዳ ቁጥር ንብረትነት አገልግሎት ዘመን የተሽከ/ጉድለት መንገድ አካባቢ የመንገዱ አከፋፈል የመንገዱ አቀማመጥ የመንገዱ መጋጠሚያ የመንገዱ ንጣፍ የመንገዱ ሁኔታ የብርሃን ሁኔታ የአየሩ ሁኔታ የተከሳሽ ተሽ/እንቅስቃሴ የአደጋው ዓይነት የደረሰው ጉዳት የተጎዱ ተሽከ/ብዛት የንብረት ጉዳት ግምት ብር የከሳሽ ስም ዕድሜ ያታ የከሳሾች ብዛት ወንድ ሴት ዕድሜ ሥራ የአካል ብቃት የከሳሽ እንቅስቃሴ የአደጋው ምክንያት

4.2. Safe Road Management System

According to the findings of this study, it has been identified that, the following aspects are common lacking factors in safe road safe management system which accelerate the occurrence of road traffic accidents in the city of AA: inappropriate driver's behavior, lack of law enforcement, poor traffic management, inconsistent road designs, deteriorating road conditions and inappropriate information system.

Figure 4.5. Common Place of Fatality in the City of AA 2003-2013



Source: Police Recorded Registration from AATPO (2003-2013)

Table 4.2 Common Place of Road Fatality in the City of Addis Ababa (2003-2013)

Common Place	2003-2008		2009-2013		Total	
	No of Death	%	No of Death	%	No of Death	%
School Area	78	3.63%	87	4.65%	165	4.11%
Industrial Area	9	0.42%	16	0.85%	25	0.62%
Church, Mosque etc of public area	116	5.41%	117	6.25%	233	5.80%
Market Area	246	11.46%	206	11.00%	452	11.25%
Recreational Area	120	5.59%	135	7.21%	255	6.35%
Hospital Area	29	1.35%	31	1.66%	60	1.49%
Office/Commercials Area	1149	53.54%	952	50.85%	2101	52.29%
Residential Area	394	18.36%	287	15.33%	681	16.95%
Other Area	5	0.23%	41	2.19%	46	1.14%
Total	2146	100%	1872	100%	4018	100%

Source: Police Recorded Registration from AATPO (2003-2013)

Magnitude of Road Traffic Accident on Hourly and Daily Bases in the City of Addis Ababa

Road traffic congestion has a significant impact on the city during working days as a whole, with high societal costs which is not only results in higher running cost of vehicles, but also a loss in productivity to the employed.

As shown in the table below road traffic accident in the city was consistently the same (Table 5.3) from Monday to Saturday which accounts 14.5 - 16% from 107,786 total

numbers of accidents during the study periods. Meanwhile, the weekend's (Sunday) accounts on average 10.5% from the total accident record.

According to the focused group discussions with traffic police officers, the common peak traffic congestion time was early in the morning (7:00 - 8:30 AM), and in the afternoon from 3:30 - 7:30 PM. And, their regular working time with two shifts is from early morning 6:30AM to 9:00 PM in the night time. But as per AATPO Statistical record (Table 5.4) there was road traffic accident during the whole 24 hours road operation time.

The highest number of injuries occurred in early evening rush hours, i.e. between 4:00pm and 7:00pm (19%). 6,087 people were injured in traffic collisions between 8:00pm and 3:00am, the hours most strongly associated with drinking and driving; this period accounted for 38% of fatal collisions. 2,265 people were injured between 12 midnight and 3:00am. Injuries occurred during these hours accounted for approximately 14% of all road collision in 2013.

This analysis of road collision statistics shows that despite the gains made, there is a need for a continuing focus on vulnerable road users and on the traditional causal factors of alcohol consumption and speeding.

Lastly, they mentioned in the discussions that unless integrated safe road management system is enhanced among different organizations and stakeholders, the overall quality of road traffic service will not be free of road traffic accident.

Table 4.3. Magnitude of Road Traffic Accident on Daily Bases in the City of Addis Ababa (2003-2013)

Week Days	2003-2013	
	No of Accident	Percentage
Monday	16,786.00	15.57%
Tuesday	16,260.00	15.09%
Wednesday	15,742.00	14.60%
Thursday	16,077.00	14.92%
Friday	16,200.00	15.03%
Saturday	15,552.00	14.43%
Sunday	11,169.00	10.36%
Total	107,786.00	100%

Source: Police Recorded Registration from AATPO (2003-2013)

Table 4.4. Magnitude of Road Traffic Accident on Hourly Bases in the city of Addis Ababa (2013)

Hours	Hours	No of Accident	%
Morning	6:00 - 7:00 AM	262	1.6%
	7:00 - 8:00 AM	225	1.4%
	8:00 - 9:00 AM	206	1.3%
	9:00 - 10:00 AM	167	1.0%
	10:00 -11:00 AM	204	1.3%
	11:00 - 12:00 AM	294	1.8%
	12:00 - 1:00 PM	501	3.1%
Afternoon	1:00 - 2:00 PM	880	5.5%
	2:00 - 3:00 PM	977	6.1%
	3:00 - 4:00 PM	949	5.9%
	4:00 - 5:00 PM	1081	6.7%
	5:00 - 6:00 PM	1067	6.7%
	6:00 - 7:00 PM	947	5.9%
Early Night	7:00 - 8:00 PM	848	5.3%
	8:00 - 9:00 PM	979	6.1%
	9:00 - 10:00 PM	949	5.9%
	10:00 - 11:00 PM	976	6.1%
	11:00 - 12:00 PM	918	5.7%
	12:00 - 1:00 AM	775	4.8%
late Night	1:00 - 2:00 AM	702	4.4%
	2:00 - 3:00 AM	788	4.9%
	3:00 - 4:00 AM	515	3.2%
	4:00 - 5:00 AM	460	2.9%
	5:00 - 6:00 AM	345	2.2%
Total		16015	100%

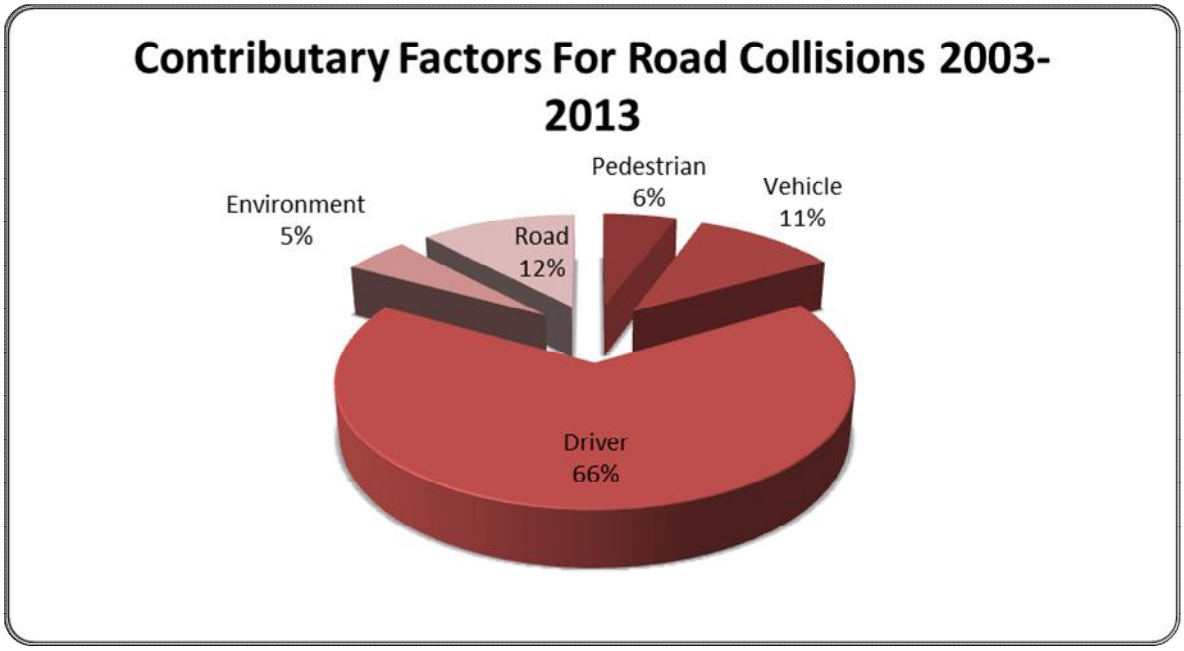
Source: Police Recorded Registration from AATPO (2013)

Contributory Factors to Road Collisions

The contributory factors to road traffic collisions are many and varied. When combined, as they do in nearly every collision, they create a very complex picture of what actually happened. These varied causation factors are often categorized as: human, environment, road and/or vehicle. The Venn diagram below compiled by the AATPO from the period 2003—2013 is a demonstration of that complexity.

Driver error accounted for 66% of all contributory factors identified in fatal collisions; pedestrian error accounted for 6%, road factors accounted for 12%, environment accounted for 5% and vehicle factors accounted for 11%.

Figure 4. 6. Contributory Factors to Road Collisions in the City of AA 2003-2013



Source: Police Recorded Registration from AATPO (2013)

Collisions Statistics (2003-2013):

Collisions involving pedestrians accounted for 83 %, Head on Collisions accounted for 2%, Rear end collisions accounted for 2 %, Right angle collisions accounted for 3% , Collisions with structure accounted for 2%, and other unknown type of collisions accounted 5 % of all injury collisions.

One out of seven of all traffic injuries collisions were head-on or pedestrian collisions. This indicates that Head on or pedestrian collision types are, on average, more severe than angle, rear-end or 'other' road collision types, which together accounted for 17% of injury collisions.

Table 4.5. Type of Collisions for Road traffic Injuries in the City of Addis Ababa (2003-2013)

Type of Collisions	No of Injuries	%
Head-on collision	555.00	2%
Rear-end collision	555.00	2%
Right-angle collision	832.00	3%
Collision with structures or run-off-the-road	555.00	2%
Pedestrian/bicyclist injuries	23,039.00	83%
overturning	836.00	3%
Others	1,387.00	5%
Total	27,759.00	100%

Source: Police Recorded Registration from AATPO (2003-2013)

Table 4.6. Type of Road Junction Collisions for Road traffic Injuries in the City of Addis Ababa (2003-2013)

Type of Road Junction	No of Injuries	%
No Junction	22,484.00	81%
Y Junction	555.00	2%
T Junction	2,498.00	9%
Round About	555.00	2%
Cross Junction	1,110.00	4%
Multiple Junction	280.00	1%
Others	277.00	1%
Total	27,759.00	100%

Source: Police Recorded Registration from AATPO (2003-2013)

Table 5.7. State of Pedestrian Movement during Road traffic Injuries in the City of Addis Ababa (2003-2013)

S/N	Pedestrian Movement	No of Injuries	%
1	At Junction With Traffic Light Availability	37	0.2%
2	At Junction With No Traffic Light Availability	90	0.4%
3	On Pedestrian Crossing	1707	7.6%
4	No Pedestrian Crossing	11883	52.9%
5	Moving on * Carriage Way *playing on carriage way *Standing on carriage way *Seating on Carriage way *Sleeping on Carriage way *Working on Carriage way	1539	6.8%
6	Moving on pedestrian lane	1244	5.5%
7	Moving on no pedestrian facility	4642	20.6%
8	others	1340	6.0%
	Total	22,482.00	100.0%

Source: Police Recorded Registration from AATPO (2003-2013)

Examination of Black Spot Treatment at identified Road Traffic Black Spot sections (RTBSs)

Despite its adverse socio-economic impact, a study on identification of road traffic accident black-spots (RTABSs) in Addis Ababa is either negligible or only a general attempt made for the city as a whole or sub city in particular without interventions/treatments at black spot sections of the road.

Thus, this thesis examine treatment of Black Spot sections of the Road using low cost engineering measures as one mechanism of accident reduction through observational check list incorporating traffic signs, rumble strips, road marking, road light, roundabouts, parking lots.

Road Traffic Accidents Black-Spots and Distribution by Sub-City

Table 1 shows the distribution of traffic accidents, its rank order and the number of RTABSs as identified through 2005/2006 study (12).

Table 4.8. Total Number of RTAs, Rank orders and RTABSs by Sub-City (2005/06)

S/N	Sub City	RTA	%	Rank	RTABSs
1	Kirkos	2,948	26.77%	1	10
2	Bole	1,750	15.89%	2	11
3	Arada	1,209	10.98%	3	24
4	Yeka	1,104	10.02%	4	10
5	Lidetta	1,064	9.66%	5	21
6	Nifas Silk Lafto	810	7.35%	6	10
7	Addis Ketema	797	7.24%	7	20
8	Akaki	615	5.58%	8	6
9	Kolfe	439	3.99%	9	4
10	Gulele	277	2.52%	10	9
Total		**11,013**	-		**125**

Source: Computed from Data obtained from AATPO (2005/06) by the Author, 2012

Obviously the frequency of road car crashes in Addis Ababa varies from one sub-city to the other. This variation in the frequency and intensity of road accidents has led to the need for identification of RTABSs for taking appropriate policy measures at relevant accident locations by considering each sub-city. Table1 shows the distribution of number of respective accidents and black-spots in each sub-city. Accordingly, Kirkos (26.77%), Bole (15.89%) and Arada (11%) sub-cities were the three leading sub-cities in the frequency of RTAs being the 1st, 2nd and the 3rd for the year specified ().

Under this thesis, from the first three leading sub cities having high score of RTA record, the first three high score of RTA road section were selected for site inspection, subsequently the remedial counter measures intervened by AACRA during the elapsed period of years and the current road conditions were inspected.

Table 4.9. Major RTABSs among the first three leading RTA sub cities (July, 2005 - June, 2006)

S/N	Sub City	Major RTABs Location	RTA	%	Rank	Remark
1	Kirkos Sub City	Olompia	423	14%	1	
2	Kirkos Sub City	Kasanchis	401	14%	2	
3	Kirkos Sub City	Wollo-sefer	350	12%	3	
4	Bole Sub City	Raguel-zuria	403	15%	1	Under Construction
5	Bole Sub City	22-mazoria-Lem-hotel-Megenagna	392	15%	2	Under Construction
6	Bole Sub City	Bole M/alem-Atlas	272	10%	3	
7	Bole Sub City	Megenagna-Imperial-Grji	262	10%	4	
8	Bole Sub City	Imperial - Tele M/Alem	197	8%	5	
9	Arada Sub City	Around Arat Kilo Square	27	10%	1	
10	Arada Sub City	Around Arat Kilo Palace	20	7%	2	
11	Arada Sub City	Minilik Square-Municipality	17	6%	3	
	Total	-	**2774**	-	-	

Source: Computed from Data obtained from AATPO (2005/06) by the Author, 2012

Black Spot Treatment Assessment

Site inspection was done together with Addis Ababa Traffic Police Officers along road sections and Junctions of black spot sections, and the site inspection feedback is summarized below in terms of interventions done, problems and recommendation of low cost engineering counter measures in the intended sections of the road.

1. Kazanchis Sub City

Olympia and Wello-Sefer RTBSs

Although these sections of the road were under high score RTA during the study period 2005/2006, the current actual situation as stated below:

Interventions

- Road Section

- There is no sharp curve affecting visibility, and there is good stoppage site
- There is multiple number of lane, no traffic Jam is frequently observed
- Improved signing
- Improved alignment
- Improved skid-resistance
- Improved pavement
- Improved roadside area
- Guardrails provided in the sections of curves
- Enough divided five-lane road
- Median, concrete barriers or guardrails are provided

- Junction

- Round about junction is provided

- Warning signs: Installed warning signs saying that there is a junction ahead.
- Lighting: If there are many accidents during dark hours, install road lighting.
- Channelization: Provide separate lanes for left-turning and/or right-turning vehicles.
- Grade separation: If the traffic volumes are high, consider grade separation.

  - Pedestrians

- Marked pedestrian crossing: Pedestrian crossings marked with vertical signs and horizontal markings.
- Channelization: Install fences to lead the pedestrians to safe crossing locations
- Grade separation: If the number of pedestrians and/or the traffic volume is high or if the number of children and elderly is significant, a grade-separated crossing should be considered.

  - Parking

- Parking is prohibited along the road sections.

Problems and Recommendations

  - Junction

- Speed limit is not provided; provided speed limit through the junction.

  - Pedestrians

- Pedestrian crossing is faded: Re-paint lane markings using thermoplastic paint or place studs pavement markers especially on bends to discourage overtaking of vehicles along the bend.
- Secure low speed: Install speed reduction devices, such as rumble-strips, before at-grade pedestrian crossings. In urban areas speed humps can be used.
- Signalization: Traffic signals will separate pedestrians from motor traffic in time. Traffic signals could introduce hazards of a different kind if vehicle speeds are relatively high in the approaches to the crossing. Therefore, approaching traffic must have adequate visibility and time to stop when required.

- Parking

➢ Automobile and bus parking is not provided along road side section.

Kazanchis RTBSs

These sections of the road ranges from Meneharya to Intercontinental Hotel then to Urel Church, and the area scores 401 road traffic accidents during the study period, mean while the current scenarios are as shown below:

Problems and Recommendations

- Road Section

➢ There are big trees along the median affecting visibility, and there is no good stoppage site and overtaking site distance.

➢ Congestion through the whole day observed

➢ High number residential and commercial area in the surrounding

➢ Pavement require maintenance

➢ There is no improved roadside area, both sides of outer lane serves as car parking lot.

➢ Guardrails are not provided in the sections of curves

➢ Three divided lane road are provided but not serving accordingly.

➢ Deteriorated and unmarked median, concrete barriers are provided

➢ You can find pothole along the main section of the road that looking for immediate maintenance.

➢ There scarcity of land for expansion of road lanes, hence access management is highly recommended.

- Junction

- Four leg junction located near high commercials area , this area looks for roundabout section for smooth trafficking
- Traffic sign at the cross junction are available but working, as seen in the visit one of the post were broken and not maintained more than ten days.
- Warning signs: Installed warning signs saying that there is a junction ahead not indicated.
- Lighting: If there are many accidents during dark hours, install road lighting are not functional accordingly.
- Channelization: Provide separate lanes for left-turning and/or right-turning vehicles were impossible unless the road is expanded.
- Grade separation: If the traffic volumes are high, consider grade separation but impossible in the area.

    - Pedestrians

- Pedestrian crossing is not provided as required: Provide markings using thermoplastic paint or place studs pavement markers especially on bends to discourage overtaking of vehicles along the bend.
- Pedestrian crossing is faded: Re-paint lane markings using thermoplastic paint or place studs pavement markers especially on bends to discourage overtaking of vehicles along the bend.
- Secure low speed: Install speed reduction devices, such as rumble-strips, before at-grade pedestrian crossings. In urban areas speed humps can be used.
- Signalization: Traffic signals will separate pedestrians from motor traffic in time. Traffic signals could introduce hazards of a different kind if vehicle speeds are relatively high in the approaches to the crossing. Therefore, approaching traffic must have adequate visibility and time to stop when required.
- Channelization: Install fences to lead the pedestrians to safe crossing locations

- Speed limit is not provided; provided speed limit through the junction.
- Obstruction along road side by construction materials
- Street vender along the road side is common practice.

  - Parking

- Parking is prohibited along the road sections but all outer sides of road lane are serving car parking lot, strong reinforcement are required along the section.
- Automobile and bus parking is not provided along road side section.
- People are waiting for taxi and other public transport long time using one outer side of lane, and this is one means for traffic congestion and high accident rate.

2. Bole Sub City

Bole Medihanialem –Atlas Square RTBSs

These sections of the road are highly commercial, public school, public gathering and entertaining section during day and night time and the number of RTA accounted 272 during the study period, and current actual situations are as stated below:

Interventions

- Road Section

- There is no sharp curve affecting visibility, and there is good stoppage site
- There is three lane two way road classification, no traffic Jam is frequently observed
- Improved signing
- Improved alignment
- Improved skid-resistance
- Partial improved pavement
- Partial Improved roadside area
- Guardrails provided in the sections of curves

- Median, concrete barriers or guardrails are provided

  - Junction

- One Round about (Edna moll) and two crossing junction (Near Medhanialem church and In front of Atlas Hotel) are provided along the section.

- Traffic Lighting installed at Atlas Square functioning good

- Channelization's for right-turning vehicles are provided at Atlas Square Area.

  - Pedestrians

- Partially marked pedestrian crossing is available:

- Channelization: Installed fences to lead the pedestrians to safe crossing locations are available.

- Obstruction; There is partial obstruction for pedestrian along pedestrian way due to construction materials.

  - Parking

- Parking is prohibited partially along the road sections.

- Private parking lots are provided at basement and compound section of commercials buildings with limited capacity.

Problems and Recommendations

  - Road Sections

- You can find pothole along the main section of the road that looking for immediate maintenance.

- Surface maintenance is required at limited segment of road sections.

- Surface maintenance is required at limited segment of roadside sections.

- Along road side area there high rise building under construction, and their construction machineries are deterioration some sections of the road, strong legal enforcement is required.

    - Junction

- No Warning signs: Installed warning signs saying that there is a junction ahead.
- Traffic Lighting is not installed at the remaining junctions: since the area is high commercials and public area during day and night time, installation junction traffic light is mandatory, hence install traffic road lighting at Edna moll roundabout and Medhanialem cross junctions.
- Speed limit is not provided; provided speed limit through the junction.

    - Pedestrians

- Along the entire section of this road, there are number of entertaining and alcohol shopping centers, so extended hour traffic regulations is advisable mainly during night time.
- Partial Marked pedestrian crossings are available: Pedestrian crossings marked with vertical signs and horizontal markings are recommended along road sections and junctions of the road.
- The available pedestrian crossings are faded: Re-paint lane markings using thermoplastic paint or place studs pavement markers especially on bends to discourage overtaking of vehicles along the bend.
- Obstruction; There is partial obstruction for pedestrian along pedestrian way due to construction materials, strong legal enforcement should be exercised regularly.

    - Parking

- Automobile and bus parking is not provided along road side section.
- Waiting station for Taxi and Bus are not provided

- Parking service along the outer lane of road sections are exercised although there is traffic sign prohibiting parking along the sections: strong traffic enforcement should be exercised.
- Wide and good accommodation parking area is advisable along the sections.
- Along road side area there are high rise buildings under construction, and provision of parking lots should be considered in their design at this construction stage for design revisions.

Megenagna - Imperial - Gergi

These sections of the road ranges from Megenana ring road to Imperial roundabout and extends to Gergi, and the sections of the road can be characterized as commercial, public school, public gathering, medical centers, entertaining and residential area. The number of RTA accounted in the study period was 262, and current actual situations are as stated below:

Interventions

- Road Sections (Megenagna to Imperial roundabout)

- There is no sharp curve affecting visibility, and there is good stoppage site
- There is multiple numbers of lanes.
- Partial improved signing
- Improved alignment
- Improved pavement
- Improved roadside area
- Guardrails provided in the sections of curves
- Median, concrete barriers or guardrails are provided

- Junction (Megenagna to Imperial roundabout)

- Round about junction is provided
- Warning signs: Installed warning signs saying that there is a junction ahead.
- Lighting: If there are many accidents during dark hours, install road lighting.
- Channelization provided: separate lanes for left-turning and/or right-turning vehicles.
- Grade separation provided along the ring road of the stated section.
    - Pedestrians (Megenagna to Imperial roundabout)
- Distantly located pedestrian overhead crossing structure provided
- Channelization: Installed fences to lead the pedestrians to safe crossing locations are available at both ends of road sections.
    - Parking (Megenagna to Imperial roundabout)
- Parking is prohibited along the entire section of the road.

Problems and Recommendations

- Road Sections
- The road sections from Imperial junction to Gerji are damaged and causing traffic congestion in between.
- You can find pothole along the main section of the road that looking for immediate maintenance. Between Imperial Junction to Gerji
    - Junction
- Daily traffic congestion is observed during pick hour at Imperial junction: this is due to the deterioration of asphalt surface.
- No Warning signs: Installed warning signs saying that there is a junction ahead.

- Traffic Lighting is not installed at the junctions.
- Speed limit is not provided
    - Pedestrians
- Road marking along Megenagna are faded
- Along the entire section of this road, there are number of entertaining and alcohol shopping centers, so extended hour traffic regulations is advisable mainly during night time.
- Marked pedestrian crossings are not available: Pedestrian crossings marked with vertical signs and horizontal markings are recommended along road sections and junctions of the road.
- Obstruction; There is partial obstruction for pedestrian along pedestrian way due to construction materials, strong legal enforcement should be exercised regularly.
- Street vender and vehicle maintenance are a regularly practiced mainly along road side section of Imperial Gerji
    - Parking
- Automobile and bus parking is not provided along all road side section.
- Waiting station for Taxi and Bus are not provided along all road sections
- Both outer lane of road sections of Imperial Gerji are serving for parking purposes for heavy and light vehicles: strong traffic enforcement should be exercised.
- Wide and good accommodation parking area is advisable along the sections.

Imperial - Tele Medhanialem RTBSs

These sections of the road ranges from Imperial round about junctions to 17 Health center then to Telemedhanialem Edna moll round about junctions, and the sections of the road

can be characterized as highly commercial, public school, public gathering, medical centers and entertaining area as stated above mainly during day and night time, the number of RTA accounted in the study period was 197, and current actual situations are as stated below:

Interventions

- Road Sections

- There is no sharp curve affecting visibility, and there is good stoppage site
- There are three lane two way road classifications.
- Improved alignment
- Partial Improved roadside area
- Median, concrete barriers from Imperial to 17 Health center

- Junction

- One crossing junction (Near 17 Health Center) and T junction crossing in between 17 Health Center and Tele.

- Pedestrians

- Partially marked pedestrian crossing is available from Imperial to 17 Health Center
- Grade separation guardrail was provided from Imperial to 17 Health Center.
- Channelization: Installed fences to lead the pedestrians to safe crossing locations are available at both ends of road sections.

- Parking

- Parking is prohibited partially along the road sections.
- Private parking lots are provided at basement and compound section of commercials buildings with limited capacity.

Problems and Recommendations

- Road Sections

- The road sections from 17 Health Center to Tele are damaged and causing traffic congestion in between.
- You can find pothole along the main section of the road that looking for immediate maintenance. Between 17 Health Center and Tele
- The road sections from 17 Health Center to Tele are not demarcated for road way and lane separation.

- Junction

- No Warning signs: Installed warning signs saying that there is a junction ahead.
- Traffic Lighting is not installed at the junctions.
- Speed limit is not provided

- Pedestrians

- Along the entire section of this road, there are number of entertaining and alcohol shopping centers, so extended hour traffic regulations is advisable mainly during night time.
- Partial Marked pedestrian crossings are available: Pedestrian crossings marked with vertical signs and horizontal markings are recommended along road sections and junctions of the road.
- The available pedestrian crossings are faded: Re-paint lane markings using thermoplastic paint or place studs pavement markers especially on bends to discourage overtaking of vehicles along the bend.
- Obstruction; There is partial obstruction for pedestrian along pedestrian way due to construction materials, strong legal enforcement should be exercised regularly.

- Street vender are a regular practice

- Parking

- Automobile and bus parking is not provided along road side section.
- Waiting station for Taxi and Bus are not provided
- Parking service along the outer lane of road sections on regular base along the entire sections: strong traffic enforcement should be exercised.
- Wide and good accommodation parking area is advisable along the sections.

3. Arada Sub City

Minilik Square, Arat Killo and Arat Killo Palace RTBSs

These sections of road ranges from Minilik square to Arat killo Palace, with 64 road traffic accidents record during the study period, besides, sections of the road is characterized as residential, commercial, public gathering, high institutional and school area. Along the section of the road, the following site inspection feedback is summarized in terms of problems and visible low cost engineering counter measures.

Problems and Recommendations

- Road Section

- Part of road sections from Minilik square to Arat killo require surface maintenances.
- There is no improved roadside area, both sides of outer lane serves as car parking lot and for street venders
- Guardrails provided in curved sections of the road require replacement and maintenance.
- Deteriorated and unmarked median, concrete barriers are provided

- You can find pothole along the main section of the road that looking for immediate maintenance.
- There are scarcities of land for road expansions, hence access management is highly recommended.

  - Junction

- Traffic light are not installed at all junctions of the road except Arat Killo palace Crossing.
- Warning signs: Installed warning signs saying that there is a junction ahead not indicated.
- Channelization: Provide separate lanes for left-turning and/or right-turning vehicles were impossible unless the road is expanded.

  - Pedestrians

- Pedestrian crossings are not provided as required: Provide markings using thermoplastic paint or place studs pavement markers especially on bends to discourage overtaking of vehicles along the bend.
- Pedestrian crossings are faded: Re-paint lane markings using thermoplastic paint or place studs pavement markers especially on bends to discourage overtaking of vehicles along the bend.
- Channelization: Install fences to lead the pedestrians to safe crossing locations
- Speed limit is not provided; provided speed limit through the junction.
- Street vender along the road side is common practice.

  - Parking

- Parking is prohibited along the road sections but all outer sides of road lane are serving car parking lot, strong reinforcement are required along the section.

- Automobile and bus parking is not provided along road side section.
- People are waiting for taxi and other public transport long time using one outer side of lane, and this is one means for traffic congestion and high accident rate.

CHAPTER FIVE

5. Conclusion and Recommendations

5.1. Conclusion

The study reveals that although one of the most venerable group of road users are pedestrian which accounts 3,531 (88%) fatality in the study period, the laxity in the provisions or interventions of safe road management system at RTABSs of road by the concerned agency like AACRA, in using low cost engineering counter measures are not promising and coordinated, the probability of other potential hazardous and black spot sections occurrences could be high and the traffic injuries is expected to become worsen and worsen.

5.2. Recommendations

Based on the black spot section treatment site inspection assessment, the following low cost engineering counter measures are recommended together with its effects in to two main parts, Road section (Links) and Junctions (Nodes) as shown below:

a. Road Section (Links)

- Improve signing: Warning signs, delineators, speed-limit signs.
- Improve skid-resistance: Rehabilitation of the super-elevation, change of surface texture to increase the friction.
- Improve pavement: Maintenance (potholes or damaged pavement on shoulder or driving-lane).
- Improve roadside area: Create a safety zone without rigid obstacles in order to reduce severity.
- Erect guardrails: If it is very difficult to improve the roadside area.
- Marked pedestrian crossing: Pedestrian crossings marked with vertical signs and horizontal markings. The effect of marked pedestrian crossings is uncertain. The

best effect is achieved if the marked crossing is combined with speed reducing devices.

- Prohibition of on road side parking, street venders
- Maintenance: Renew the horizontal markings and/or the pavement.
- Separate the directions: Install median, concrete barriers or guardrails.
- Increase sight distance: Make sure that sufficient sight distance for overtaking is provided at reasonable intervals along a road section.

b. Junction Section (Nodes)

- Visibility: Increase the visibility of the junction, especially from the secondary road approach.
- Warning signs: Install warning signs saying that there is a junction ahead.
- Speed limit: Change the speed limit through the junction. A local speed limit through the junction will reduce the number of accidents and also the severity.
- Rumble strips: Apply rumble strips in order to increase the driver's attention and to reduce speed.
- Lighting: If there are many accidents during dark hours, install road lighting. Lighting has a double effect. Firstly, it announces the junction in general and secondly, it makes it easier to observe traffic islands and signs as well as other vehicles etc.
- Channelization: Provide separate lanes for right-turning vehicles. When a separate lane for right-turning vehicles is used, a median, designed to give shelter for vehicles waiting in the left-turning lane, should be constructed.
- Traffic control: If there is no regulation, install yield-sign or stop-sign in the approach of the secondary road. If the junction is yield- regulated, change it to stop-regulated.
- Visibility: Make sure that the junction is visible in all approaches and that there is enough sight distance. It is important that there are no billboards, advertisement signs, etc. obstructing the sight from the secondary road towards the main road.
- Lighting: If there are many accidents during dark hours, install road lighting.

- Modern roundabout: If the traffic volume is similar on all approaching roads, consider reconstruction to a "modern" roundabout.
- Marked pedestrian crossing: Pedestrian crossings marked with vertical signs and horizontal markings. The effect of marked pedestrian crossings is uncertain. The best effect is achieved if the marked crossing is combined with speed reducing devices.
- Channelization: Install fences to lead the pedestrians to safe crossing locations.
- Secure low speed: Install speed reduction devices, such as rumble-strips, before at-grade pedestrian crossings. In urban areas speed humps can be used.
- Signalization: Traffic signals will separate pedestrians from motor traffic in time. Traffic signals could introduce hazards of a different kind if vehicle speeds are relatively high in the approaches to the crossing. Therefore, approaching traffic must have adequate visibility and time to stop when required.
- Grade separation: If the number of pedestrians and/or the traffic volume is high or if the number of children and elderly is significant, a grade-separated crossing should be considered. Grade separation (over- and underpasses) is very effective, if it is used by pedestrians.
- strict traffic police enforcement and speed control

2. Basic requirements for improved safe road management system, the following interrelated area of concern should get further investigation or study:

    - Political concern and priority
    - Funding
    - Implementation
    - Monitoring, evaluation and research for prevention and reduction traffic injuries.

Reference

1. Jeanne Breen, Richard Martin Humphreys, Sevara Melibaeva, SSATP, Africa Transport Policy Programme, June 2013. Guideline for Mainstreaming Road Safety at Regional Trade Road Corridors.

2. WHO (World Health Organization). 2009. "Global Status Report on Road Safety—Time for Action." Geneva.

3. Peden,M. Scurfield,R.Sleet,D.Mohan,D.,Hyder, AA.,jarawan,E.and Mathers,C(0eds)(2004). World report on road traffic injury prevention.

4. Bliss, T. 2004. "Implementing the Recommendations of the World Report on Road Traffic Injury Prevention." Transport Note No. TN-1, World Bank, Washington, DC.

5. Bliss, 2011a. "Global Directions in Road Safety." Strategic Road Safety Forum, Monash University Accident Research Centre (MUARC), Melbourne, Australia, June.

6. Bliss, 2011b. "Producing Road Safety Interventions: The Institutional Dimension." MUARC (Monash University Accident Research Centre) Annual Transport Safety Lecture, Melbourne, Australia, June.

7. Bhalla, K., S. Shahraz, M. Naghavi, and C. Murray. 2008. "Estimating the Potential Impact of Safety Policies on Road Traffic Death Rates in Developing Countries."Ninth World Conference on Injury Prevention and Safety Promotion, Merida,Mexico.

8. FDRE Population Census Commission, 2008, Summary and statistical report of the 2007 population and Housing census, Addis Ababa.

9. CES in association with SABA Engineering, 2005. Urban Transport Study and Preparation of Pilot Project for Addis Ababa.

10. Vital Events Indicator and Causes of Death from Longitudinal DHSA and AAMSP in six Ethiopian University, September 2013 EPHA.

11. Addis Ababa Police Commission Report 2006-2010

12. United Nations. (2011). *Improving global road safety* (Note by the Secretary-General). Sixty-sixth session, Agenda item 12, Global road safety crisis. Retrieved on November 10, 2011 from:

    http://www.who.int/roadsafety/about/resolutions/sept_2011_sg_report_en.pdf.

13. Eva Molnar, Director Transport Division, United Nations Economic Commission for Europe.

    ISO Focus, WWW.iso.org/isofocus , October 2009

14. Planning Commission, Government of India (Road Safety and Traffic Management) , Yojana Bhawan, Parliament Street ,New Delhi - 110 001 www.infrastructure.gov.in February 2007

15. Marczyk, Geoffrey R., 1964– Essentials of research design and methodology/Geoffrey Marczyk, David DeMatteo, David Festinger.

16. Kazdin, A. E. (1982). *Single-case designs: Methods for clinical and applied settings.* New York: Oxford University Press.

17. Kazdin, A. E. (2003a). Methodology: What it is and why it is so important. In A. E. Kazdin (Ed.), *Methodological issues and strategies in clinical research* (3rd ed., pp. 5–22). Washington, DC: American Psychological Association.

18. Road Safety and Traffic Management, **The Secretariat for the Committee on Infrastructure** Planning Commission, Government of India Yojana Bhawan, Parliament Street New Delhi - 110 001 www.infrastructure.gov.in February 2007

19. Krug E (Ed). Injury: A Leading Cause of the Global Burden of Disease. Geneva: WHO, 1999.

20. Krug, E. (2002). How can road safety be improved? The BMJ asked four experts for their views. British medical journal. 324, 1116, retrieved January march 10 2006 from http://bmjjournal.com/cgi/content/full/324/7346/1116

21. Astrom, J. S, Kent, M.P. and Jovin, R. D. (2006) Signatures of Four Generations of Road Safety Planning in Nairobi City, Kenya In: Journal of Eastern African Research and Development. Vo. l20, pp. 186-201.
22. Peden, M. (Ed), (2004), World Report on Road Traffic Injury Prevention. World Health Organisation, Geneva.
23. Mock CN, Abantanga F, Cummings P, Koepsell TD. Incidence and outcome of injury in Ghana: a community-based survey. Bull World Health Organ 1999; 77:955-64.
24. Mock CN, Adzotor E, Denno D, Conklin E, Rivara F. Admissions for injury in a rural hospital in Ghana: implications for prevention in the developing world. Am J Public Health 1995; 85:927- 31.
25. Jacobs G, Aeron-Thomas A, Astrop A. Estimating global road fatalities. TRL Report 445. Berkshire, Transport Research Laboratory, 2000.
26. Sathiyasekaran BW. Population-based cohort study of injuries. Injury 1996; 27:695-8.
27. Bohning D, Na Ayutha RS. A case-control study of non-fatal traffic accidents on hospital patients in Bangkok metropolis. Soz Praventivmed 1997; 42: 351-7.
28. Lie, G.H., Baker, S.P. (1991).A comparison of injury death rates in China and United States 1986; Am J Public Health; 81(5):605-9.
29. Odero, W., Garner, P. and Zwi, A. (1997). Road traffic injuries in the developing countries: a comprehensive review of epidemiological studies. Journal of Tropical Medicine and International Health. 2(5), 445-460.
30. Leon, S.R. (1996).Reducing death on the Road.The effects of minimum safety standards, Unpublicised crash test, seat belts and alcohol. Am J Public Health; 86(1):31-3.
31. Søderlund, N. and Zwi, A. B. (1995). Traffic-related mortality in industrialized and less developed countries. Bulletin of the World Health Organisation 73 (2), 175-182.
32. Majumder,B.,Karmakar,R.,Bose,T.,Dasgupta,S.,Basu,R.(1996).Some host factors and Seasonal variations in fatal road traffic accidents occurring in Eastern Sub urban Calcutta.Indian J Public Health;40(2):46-9.
33. Zhang,J., Fraser,S.,Lindsay,J.,Clarke,K,Mao,Y.(1998).Age specific pattern of factors Related to fatal motor vehicle traffic crashes: Focus on young and elderly drivers.Public Health; 112(5): 289-95.

34. Peden, M., Scurfield, R., Sleet, D., Mohan, D., Hyder, A., Jarawan, E. and Mathers, C. eds (2004) World report on road traffic injury prevention Geneva, World Health Organization
35. Bliss, T. (2004) Implementing the Recommendations of The World Report on Road Traffic Injury Prevention. Transport Note No. TN-1, The World Bank, Washington DC
36. Bliss,T. and Breen, J. (2008) Implementing the Recommendations of The World Report on Road Traffic Injury Prevention Country guidelines for the conduct of road safety management capacity reviews and the related specification of lead agency reforms, investment strategies and safety programs and projects, Global Road Safety Facility, World Bank, Washington.
37. Land Transport Safety Authority (2003) Road Safety to 2010, Wellington, New Zealand
38. Elvik, Rune and Truls Vaa , The Handbook of Road Safety Measures, Elsevier Ltd, London, 2005.
39. K.Geurts, G. Wets, Black Spot Analysis Methods: Literature Review, Onderzoekslijn Kennis Verkeersonveiligheid, RA-2003-07 Belgium, 2003.
40. Guo, Z. J. Gao L. Kong, The Road Safety Situation Investigation and Characteristics Analysis of Black Spots of Arterials Highways, Key Laboratory of Road and Traffic Engineering of the Ministry of Education, Tongji University, Shanghai 200092, China, 2003.
41. Rokytová, Jitka, Black Spots Treatments on Routes in Rural Areas, Transport research centre, Brno, the Czech Republic, 2000.
42. Walmsley DA, Summersgill and C.Binch(1998). Accidents on Modern Rural Single-carriag way Trunk Roads. TRL 336, England. 31
43. Jonnessen, S. and Sakshaug, K, Lecture Note in Traffic Safety and Environmental Engineering, Addis Ababa University, Addis Ababa, (2006).
44. Safety design and operational practices for streets and highways, US Department of Transportation, 1980.
45. Ezra Hauer, Identification of "sites with promise", Transportation Research Board 75th Annual Meeting, 1996.

46. Road safety in Africa, Appraisal of road safety initiatives in five selected countries , Terje Assum, Oslo October 1997.
47. *Central Statistical Agency of Ethiopia.* "Census 2007, preliminary (pdf-file)" *(PDF).* Archived *(PDF) from the original on 18 December 2008*. Retrieved 2008-12-07.
48. *http://www.ethiodemographyandhealth.org/Chapter_2_Population_Data_Sources.pdf*
49. "United Nations Economic Commission for Africa". UNECA. Retrieved 5 May 2012.
50. "NGA: Country Files". Earth-info.nga.mil. Archived from the original on 4 May 2012. Retrieved 5 May 2012.
51. "INTERNATIONAL CONFERENCE ON MULTI-NATIONAL CONSTRUCTION PROJECTS: Addis Ababa Ring Road Project - A Case Study of a Chinese ..." (PDF). Retrieved2010-12-08.
52. . *Railways Africa. 2 October 2013. Retrieved 2013-11-25.*
53. *"Sub-Saharan Africa gets its first metro". The Economist. 17 September 2015. Retrieved 23 September 2015.*