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GIS BASED ROAD TRAFFIC ACCIDENT BLACKSPOT SITES MAPPING: THE CASE OF HOSANNA TOWN

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BY

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TABLE OF CONTENTS

PAGES CONTENTS

Acknowledgement i
Table of Contents ii
List of Figures iv
List of table v
Abstract vi
List of Acronyms vii
Definition of Terms viii
Chapter One Introduction 1
1.1 Back Ground of the Study 1
1.2 Statement of the Problem 2
1.3 Objective of the Study 3
1.3.1 General Objective 3
1.3.2 Specific Objectives 3
1.4 Research Questions 4
1.5 Scope of the Study 4
1.6 Significance of the Study 4
1.7 Limitation of the Study 5
1.8 Organization of the Paper 5
Chapter Two Review of Related Literature 6
2.1 General Concept 6
2.1.1. Accident Blackspots/ Hotspots 8
2.2 Types of Accidents 9
2.2.1 Vehicle to Vehicle Compatibility 9
2.2.2 Front, rear and side under-run guards on trucks 9
2.3 Causes of Accidents 11
2.4 Road Fatalities in Africa 12
2.4.1 Fatality Rates 12
2.4.2 Profile of Road Fatalities 13
2.5 Sex and Age 14
2.6 Risk Factors 14

2.7 Road Safety Initiatives 15
2.8 Road Safety Initiatives 16
2.9 The Burden and Trends of Road Traffic Injuries in Developing Countries 18
2.10 Geographic Information System (GIS) 18
2.10.1 Accident database and GIS 19
2.10.2 The use of GIS in Blackspot analysis 21
Chapter Three 22
Methodology and Background of the Study Area 22
3.1 Description of the Study Area 22
3.1.1 Physical characteristics 24
3.1.2 Economic activity 22
3.1.3. Climate 25
3.1.4 Rain fall 26
3.1.5 Road network of the town 26
3.2 Methodology 28
3.2.1 Data collection 28
3.2.2 Data and data sources 29
3.2.3 Data analysis and presentation 30
Chapter Four 31
Results and Discussion 31
Chapter Five 51
Conclusion and Recommendation 51
5.1 Conclusion 51
5.2Recommendation 51
References 52
Appendix 55

LIST OF FIGURES

Figure 1: The Study Area, Hosanna Town 23

Figure 2: Average monthly maximum and minimum temperature of the study area 25

Figure3: Average monthly rainfall distribution for the study area 26

Figure 4: Road Network of Hosanna Town 27

Figure 5: Framework of the project 30

Figure 6: The Slope Map of Hosanna Town 35

Figure 7: Road traffic accidents and sex of drivers 41

Figure 8: Accident and hours of days 42

Figure 9: Black spot Sites of Hosanna Town 44

Figure 10: Accident areas buffered by 100m distances 45

Figure 11: Buffered GPS points of accident areas Zoomed 46

Figure 12: Indicates intersections of buffer Zones 47

Figure 13: Map showing zoomed portion of black spots 48

Figure 14: Black spot Sites of Hosanna Town 50

LIST OF TABLES

Table 4.1. Road accident trend and cost of property damage inHosannaTown 31

Table 4.2. Road accident severity by accident type 31

Table 4.3. Road accident severity by age group 32

Table 4.4. Major causes and factors of Road Traffic Accident 32

Table 4.5. Factors of road traffic accidents in relation to vehicles' technical problems 33

Table 4.6. Road traffic accident and weather conditions 33

Table 4.7. Relief of the road and Road traffic accident 34

.....

Table 4.8. Light condition and road traffic accident..... 36

.....

Table 4.9. Road type in connection with road traffic accident 36

Table 4.10. Road condition and its relation with road traffic accident 36

Table 4.11. Road accident characteristics and affected pedestrians 37

Table 4.12. Job status of the victim pedestrians 37

Table 4.13. Health and physical status of victim pedestrians 38

Table 4.14. Road accidents and road division 38

Table 4.15. Service year of the vehicles involved in road accidents in Hosanna 39

Table 4.16. Major vehicle involvements in road traffic accident 39

Table 4.17. Educational background of the drivers 40

Table 4.18. Driving experience and road accident 40

Table 4.19. Age of drivers and road traffic accident 41

Table 4.20. Road traffic accidents and days of a week..... 42

Abstract

This study tried to identify the spatial distribution of accidents after collecting four years secondary data from Hosanna Administration Traffic Police Office. DEM was downloaded from USGS earth explorer of ASTER satellite image of 30mx30m resolution relief of the area. Road network of asphalt and gravel roads of Hosanna town was digitized from the google earth. Accident data from the field was collected using GPS and then, overlaid in road network of the study area. Finally, black spot areas were mapped using spatial analyst tools of GIS. This study showed the black spot sites in areas where there were zebra road crossings, squares, and crossroads. These black spot sites were mapped.

Traffic accident data analysis in Hosanna during the study period showed that major victims of road traffic accident in Hosanna were 65% pedestrians, 72% economically active citizens, and 85% of male. The material destruction in Hosanna estimated to be more than one million Ethiopian Birr. Road traffic accident was caused by many factors like human errors, roads conditions, weather conditions, light conditions and vehicle conditions. most accidents were caused by drivers' errors. These are negligence of drivers, gap of driving skills and experiences and low level of education, driving with the speed beyond expected and failure to keep driving ethics like giving priority for pedestrians and other vehicles.

These human errors that needs to be rectified by promoting education and awareness creation. The government also ought to check enforcement of traffic law in the Town.

***Key words**: Road traffic accident, GIS, GPS, Hosanna Town, Road transport, blackspots*

Acronyms of Terms

ASTER	Advanced Space borne Thermal Emission and Reflection
ETB	Ethiopian Birr
CDC	Center for Disease Control
DEM	Digital Elevation Model
ESRI	Environmental Survey and Research Institute
GIS	Geographical Information System
GPS	Geographical Positioning System
GNP	Gross National Product
GRSP	Global Road Safety Project
HRT	Hosanna Town Road Transport Unit
IPIFA	Injury Prevention Initiative for Africa
MADD	Mothers Against Drunk Driving
RT	Roads and Transport
RTIRN	Road Traffic Injury Research Network
SNNPR	Southern Ethiopia Nations, Nationalities and Peoples Region
SRTM	Shuttle Radar Topographic Mission
UNVRT	United Nations Vienna Convention for Road Transport
USGS	United States Government Survey
WHO	World Health Organization
DALY	Disability Adjusted Life Years

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Road traffic accident is severely increasing from time to time and currently become a worldwide problem. This is because of a number of reasons with diversified causal factors of accident. But the level of severity of road traffic accident varies in developed and developing regions. Data found from WHO report 2009 indicates the road traffic accident is the leading cause of death among people aged 5 – 44 which has a greater impact on the global economy and health of the population. (WHO,2009). According to World Health Organization (WHO) road traffic accident is the leading cause of death globally. An estimated one million people are killed and as many as 50 million are injured, in developing countries due to road traffic accident each year. If present trend continues, road traffic injuries are predicted to be the third leading contributor to the global burden of deaths and injuries by 2020 (WHO, 2002).In almost all developing countries road traffic crashes have become one of the leading causes of death in older children and economically active adults between the ages of 30 and 49 years (Jacobs, et al ,2000).

Despite this fast growing problem, little attention has been given to road traffic injury prevention in majority of developing countries. However, undeniable efforts have been made to tackle with the accident problem. Efforts to combat the problem of road accidents have been hindered by lack of budget and relevant data. (Atubi and Onokala, 2009).In majority of developing countries, accident occurrences and related deaths are related to either population or number of vehicles (Gbadamosi, 2002).

In developing countries traffic accident has become a common phenomenon even on good quality and standardized roads. The main cause of it is human error; the error caused by drivers or pedestrians. (Atubi and Onokala, 2009).However, the effectiveness and failure of analysis of road traffic accident at specific geographical area depends upon the effective application of proper traffic control devices, and roadway design practice. Effective mechanisms to alleviate the current severe road traffic accident lies in a systematic approach that is directly connected with the use of accurate and relevant accident data (Sarin, 2000).

However, in almost all developing countries of Asia, Africa and Latin America, the data required for such analysis is not always available. Most of the accident information available

in police records is incomplete and therefore, may not be utilized to the fullest extent (Sarin, 2000).Hotspot is a term used to refer to a section of road that is regarded as a high risk location for crashes. Hotspot identification is very important to alleviate severity and the frequency of road traffic accidents in particular locations by improving the physical conditions or management (Kowtanapanich, 2006). According to Gregory and Jarett, (1994), hotspot or a high risk site is the number of personal injury accidents occurring in a 100m length in a three year period on a particular class of road.

As road traffic accident is spatially distributed in nature, use of geographic information system (GIS) will provide the capability to store, update, retrieve, compare, and spatially display data (Li, 2006).GIS is currently preferable tool electronically generated and display hotspot maps from a well-designed accident database and can also produce rankings of high accident rates. Application and effective analysis of road traffic accident directly depends on the advancement in GIS and remote sensing technology. As the GIS and remote sensing technology consumes less time, the need to apply GIS is very important. This will inform society the severity of accident so as to provoke stakeholders participate in the preventive mechanism with concerned bodies. This study applies GIS to identify the causes and effects of road accidents and maps road accident sites in Hosanna town from the year 2013 up to 2016/17.

1.2 STATEMENT OF THE PROBLEM

Road transport is very important mode of transport, as it gives door to door services with relatively cheapest prices. But it is more vulnerable to road traffic accident than any other modes of transport. It also generates social, economic, political and environmental problems (WHO, 2009). In the case of economic problem, road traffic accident results in the destruction of materials which can be estimated in millions in Ethiopian currency. This in turn comes up with pressure in country budget to replace material destruction. The accident is also killing economically active part of the society.

Socially and politically, accident causes the need for extra vehicles this in turn becomes an assignment for government to respond to the society. In Ethiopia the rate of road traffic accident is very high, because of poor road infrastructure, poor enforcement of traffic laws and other factors. The social and economic costs of road traffic injuries are enormous. The annual loss to developing country economies, due to road traffic injuries, is estimated at US$ 100 million. This figure is about twice the total official development aid and loans these

countries receive (Ministry of Federal Affairs, July, 2002). Globally, road traffic accident kills about one million people each year. In Ethiopia about 1,800 people lose their life and 7,000 people become victim of serious injury every year. (WHO, 2002).

According to the unpublished periodic regional performance report of SNNPR, Road & Transport Bureau (2007), from 2003-2007 about 1135 people lost their life, 1321 were seriously injured, 1222were slightly injured and 1.206billion birr estimated property were distracted .Previous studies have shown that the major traffic accidents have resulted from transportation development, unsafe road, increasing number of vehicles, illegal on street parking habit, poor land use, illegal way of getting license, less driving experience, human behaviour, alcohol consumption (Heidi,2002).

There is a gap of adequate and reliable data collection system, narrow road size, little attention given to pedestrians, increased number of two wheeled and three wheeled vehicles. Even if GIS technology is the modern tool to map road traffic crime, attention is not given. The victims of road traffic accident are economically active ones and children. The cost of damaged property and expenses to cover and rehabilitation as the result of road accident hinders development. Traffic accidents data contain a lot of information. However, the spatial information of traffic accidents is generally described as address with text. So they cannot be displayed on a map and analysed spatially. Areas of vulnerability were not selected and mapped to make cautions in the identified sites of roads. Therefore, this study tries to present Geographical position information based accident data with geographic coordinates in Hosanna Town.

1.3 OBJECTIVE OF THE PROJECT

1.3.1 GENERAL OBJECTIVE

The general objective of this study is to identify road accident blackspot sites, with a view to map them and explore their causes and effects in temporal and spatial dimensions.

1.3.2 SPECIFIC OBJECTIVES

The specific objectives of this project are:

1. To identify the road traffic accident blackspot sites in Hosanna town between the years (2013/14-2016/17)

2. To map road traffic black spots

3 To identify major causes & effects of road traffic accidents black spots in Hosanna town

4. To suggest areas of interventions.

1.4. RESEARCH QUESTIONS

1 Where are the road traffic accident black spot sites in Hosanna from 2013/14-2016/17?

2 what are the geographic coordinates of the black spots

3 What are the main causes &consequences of road traffic accidents in Hosanna?

4 Which accident site is dangerous along the route?

1.5 SCOPE OF THE STUDY

The study covers municipal administrative boundary of Hosanna town, which experiences unexpected number of road traffic accident which increases with time. Among various factors of accident drivers factors, pedestrians factors, mechanical factors of vehicles, road environment and congestion of small passenger vehicles (Bajaj) and bicycles. This project mainly focuses on the identification of road traffic accident sites, major causes, temporal and spatial variations of road traffic accident in Hosanna town from 2013/14-2016/17.

1.6. SIGNIFICANCE OF THE STUDY

Hosanna town is one of the zonal towns in the SNNPR where vehicles travel from the capital, Addis Ababa to Wolayita and the tourist destinations of Arbaminch, the center of conference for the central zones of southern Ethiopia with number of vehicles increasing from time to time the vulnerability of road accident is also increasing with time. Accordingly, the study is helpful to give insight to road accident and managing risk exposure with designing roads for safety, setting road safety rules, application of an international traffic sign post and improving transportation policy. It is important to make society keep themselves from road traffic accident. Road authority will make decision during road design and construction to reduce road traffic accident. It will also provide information for drivers and transport office to take care on high risk areas. It will also make GIS technology applicable in mapping high risk areas. The findings may also motivate researchers to conduct further research in the town.

1.7 LIMITATION OF THE STUDY

Poor data management system and incomplete traffic data in police office and in availability of members of some traffic policemen appointing for longer days for key information.

1.8. ORGANIZATION OF THE PAPER

Chapter one deals with the back ground of the study, objectives to be achieved during the course of the study, the significance, scope and the limitations of the study. Chapter two also deals with the review of the related literatures. It describes the characteristics, causes and effects of road traffic accidents according to various scholars and the application of GIS technology in mapping road accident sites. Chapter three describes background of the study area, data sources, materials and methods used for the project understudy. Chapter four presents results and discussions. It also describes road traffic accident characteristics. Finally, chapter five gives conclusion and recommendation of the project.

CHAPTER TWO

REVIEW OF RELATED LITERATURE

2.1 GENERAL CONCEPT

Accident is defined as anything which happens by chance, anything occurring unexpectedly and undersigned (Odugbemi, 2010). Road traffic accident is a collision or similar incident involving a moving vehicle, resulting in property damage, personal injury or death (Astrom, 2006). An "accident is a sudden phenomenon or happening which is resulted in an unexpectedly, unfortunately, by chance or probability." and sometimes an "accident" is defined as "the sudden happening of events that comes up with injury, death or property damage" (Encyclopadia Britannica Vol. 18). Therefore, the definition given to road traffic accidents is related with road accidents. Road traffic interact with human, environment and road conditions that efficiency and safety of road traffic depends on performance and interaction of the human, environment and road conditions. (Encyclopadia Britannica Vol. 18.) Road traffic accident is an unexpected phenomenon that occurs as a result of the use or operation of vehicles including bicycles and handcarts on the public highways and roads. Accidents may be fatal, resulting in deaths of the road users (passengers, drivers or pedestrians), or minor when it is not severe enough as to cause substantial hardship (Sarin, 2000).

There are different meanings being given by different scholars concerning road accident death. But as defined by the United Nations Vienna Convention of Road Traffic (UNVCRT, 1968), a road accident death is seemed to have occurred when a person injured or dies within 30 days of the crash. However, not all countries use a 30 days definition with some countries using on <spot death>, within 24 hours, 3 days, etc. In Ethiopia, however, road accident fatality is not clearly and uniformly defined. Accident deaths shown in the accident statistics are mainly on-the-spot deaths. The inclusion of victims who died in hospitals within a short period of time during police investigation is probable. It is quite dependent on the follow up of the investigating policemen. If the victim dies after the preparation of the monthly summary of the accident report, the severity class will most likely remain unchanged. But comparing the reliability of the accident statistics, the fatal accident statistics are more complete and reliable than the non-fatal accident data due to fatal accident information is needed to enforce the law and carryout prosecutions Road traffic injuries are a global problem affecting all sectors of society. In fact, road safety has given less attention at the

national and regional levels as compared the pressure road accident put in the recent world reality. This is mainly because resulted in part from a lack of relevant information on the level of the severity of accidents and its preventive mechanisms; a fatalistic approach to road crashes; and absence of the political commitment and multidisciplinary collaboration needed to combat it effectively. However, it is possible to do much to alleviate road traffic accidents. Indeed, majority of developed nations have been reduced road traffic injury pressure by 50 percent over last few decades. Despite the fact that the total number of reported accidents decreased the last few years, safety is one of the challenging issues in the transportation industry in Ethiopia. The need to evaluate the impact of traffic accident safety is the reason for developing a suitable methodology. Road traffic accident is the result of complex and diversified factors and it mostly occurs as the result of the combination of two or more factors that causes road traffic crash. Road traffic accidents happens with the interaction of diversified factors; out of which are road environment, traffic characteristics and human errors are the main ones.

Most research findings confirmed that 70% to 80% of all road traffic accidents are as the result of human error. However there is no common agreement among scholars on the term human error; and is often controversial. It doesn't satisfactorily describe that large number of injuries and deaths that occurs on the road as the result of driving errors while abilities to do so are impaired by alcohol or drugs, lack of experience, lack of distribution of attention etc. (WHO, 2002). WHO reported in 2009 in USA Majority of road traffic crash victims were Drivers 62%, then passengers (26%) and the least were pedestrians which account 12% of the total RTDs.(WHO,2009)

Even though death rates have been decreasing over the last four to five decades in many high income countries for instance in china being 6.00 per 100,000 population in 2007(18), road traffic injuries remain an important cause of death, injury and disability. Globally, the number of motorized vehicles is rapidly increasing with effect of national and international development data in Thailand showed the number of motorized vehicles almost doubled from 6.3 million to 11.5 million between the year 1991 and 2001 increasing the burden of road traffic fatalities and injuries despite the national development (WHO, 2009).

A study it is more important to consider in low and middle income countries who are striving to overcome the economic independence and to reside with the high income countries, especially in there is already a burden of communicable diseases.

2.1.1 ACCIDENT HOTSPOTS

Definition for hotspot is given by certain scholars as the areas of high traffic crash. There is very little information given to the standard numerical and spatial factors as to what makes areas to be black spots. Black spot identification is important in the research of traffic safety. Many countries and cities have applied various methods to identifying black spots with the real situation of road traffic. Meanwhile, many documents have discussed the methods of black spot identification, and also compared the advantages and disadvantages of them. Identification of traffic accident prone method focuses on the systematic mechanism based on potential of reducing accidents (HU, 2005).

According to Gregory and Jarrett (1994) black spots are areas of "high risk sites" or accident prone areas by the number of personal injury accidents happening in a 100m grid square or 100m length in a three year, one year, six months period on the particular class of roads. Areas of back spots to be referred as "high risk sites" there should be accident record data for consecutive twelve years for a particular accident black spot sites. If twelve accidents are recorded in a given 100m area across the road within twelve years of time, then this area is termed as "high risk sites". (Gregory and Jarrett, 1994).

Practically there is no standardization of what makes black spots areas high risk sites are challenging and would be open for interpretation. (Anderson, 2003). In order to minimize hot spots or high risk levels in specific areas the exact causes of the accidents must be identified. In other words the hotspot is there because of a high number of accidents but the cause of accidents may differ. It is clear that there are diversified factors or causes for the occurrences of different black spots nor high risk sites. For instances some incidences could be caused by road conditions, weather conditions, others by a blind bend and others because it is near a public house, and all of these factors put together can cause a "hotspot", but take the accident rate on their own and the area may not be a hotspot. Black spot analysis is a prerequisite for the management of road traffic safety and it involves the systematic collection of data on traffic accidents that will enable the identification and determination of the place where there are high concentrations of road accidents. Interventions in places of accumulation of traffic accidents are considered one of the most effective approaches in prevention of traffic accidents on roads. When hotspots locations are known, it will assist the stakeholders responsible for road safety and the road users to know the areas that need urgent attention when making safety decisions

2.2 TYPES OF ROAD ACCIDENT

Car accidents fall in to several major categories. Different people give different names for car accidents. These are rear end collisions, side collisions, roll overs and single car accidents and so on. Collisions between cars and poles or trees or with other static materials are characterized by the severity of the injuries produced. Current legislation only requires the use of crash tests with the barriers representing car to car impacts. (Elizabeth and Maureen, 2003)

2.2.1 VEHICLE-TO-VEHICLE COMPATIBILITY

Achieving vehicle-to-vehicle compatibility in crashes depends upon the particular mix of motor vehicle. In the United States, for example, there is a greater need to reconcile sports utility vehicles and other light truck vehicles with passenger cars. The United States National Highway Traffic Safety Administration has made vehicle compatibility one of its leading priorities and has published its proposed initiatives in a recent report. In Europe, work focuses on trying to improve car-to-car compatibility for both front-to-front and front-to-side crashes and recommendations on this have been put forward. In low-income and middle-income countries, issues of vehicle-to-vehicle compatibility are related more to collisions between cars and trucks – both front-to-front impacts, as well as between the front of the car and the rear of the truck. The first priority for these countries must be to improve the geometry and structure of trucks so as to better accommodate impacts from smaller vehicles – not only cars, but motorcycles and bicycles as well.

The frontal structures of many new cars are capable of absorbing their own kinetic energy in crashes, so avoiding any significant intrusion of the passenger compartment. However, there is currently no legal control, by means of performance requirements, of the relative degrees of stiffness of the fronts of different models of cars. Consequently, when cars of differing stiffness collide, the stiffer car crushes the weaker car. (Elizabeth and Maureen, 2003)

2.2.2 FRONT, REAR AND SIDE UNDER-RUN GUARDS ON TRUCKS

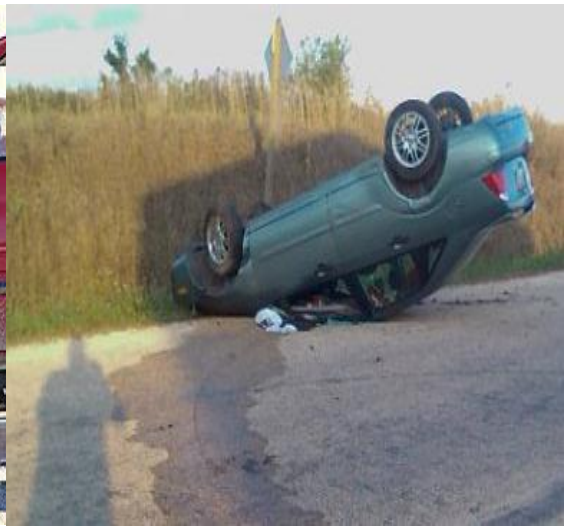
The provision of front and rear under-run protection on trucks is a well-established means of preventing “under-running” by cars (whereby cars go underneath trucks, because of a mismatch between the heights of car fronts and truck sides and fronts). Similarly, side protection prevents cyclists from being run over. It has been estimated that the provision of energy-absorbing front, rear and side under-run protection could reduce deaths by about

12%. It has also been suggested that the benefits would exceed the costs, even if the safety effect of these measures was as low as 5%. A traffic accident is defined as any vehicle accident occurring on a public highway (i.e. originating on, terminating on, or involving a vehicle partially on the highway). These accidents therefore include collisions between vehicles and animals, vehicles and pedestrians, or vehicles and fixed obstacles. Single vehicle accidents, in which one vehicle alone (and no other road user) was involved, are included. All fatality and injury totals include pedestrians, motorcyclists and bicyclists unless otherwise noted. (Elizabeth and Maureen, 2003)

Rear_end collision

front collision

Side collision



rollover accident

Source: http://photobucket.com/image/car%accident

2.3 CAUSES OF ACCIDENTS

According to research conducted on the causes of road traffic accidents in Nigeria after obtaining series of 32 years accident records more than 90% of causes of road traffic accidents could be attributed to recklessness on the part of drivers, ignorance of highway codes, driving under the influence of alcohol, over speeding... etc. (Atubi, 2013).

Many factors result in car accidents, and sometimes multiple causes contribute to a single accident. Factors include the following:-

- Driver distraction, including fiddling with technical devices, talking with passengers, eating or grooming in the car, dealing with children or pets in the back seat, or attempting to retrieve dropped items;
- Driver impairment by tiredness, illness, alcohol or drugs, both legal and illegal. MADD (Mothers Against Drunk Driving) is an organization made up of the families of the dead who were killed in car accidents caused by drunk drivers;
- Mechanical failure, including flat tires or tires blowing out, brake failure, axle failure, steering mechanism failure;
- Road conditions, including foreign obstacles or substances on the road surface; making the roads slick; road damage including pot holes;
- Speed exceeding safe conditions, such as the speed for which the road was designed, the road condition, the weather, the speed of surrounding motorists, and so on.

The annual cost of road crashes is in excess of US $500 billion, and in the developing world the estimated cost is about US $65 billion each year. Due to the scarcity of costing data for African countries, it is difficult to make a precise cost of road crashes in Sub- Saharan Africa. The current estimate of costs of crashes in the continent is US$ 3.7 billion per year, of which South Africa alone accounts for 2 billion. However, the estimated costs as a percentage of the national Gross National Product (GNP) in most African countries range from about 0.8% in Ethiopia and 1% in South Africa to 2.3% in Zambia and 2.7% in Botswana to almost 5% in Kenya. (Elizabeth and Maureen, 2003)

Most authorities emphasize speed as a primary cause of accidents, although most experts agree that speed alone rarely causes an accident. Proponents may also argue that slower driving causes no harm. On the other hand, critics of the "speed kills" mentality claim that this argument ignores complex factors that influence accident outcomes, and thus fails to

address the true causes of accidents. Each year, an estimated 1.2 million people are killed in road crashes and up to 50 million injured worldwide. Road traffic injuries are currently ranked 9th globally among the leading causes of disease burden, in terms of disability adjusted life years (DALYs) lost. In the year 2020, road traffic injuries are projected to become the 3rd largest cause of disabilities in the world. Developing countries bear the brunt of the fatalities and disabilities from road traffic crashes, accounting for more than 85% of the world's road fatalities, and about 90% of the total DALYs lost due to road traffic injuries. The problem is increasing in these countries at a fast rate, while it is declining in all industrialized nations.

2.4 ROAD FATALITIES IN AFRICA

A recent Global Road Safety Project (GRSP) study shows that about 10 per cent of global road deaths in 1999 took place in Sub-Saharan Africa where only 4 per cent of global vehicles are registered. Conversely, in the entire developed world, with 60 per cent of all globally registered vehicles, only 14 per cent of road deaths occurred. However, given the widely recognized problem of under-reporting of road deaths in Africa; the true figures are likely to be much higher, as the police reported road fatalities represent only the tip of the injury pyramid. According to this GRSP study, the adjusted true estimate of total road deaths for all Sub-Saharan African countries for the year 2000, based on the police department's records, ranges between 68,500 and 82,200. However, the estimated fatality figure of 190,191 for Sub-Saharan Africa presented in the 2004 World Report, based on health care data, is much higher, and reflects the magnitude of under-reporting in police statistics. Two countries, South Africa and Nigeria, account for most of the reported deaths in Sub- Saharan Africa. The South African figure of over 9,000 has been consistent over time, while Nigeria with 6,185 deaths has declined from a high of over 9,200 in the early 1990s. Ethiopia, Kenya, Uganda, Tanzania and Ghana are the other countries that experience high numbers of road deaths (Elizabeth and Maureen, 2003)

2.4.1 FATALITY RATES

There is no single accepted indicator that accurately describes the overall road safety situation in a particular country. The number of fatal crashes per million vehicle per kilometres travelled per annum, as a measure of exposure to motor vehicle traffic, is the most common method often used in highly motorized countries. However, because of the

absence of accurate data on vehicle usage in most African countries, it is not possible to apply this method. Instead, fatality rates, the number of reported fatalities per 10,000 registered motor vehicles, are normally used.

World Health Organization (WHO) and ministry of health sectors use the number of deaths per 100,000 population per annum, to calculate fatality risk or fatality rates to report diseases and causes of death.

This variation confirms that both mechanisms of calculating fatality rates come up with several errors besides various definitions given for road fatalities or death. under_ reporting of crashes, the resulting injuries and deaths; absence of single uniformly accepted definition for a vehicle; lack of relevant record of the total number of registered vehicles; and lack of accurate population data for the year of reporting. There are wide variations in fatality rates: from 270 in Central African Republic to 8 in Chad. The highest rates, all in excess of 100, are reported in Ethiopia, Malawi, Tanzania, Uganda and Ghana. For most of the countries, the rates lie between 40 and 130. (WHO, 2002).

2.4.2 PROFILE OF ROAD FATALITIES

Most studies reveals that Vulnerable road users to be pedestrians, pedal cyclists and public transport passengers. These are the most affected, and pay a heavy toll for their participation in traffic. Pedestrians account for the highest proportion of road fatalities in almost all African countries, ranging between 31% in Zimbabwe and 51% in Ethiopia. Involvement of pedestrians is much greater in urban environment than in rural areas. Studies in Addis Ababa and Abidjan reported extremely high proportion of pedestrian casualties of 90% and 75%, respectively. Passengers rank second, accounting for 32% to 46%. Pedestrians and passengers altogether represent over 80% of all road deaths. Drivers account for a small share of fatalities, of less than 10 per cent. Among sub-Saharan countries, only South Africa has the largest share of driver fatalities (22%). (WHO, 2002).

2.5 SEX AND AGE

Males covers greater share in road traffic crashes and account for over 67% of those killed. This can partly be explained by their greater exposure to traffic as drivers and as frequent travellers in motor vehicles for work and leisure activities. Females are involved mainly as passengers and pedestrians. In Botswana, for instance, a recent study showed that females accounted for as high as one- third of all pedestrian fatalities and 43 per cent of all pedestrian casualties. Over 75 per cent of road traffic casualties in Africa are in the economic productive age bracket of between 16 and 65 years. Those aged over 65 years account for a small proportion of road casualties, partly due to their small numbers in the population pyramid of developing countries. Children often get injured as pedestrians; up to 30% of Botswana's pedestrian casualties were aged less than 16 years. Based on sex related traffic accident data in Hosanna town drivers causing traffic accident, 98% of drivers were male and only 2% were female from 2013_2016/17. In India among 364 fatalities 362 were male and only 2 were females. Concerning age of the victims more than 80% were male and only less than 20% were female.

(http://www.ijrdh.com/files/RTA%20article%206.pdf)

2.6 RISK FACTORS

Reports for various countries (Kenya, Uganda, Ethiopia, Tanzania, Ghana, South Africa, and Zimbabwe) show that most of the road crashes are largely due to a range of human error, road and vehicle factors that include:

1) Over speeding, perilous overtaking;

2) Alcohol and drug abuse;

3) Driver negligence, poor driving standards;

4) Vehicle overload;

5) Poor maintenance of vehicles;

6) Bad roads and hilly terrain;

7) Negligence of pedestrians;

8) Distraction of drivers (e.g. speaking on cell phones). These findings need to be taken with caution as the single causes usually reported by the police oversimplify the reality.

Also, traffic police are often more inclined to cite the driver as being at fault than a pedestrian or cyclist because of the rules and guiding principles existing at this moment in time in Ethiopia, special investigation teams are needed to assess the contribution of the various risk factors at the time of a crash. Special investigation teams are needed to assess the contribution of the various risk factors at the time of a crash. Although the factors cited above are the most commonly reported in routine police statistics, there are broader underlying inter-related factors contributing to the rising magnitude and burden of road traffic injuries in Addis Ababa. These include:

- Rapid growth in motorization and human population;
- Increased spatial interaction of road traffic, in terms of the volume and direction of movement;
- Deficiencies and problems in road user behavior;
- Conditions and environment of work in the public transport sector, with special reference to buses and minibuses;
- Social and economic conditions prevailing in Ethiopia; serious deficiencies in the road network development and maintenance; and deficiencies in road safety planning, management, enforcement and interventions. Firm political commitment and resources are needed at the national and international levels to effectively address these social, economic and developmental issues (Elizabeth and Maureen, 2003).

2.7 ROAD SAFETY INITIATIVES

Like in other developing nations, many African countries have established road safety agencies in form of National Road Safety Council or Road Safety Committee since the early 1980s, mostly within Ministries of Transport and Roads, with the aim of preventing road "accidents". They are inter-sectorial in composition, with membership derived from both governmental and non-governmental sectors, and operate mainly at the national level. Stake holders working in collaboration among themselves in road traffic safety measures are seem they may not give much attention, as they have their own regular duties in their institutions and they consider the traffic safety as part time duties. Their roles and capacity to effectively function, however, vary from country to country. Activities includes:

A. Ensuring law enforcement,

B. Collecting road accident statistics,

C. Revising traffic legislation,

D. Promotion of road safety education,

E. Ensuring adequate provision of medical facilities for traffic injury victims,

F. Undertaking research in road safety, and co-ordination of all road safety activities.

In general, in Ethiopia – Hosanna, inter disciplinary collaborative road safety activities among organizations like road safety committee in government structures and school road safety clubs have largely been ineffective, as they do not have the capacity to function effectively due to inadequate funding, lack of sufficient human and material resources, as well as lack of authority to fully discharge their duties. A more effective central agency for road safety, with adequate resources and trained personnel, is needed in each region.

2.8 ROAD TRAFFIC INJURY RESEARCH

There are some emerging initiatives to improve awareness and documentation of road crashes in Africa. The Injury Prevention Initiative For Africa (IPIFA), formed in 1997 by a small team of researchers, is exemplary. IPIFA is a non-profit organization with membership from 12 African countries (Uganda, Kenya, Ghana, Nigeria, Egypt, Ethiopia, Eritrea, Zambia, Zimbabwe, Mozambique, South Africa and Mauritius).

The aims of IPIFA are to conduct research in injury control and promote safety, develop and conduct training programs in injury epidemiology, prevention and acute care; undertake advocacy for the prevention and control of injury; facilitate the exchange of knowledge in Africa, and act as a liaison between Africa and international and continental stakeholders in injury control. IPIFA has taken on the challenge of injury control on a continent where the problem is largely unrecognized and where the magnitude of the problem has been demonstrated to be huge. IPIFA works closely with the WHO and Global Forum for Health Research, and has received considerable financial support from these organizations.

Other institutions and organizations, which have provided funding for injury research to IPIFA, include the Graduate Institute of Geneva on Small Arms Survey and the Road Traffic Injury Research Network (RTIRN). In addition, individual members of IPIFA have been able to win competitive research awards from various agencies such as the National Institutes of Health, Center of Disease control (CDC), Rockefeller Foundation, and the

Volvo Research Foundations. The key research areas identified through these initiatives encompass the following topics: Pedestrian and cyclist mobility, Policy issues and Emergency medical systems.

The Future - According to a World Health Organization/World Bank report "The Global Burden of Disease", deaths from non-communicable diseases are expected to climb from 28.1 million a year in 1990 to 49.7 million by 2020 - an increase in absolute numbers of 77%. Traffic accidents are the main cause of this rise. Road traffic injuries are expected to take third place in the rank order of disease burden by the year 2020."The Magnitude of the Problem" - On average in the industrialized countries, and also in many developing countries, one hospital bed in ten is occupied by an accident victim.

Traffic accidents are a major cause of severe injuries in most countries. Developing countries have nearly four times the number of deaths from these causes as the developed world. According to the WHO, Ethiopia has the highest rate of fatalities per vehicle in the world. Uganda ranks second in road fatality rates in the world behind Ethiopia. Emergency medical systems are often poor and injury prevention programs are rarely available (WHO, 2002).

Road traffic accidents currently kill 1,800 Ethiopians a year and injures another 7,000. Alarmed by the increasing carnage, Shell Ethiopia, the largest fuel distributor in Ethiopia with a 43 % market share, launched an awareness campaign: “Drive to Live”. The campaign is intended to promote the value of safety rules and the benefit of implementing “defensive driving” for drivers employed by the transport companies. It was reported that the Road Transport Authority of Ethiopia had imported four patrol cars to police traffic in the capital, that trap for over speeding, although it is not realized the future hope.

In Ethiopia, the capital Addis, there were different workshops and presentations had been coordinated and conducted to respective authorities, aimed global initiative in benchmarking road-traffic enforcement through international sharing of good practices and successfully implemented enforcement strategies. The Conference laid special emphasis:-

- In re-defining the enforcement with current relevance;
- In suggesting the role and coordination of responsible agencies in enforcement;
- Definition and allocation of traffic related fines;

- Accident Investigation and Analysis as a core issue to understanding the complex issues relating to enforcement;
- Legislation for important enforcement issues like: dangerous driving, driving under the influence of alcohol and drugs, over-speeding, school transportation, parking, protection for two wheeler riders etc.;
- Tools and systems for effective enforcement;
- Infrastructure for enforcement;
- Expertise and Skills for enforcers;
- Driver Training;
- Vehicle Certification and enforcement;
- Public dealing;
- Crisis Management and handling of collisions;
- Global coordination and dissemination of best practices

  (Ministry Of Federal Affairs, July, 2002)

2.9 THE BURDEN AND TRENDS OF ROAD TRAFFIC INJURIES IN DEVELOPING COUNTRIES

Why still the road traffic accident increases? Why so many accidents?

The social and economic costs of road traffic injuries are enormous. The annual loss to developing country economies, due to road traffic injuries, is estimated at US$ 100 million. This figure is about twice the total official development aid and loans these countries receive. The fatalities and injuries due to road traffic crashes in developing countries are rising, fuelled by rapid growth in motor vehicle numbers. In Ethiopia, for instance, four-wheel motor vehicles increased by 3 per cent per year. (Ministry of Federal Affairs, July, 2002).

2.10 GEOGRAPHIC INFORMATION SYSTEM (GIS)

Geographical Information Systems (GIS) are computer-based systems that enable users to collect, store, and process, analyse and present spatial data(David,2003).It provides an electronic representation of information, called spatial data, about the earth's natural and man-made features.

A GIS references these real-world spatial data elements to a coordinate system. These features can be separated into different layers. A GIS system stores each category of information in a separate "layer" for ease of maintenance, analysis, and visualization. For example, layers can represent terrain characteristics, census data, demographics information, environmental and ecological data, roads, land use, river drainage and flood plains, and rare wildlife habitats. Different applications create and use different layers. A GIS can also store attribute data, which is descriptive information of the map features. This attribute information is placed in a database separate from the graphics data but is linked to them. A GIS allows the examination of both spatial and attribute data at the same time. Also, a GIS lets users search the attribute data and relate it to the spatial data. Therefore, a GIS can combine geographic and other types of data to generate maps and reports, enabling users to collect, manage, and interpret location-based information in a planned and systematic way. GIS systems are dynamic and permit rapid updating, analysis, and display. They use data from many diverse sources such as satellite imagery, aerial photos, maps, ground surveys, and global positioning systems (GPS) (ESRI, 2010).

2.10.1 ACCIDENT DATABASE AND GIS

GIS permits users to display database information geographically. Organisation uses Geographical Information System (GIS) to obtain better information for better decision making. GIS presents the real-world objects on map and easy to use spatial tools for performing the most complicated task. In our real-world spatial objects are presented in different ways. In Geographical Information System, spatial objects are represented as point, line and polygon. ArcGIS is GIS software which belongs to ESRI software solutions. In ArcGIS desktop, there are three main applications of our interest ArcMap, Arc CatLog and Arc Toolbox. It can also provide a common link between two or more previously unrelated databases. The most useful aspect of GIS as a management tool is its ability to associate spatial objects (street names, milepost, route number, etc.) with attribute information (accidents, cause, etc.). Most of the documents reviewed consider the use of GIS in transportation under either for general data maintenance (primarily inventory of transportation-related incidents) or for simple data analysis (Liang, Masoem and Hua, 2005).

Linear Referencing and Dynamic Segmentation

Linear referencing tools are an extension available with Arc Info for use in ArcMap. They are designed specifically for transportation or other linearly-based data such as pipelines or transmission lines. These tools are invaluable to crash data analysis and were used throughout the research. Dynamic segmentation, a useful tool when working with linear referencing data, Linear Referencing Systems Referencing System" or LRS is a GIS data management system built around the route-mile point system used by most transportation agencies. Instead of features being located by a latitude-longitude (lat/long) or other coordinate system reference, features are located by specifying a distance along a measured line (route). A linear referenced line is a polyline that has measures associated with it. The line will have a beginning mile point (usually zero) and an ending mile point. All locations on the line between those points can then be identified by an intermediate mile point value that is somewhere between the beginning and ending mile point. Non-LRS lines in GIS can be measured, but they do not have intermediate measures associated with any point on the line, the measure is a static value (Esri 2011c).

Linear referencing is useful in crash data analysis because it can represent point and line features of the roadway in the same geographic context. Linear attributes such as number of lanes, roadway width, speed limit, curvature, functional classification, and others can all be represented in a table with mile points and the appropriate variable value for that segment. Point data such as crash location is represented in LRS the same way except that there is only one mile point listed in the table rather than two. When data are mapped using LRS the data is referred to as a "Route Event," signifying that it is an event that occurred on that route crash. A new record with attributes can be added to any Route Event Layer table and it will instantly be digitized on the map. No manual drawing or processing is necessary. Dynamic segmentation is an LRS process that allows data to be overlaid in order to merge or collect attributes, a very useful operation in crash data analysis (Mitra 2009).

Dynamic segmentation is a process that takes two different route event tables or layers and merges them into one file with mile point locations adjusted accordingly. In addition, the attributes of each layer will both be present in the new file. The speed data and AADT data are combined and the output has new mile point breaks and the appropriate data for each segment. The final product dataset of segments that are each homogeneous with respect to the input data. This feature of LRS is extremely useful in crash analysis because it allows the

creation of 17 segments with homogeneous characteristics. These segments and the associated characteristics can then be input into statistical models for further analysis. Overlay's can also be done with points and lines. The output is a point file that has added the attributes of the line to its attribute table, but there is no change in the mile points. This is useful for determining crash variables that are not recorded in the crash record but are available in an LRS line file within GIS.

2.10.2 THE USE OF GIS IN HOTSPOT ANALYSIS

Geographic Information System (GIS) is a computer system for capturing, storing, querying, analysing and displaying geographic data. GIS represents a new paradigm for the organization of the information and the design of information system, the essential aspect of which is the use of concept of location as the basis of structuring of information systems. Traffic accident analysis means to investigate the causes of accidents, to determine hazardous locations (Accident Prone Locations) and to determine to enhance road features, to evaluate traffic safety and enhancement. GIS can easily represent accident and road accident based results using various tools like linear referencing, dynamic segmentation, and spatial analyst (Deepthi and Ganeshkumar2010). Moreover query can be easily performed, enhanced by graphical representation. Road characteristics, demographic and socio-economic data enhance highway safety analysis can also be integrated into the analysis (Kamalasudhan, 2011).

FUNCTIONAL COMPONENTS OF GIS

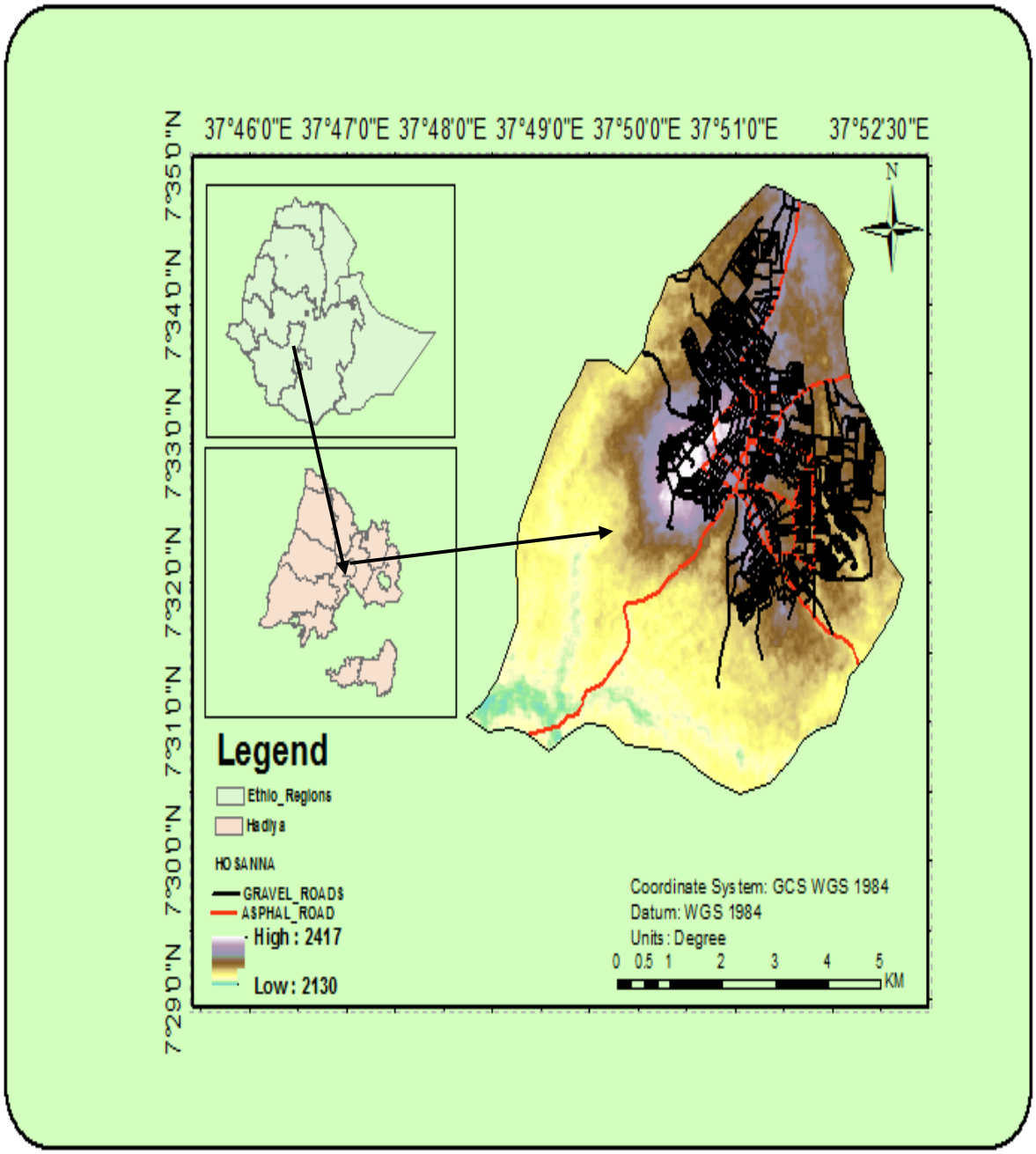
GIS is capable of bringing together the data elements necessary for solving problem with the spatial context analysing events. The five basic functional component are: data acquisition and data verification, data storage and database management, data transformation and analysis, data output and presentation, and user interface. (Knowles and Hillieri, 2008).

CHAPTER THREE

METHODOLOGY

3.1 DESCRIPTION OF THE STUDY AREA

Hosanna, is found in Southern Nation, Nationalities and Peoples Region in Hadiya Zone, locally known as *Wachemo,* is located at 232km south from the capital Addis Ababa, 168kms away from Hawassa, and 89kms away from Butajira. It is the town of Hadiya zone. Hosanna town lies on an elevation ranges from 2130m_2417meters above mean sea level, across the main high way leading from Addis Ababa via Butajira to Wolayitasodo. It is found 7°30’30’’N_7°35’30’’N latitude and 37°48’30’’E_37°54’30’’E longitude. It is surrounded by *Lemo wereda*, one of the *weredas* of the Hadiya zone. The town has the toatal area of 37.13square kilometres. It serves as a major business center for inhabitants in the area. Hosanna is the administrative center of the Hadiya zone, with the population of 133, 764. Out of which 65,132 are males and 68,632 are females. (CSA, 2007).



Source: Ethio_GIS and Google Earth

Figure 1: The Study Area, Hosanna Town

3.1.1 Physical characteristics

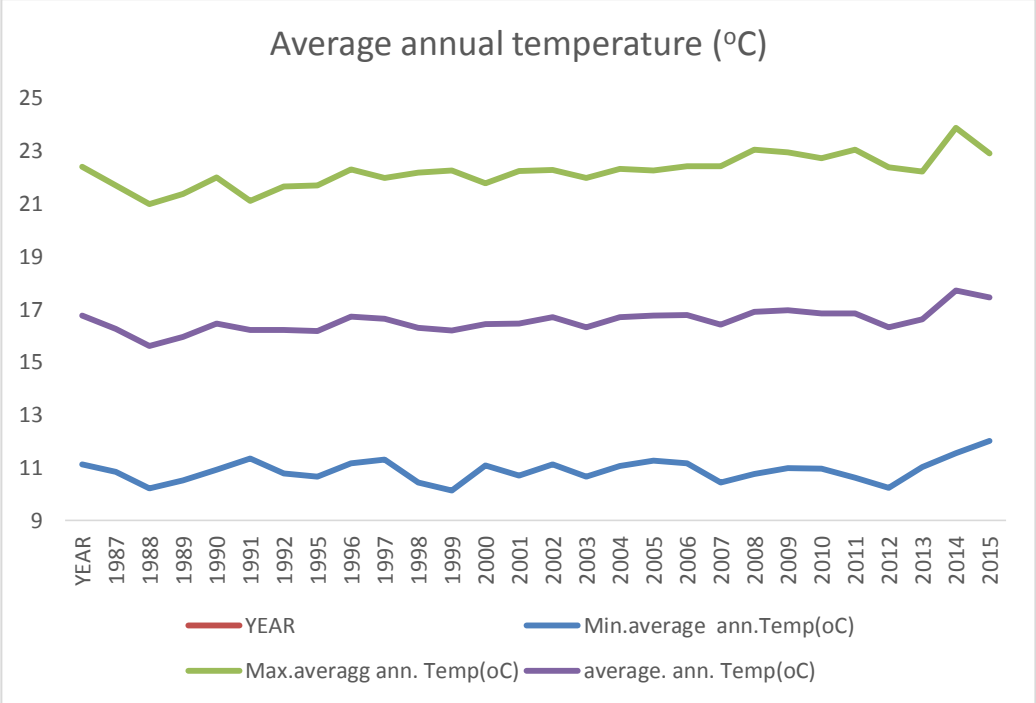
Physically, Hosanna covers about 37.13 square kilometres of land with alternatively changing horizontal vertical landscape orientation. It includes several ups and downs, hills and plains which can commonly be said that the town is inclined dominantly from west to east. (Tamirat, 2005). The present day landscape of Hosanna owes its actual surface from the past volcano tectonic activities with the slight modification by local thick soil formation, soil erosion and to some extent by gulley formation. Hosanna is found at the south eastern edge of the western plateau physiographic region which is very close to the left margin. Its location on a topographically higher area makes the town to serve as a divide for the Gibe-Omo and Rift-Valley lakes drainage basins (Mulugeta, 2000). Its elevation within the town ranges from 2417m in areas around *Balewold Orthodox Church including* Queen Eleni Mohammad Hospital to 2200m above mean sea level are around *Tekle Haymanot* Church. According to National Urban Plan Institute (2000), the slope characterizes the town, which gradually descends from the north to south elongated and highly elevated land mass to the east and west. Generally, about 75% of the town is with slope less than 10%, which is almost suitable for road transport services.

3.1.2 Economic activity

The main economic activities of the town are trade, public services, transport, and the like. Among these activities trade, hotel and restaurants are the main ones. The physical characteristic of the housing units in the town has revealed that the majority of them are dilapidated around "Arada" and without the requisite services; however, there are newly emerging housing units at the center and periphery of the town. Its proximity to Addis Ababa, *Butajira* and *WolitaSodo* towns creates good opportunity of the future development of the town. Hosanna has access road that links the town with Addis Ababa, *Buttajira*, *WolayitaSodo* and *Wolikete* town with asphalt road and other surrounding *weredas* with gravel road connected. Hosanna town is now administratively divided into three sub towns: *Sech Duna*, *Gofermeda* and *Addis ketema* sub cities

3.1.3 Climate

The whole study area is lying within a tropical climate as a humid region (Ethiopian meteorological Agency, 2017). The climate of Hosanna town is characterized by four distinct seasonal weather patterns; that are the main wet season "kiremt" which extends from June to August, a minor rainy season "mehir" extends from September to October, a little rainy season "belg" extends from March to May and more likely no rainy season "bega" extends from December to February. In general based on local climatic classification, Hosanna Town is grouped under "woeina-dega" climatic zones. As meteorological data has shown that the annual mean average temperature of the town for consecutive 28 years is around 10^0c and the maximum temperature reaches up to 25^0c by the year 2015 as indicated in the following graph.

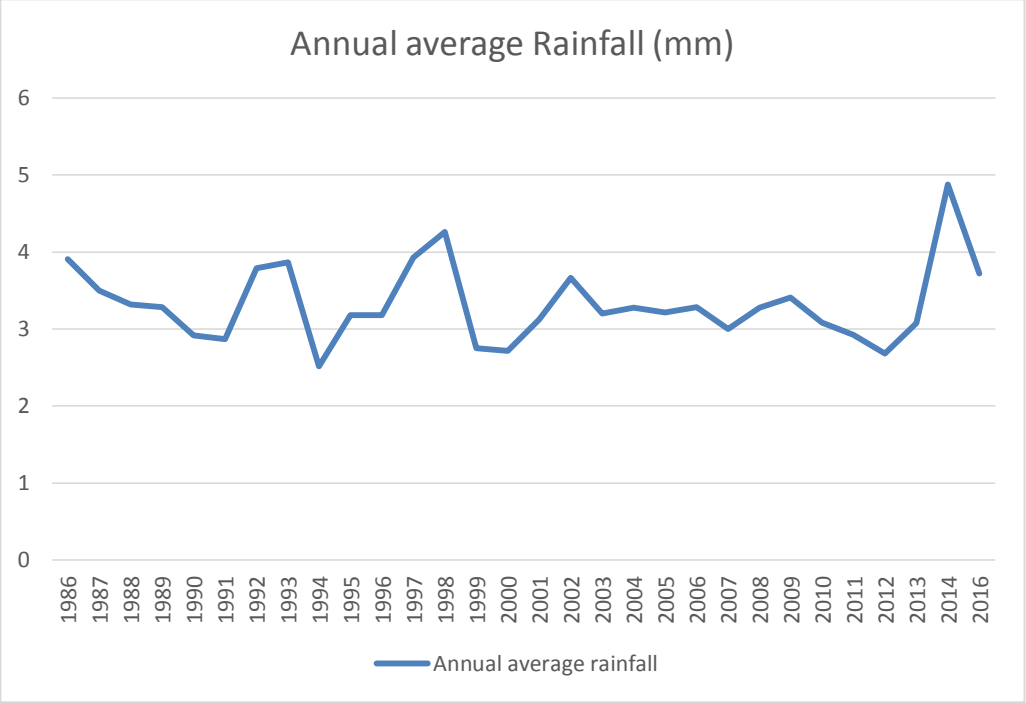


Source: Ethiopian Meteorological Agency, 2008

Figure 2: Average monthly maximum and minimum temperature of study area.

3.1.4 Rain fall

The variation in the seasonal distribution of rainfall in Ethiopia can be attributed by the reference to the position of the Inter-Tropical Convergence Zone (ITCZ), the relationship between upper and lower air circulation, the effects of topography and the role of local convection currents and the amount of rainfall. As meteorological data has shown that the highest average annual rainfall of the area was recorded in 2014 while the lowest was in 1994 as shown in the graph below.



Source: Ethiopian Meteorological Agency, 2008

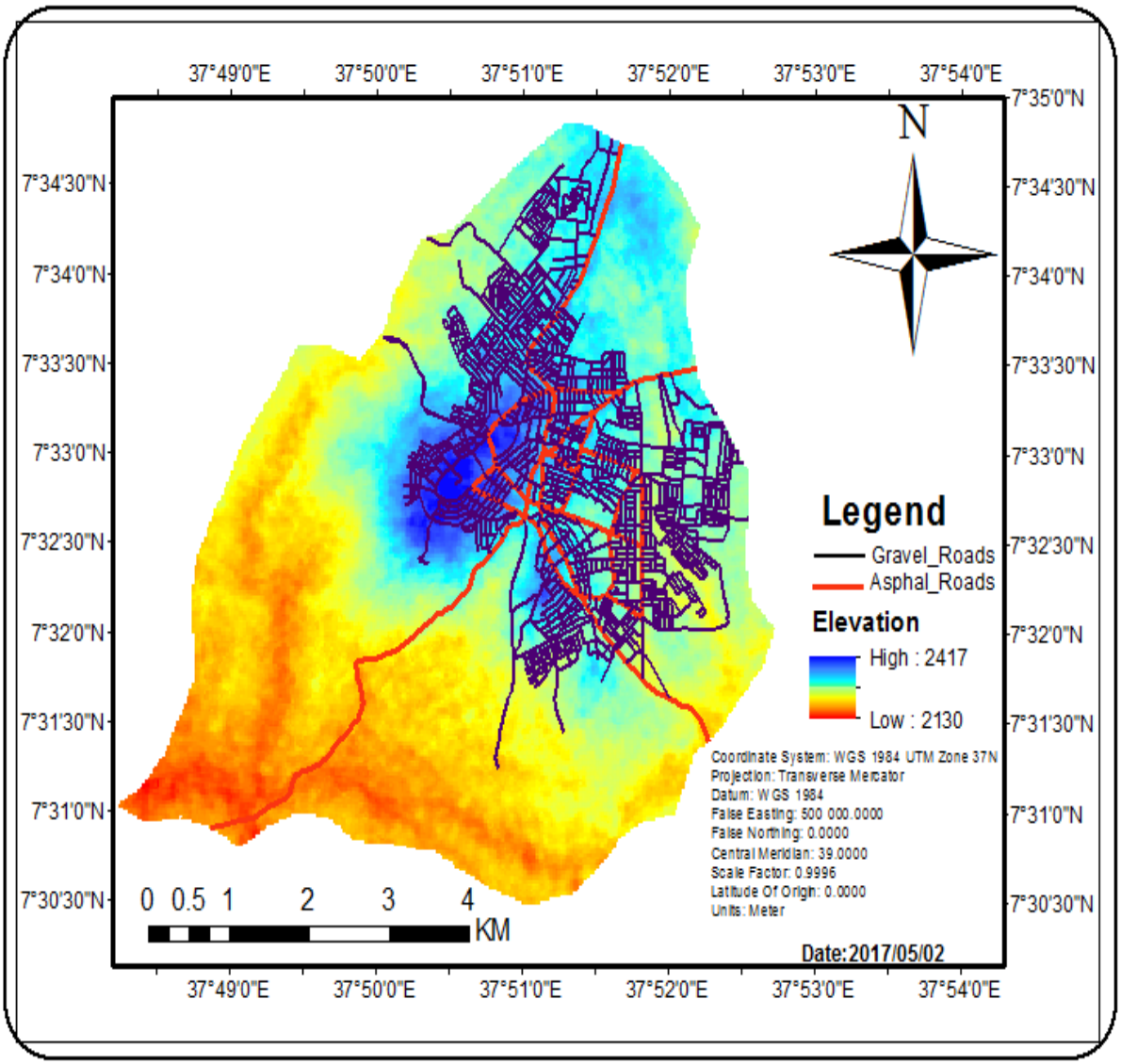
Figure3: Average monthly rainfall distribution for the study area

3.1.5 ROAD NETWORK OF THE TOWN

Road is very important infrastructure and use as an indicator of level of development of a particular country. Road network is the geographical expression of roads with line feature. Hosanna Town has the network of 74.4km of roads. Out of which 11.8kms was asphalt roads,46.9kms was gravel roads,14.3kms was coble stone roads and only 1.4 was pedestrians walkway coble stone roads.(source: Hosanna Municipality,2017).

As it is depicted in figure 4, red colour represents asphalt roads and black colour indicates gravel road. For this research purposes the road network presented are asphalt roads and gravel roads.

The structure of the road network in the town is determined by the existing patterns of layout and density of housing and building characteristics. In high-denser areas the block building results in a large number of intersections with short distances between roads are edged with sideways on both sides of the roadway. Buildings, fences and other vertical objects border the streets.



Source: digitized from google earth

Figure 4: Road Network of Hosanna Town

3.2 MTHODOLOGY

3.2.1 DATA COLLECTION

The data were collected from both primary and secondary sources. The primary data was collected from the field with the use of Global Positioning Systems (GPS) and observation. The data from primary sources were the geographic coordinates of the accidents sites. The GPS survey was carried out all over the main asphalt roads of Hosanna town. Google Earth was also used to extract asphalt and gravel route network of the town. The secondary data was collected from existing records of traffic accidents of different routes in the town administration police office, road transport unit and Hadiya zone police department. Sources like internet, reports, Journals of governmental and other institutions were used. The database were structured in a format for implementation using the application of Arc GIS10.3 environment. Similarly Microsoft words and RS excel was used for writing reports in textual format.

Three approaches used were data processing, provision of digital cartographic features, and geocoding. As the accident data is in the form of hard copy in police office, to enable data processing & exploitation, the database has to be created. The basic accident data parameters in all accident forms can be summarized in the following categories (Amer, Sarim and Atef, 2004).

-General Information:-year, month, day of the week, hours---etc.

-Location: - areal name, GPS coordinates

-Road user:-age, sex, road user type, alcohol consumption, seat belt use, car passenger position, driver license, category, date of issue---etc.

-Injury details:-extent, number of persons injured, injured persons details, evacuation means etc.

-Road environment:-road type, road category, weather condition, lighting condition, road surface, traffic control

-Vehicle:-vehicle type, vehicle service year--etc.

-Accident:-accident type, manoeuvre type—etc.

Location data were taken by place name from secondary data.so that geocoding is possible. Finally, geocoding tool combines the address locator with stored data, each one of the accident is placed to the incident location point. Each accident point contains its attributes data, in order to perform further analysis.

Slope map of Hosanna was obtained from website of USGS of ASTER satellite DEM with the resolution of 30mx30m accessed on 26/04/2017. After it was downloaded, DEM was overlaid and masked by the Hosanna Town shapefile and Slope data was processed using Arc GIS 10.3. The accident site point data was taken by GPS and fed in to MS excel 2013 software and overlaid on road network. Digital camera was also applied to capture some of the field survey and some of the photos already captured by the Hosanna town traffic police.

3.2.2 DATA AND DATA SOURCES

No.	Data	Sources	Relevance
1	DEM	Website(SRTM)	To generate slope and elevation
2	Road Network	google earth	To extract and digitize road network of the study area
3	GPS Coordinate	Field Survey	To collect data of accident sites
4	Image samples	Field survey	To capture images

The hot spot sites along road network were identified in Arc GIS10.3 environment. The road networks were digitized from the google earth and clipped by the Hosanna shapefile. The slope map derived from shuttle radar topographic mission (SRTM) by Arc GIS environment.

The project work was started by collecting road traffic accident data showing (fatality, serious and slight injuries and property damage) accident characteristics in relation to weather condition and road conditions from Hosanna town police office from 2013/14-2016/17 for four years. The data was analysed in tabular form. After main accident sites were selected GPS points were collected and fed to MS excel software. The GPS data was then added to road network of Hosanna town with the help of Arc GIS10.3. Finally, Shuttle Radar Topographic Mission (SRTM) data was down loaded and masked by Hosanna shapefile then, black spot points were overlaid to indicate the slope of the study area to check the relationship between slope (relief) and traffic accident vulnerability of the study area.

3.2.3 DATA ANALYSIS AND PRESENTATION

No.	Method	Purpose	Software
1	Digitizing	To convert analogue data in to digital form to use in GIS environment	Google earth
2	Overlay	To select accident sites, slope & road network	Arc GIS 10.3
3	Buffering	To identify blackspots	Arc GIS 10.3
4	Spatial analysis	To generate slope, overlay GPS points, and identify blackspots,	Arc GIS spatial analyst tools

FRAMEWORK OF THE PROJECT

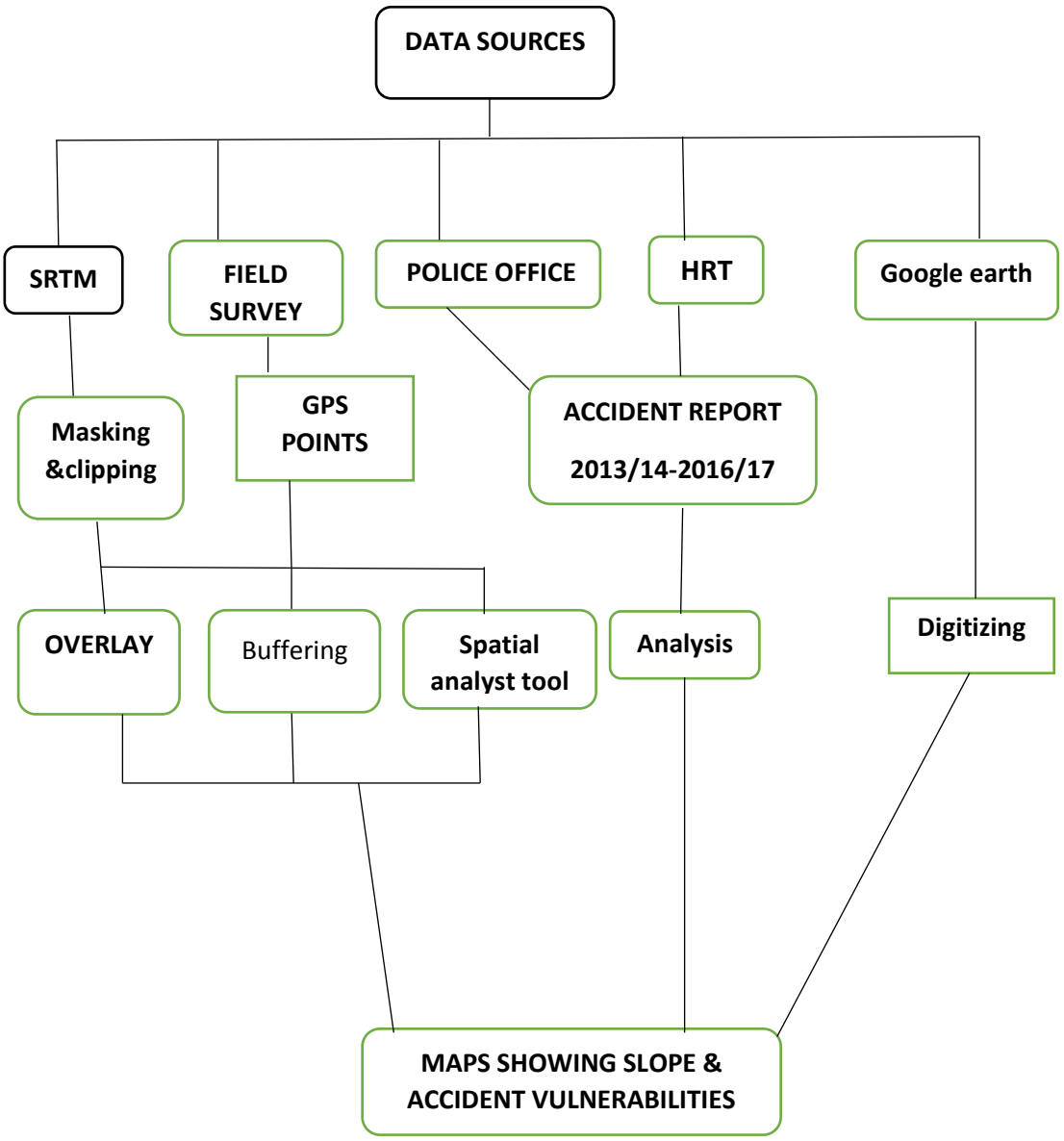


Figure 5: Framework of the project

CHAPTER FOUR

RESULTS AND DISCUSSION

There are multiple factors for the occurrences of even for a single traffic accident. Some of the causes come from drivers, vehicles, road condition and pedestrians. Different accident causes varying casualties like fatality, serious injuries, slight injuries and property damage.

Table 4.1 Road accident trend and cost of property damage in Hosanna Town (2013/14-2016/17)

Year	Casualty				Property damage cost (ETB)
	Fatality	Serious injuries	Slight injuries	Property damage	
2013/2014	5	12	15	15	433,250
2014/2015	7	14	16	29	237,260
2015/2016	6	13	8	39	225,000
2016/2017	23	20	6	21	394,500
Total	41	59	45	99	1,290,010

Source: Hosanna Town Administration Police Office, 2017

The trend of road traffic accident in Hosanna town from 2013/14-2016/17 reveals that the number of deaths and injuries with material distraction are increasing from year to year. This might be due to low enforcement of traffic law and lesser awareness creation among community and transport partners.

Table 4.2 Road accident severity by accident type (2013/14-2016/17)

Accident Type	Casualty type				
	Fatal	Serious	Slight	Total (%)	Damage only
Pedestrians	20	27	15	42.8	59
Head-on	2	14	4	13.8	4
overturning	15	5	10	20.7	8
Fall from vehicle	1	4	4	6.2	3
Right angle	-	-	3	2	11
Rear end		5	1	4.1	12
Sideswipe	-	-	-	-	1
Others	3	4	8	10.3	1
Total	41	59	45	100	99

Source: Hosanna Town Administration Police Office, 2017

According to data collected by the traffic police from 2013/14-2016/17 about 43% of the road traffic accident victims were pedestrians as the drivers were not giving priority for pedestrians even on zebra crossings. On the other hand the awareness creation on road traffic accident might be lower than expected. Besides, there might be given less attention for

driving ethics and driver's discipline during training before the trainees are given driving licenses.

Table 4.3 Road accident severity by age group from 2013/14-2016/17

Victims	Age (in year)	Casualty type						Total
		Fatality		serious injuries		slight injuries		
		M	F	M	F	M	F	
Drivers	<18	-	-	-	-	-	-	-
	18-30	2	-	12	-	10	-	24
	31-50	3	-	1	-	-	-	4
	>50	2	-	-	-	-	-	2
	Subtotal	7	-	13	-	10	-	30
Pedestrians	<18	-	-	1	1	2	-	4
	18-30	7	-	16	4	21	4	52
	31-50	11	6	10	5	2	1	35
	>50	2	-	2	-	-	-	4
	Subtotal	20	6	29	10	25	5	95
passengers	<18	-	-	-	-	-	-	
	18-30	4	-	5	-	3	-	12
	31-50	4	-	1	1	2	-	8
	>50	-	-	-	-	-	-	-
	Subtotal	8	-	6	1	5	-	20
Total		35	6	48	11	40	5	145

Source: Hosanna Town Administration Police Office, 2017

As it is indicated on table 4.3 more than 72.4% of the total fatalities and injuries affected age groups between 18-30 all the victims of drivers, pedestrians and passengers. This shows that the productive age groups are always affected by road traffic accidents. And 85% of males and only 15% of females are attacked by road traffic accidents. This might be males' active participation on economic and social activities than females.

Table 4.4 Major causes and factors of Road Traffic Accident (2013/14-2015/16)

Causes	Fatal	Serious	Slight	Total (%)	Damage only
Improper turning	5	3	-	5.5	11
Failure to give priority for vehicles	-	2	3	3.4	17
Driving too close	-	2	-	1.4	2
Over speed	10	18	12	27.6	44
Failure to respect right rule		-	-	-	-
Failure to give way for pedestrians	23	29	24	52.4	18
Others	3	5	6	9.7	7
Total	41	59	45	100	99

Source: Hosanna Town Administration Police Office, 2017

Table 4.4 shows that the major causes of road traffic accidents from 2013/14-2016/2017 in Hosanna Town were driving with the speed beyond expected and failure to give priority for pedestrians on their crossing roads together made more than 78% of the total accidents. This might be drivers' disciplinary problem during their training for their driving licenses, low enforcement of law by traffic police and road and transport offices.

4.5 Factors of road traffic accidents in relation to vehicles' technical problems

Defects of vehicles	Casualty type				
	Fatal	Serious	Slight	Total (%)	Property damage
Brake	1	-	1	1.4	-
Steering wheel	-	-	-	-	-
Tyre		-	-	-	-
Light	1	-	1	1.4	5
With no problem	21	39	26	59.3	49
Not stated	18	20	17	38	45
Total	41	59	45	100	99

Source: Hosanna Town Administration Police Office, 2017

According to the Hosanna Town administration traffic police data, more than 60% of the causes of accident from 2013/14-2016/17 was without mechanical and technical problems of vehicles. The main causes of accidents might be negligence and ethical problems of the drivers in addition to lesser enforcement of law.

Table 4.6 Road traffic accident and weather conditions (2013/14-2016/17)

Weather conditions	Casualty type				
	Fatal	Serious	Slight	Total (%)	Property damage
Good weather	28	43	35	75	56
Cloudy & Foggy	2	3	-	3.5	2
Hot	3	9	7	13	10
Heavy rain	-	-	2	1.4	6
Light rain	2	-	-	-	1
Cold	3	3	1	4.8	20
Other	3	1	-	2.8	4
Total	41	59	45	100	99

Source: Hosanna Town Administration Police Office, 2017

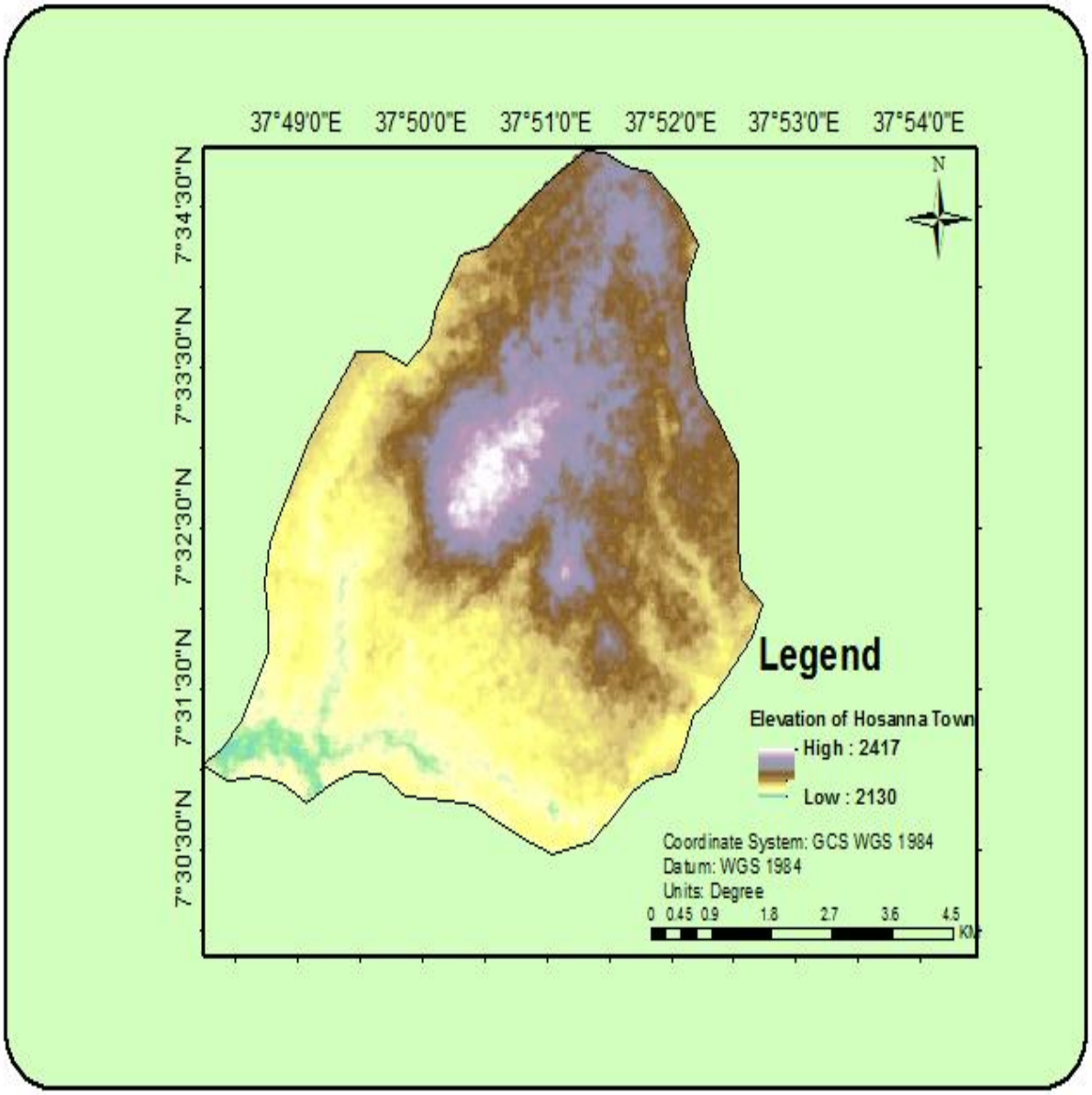
As it is indicated on table 4.6 majority of the road traffic accidents in the Hosanna town from 2013/14-2016/17 were happened in a good weather condition. This shows that the influence of the weather condition for the occurrences of road traffic accidents was insignificant.

Table 4.7 Relief of the road and Road traffic accident

Relief of the roads	Casualty				
	Fatal	Serious	Slight	Total (%)	Property damage
Straight and plain	26	32	28	59.3	69
Straight with gentle slope	4	11	7	15.2	15
Ups and downs	-	-	-	-	-
Slight meandering	-	-	-	-	-
Heavy meandering	-	-	-	-	-
Hilly	4	5	4	9	2
Down hill	7	10	5	15.2	13
Others	-	1	1	1.4	-
Total	41	59	45	100	99

Source: Hosanna Town Administration Police Office, 2017

According to traffic police data shown in table 4.7, about 60% of the road accidents are happened on straight and plain roads environments. This indicates that the relief structure was not significant cause for the accident in Hosanna town from 2013/14-2016/17.The straight and plain roads environments might have made drivers drive with the speed beyond expected with in town.



Source: SRTM from USGS

Figure 6: The Slope Map of Hosanna Town

Table 4.8 Light condition and road traffic accident

Light condition	Casualty				
	Fatal	Serious	Slight	Total (%)	Property damage
Daylight	25	40	34	68.3	79
During sun set	3	4	5	8.2	-
During sun rise	1	5	4	7	6
At night with good road light	12	10	2	16.5	14
Other	-	-	-	-	-
Total	41	59	45	100	99

Source: Hosanna Town Administration Police Office, 2017

As data in table 4.8 reveal more than 68% of the accidents in the town from 2013/14-2016/17 were occurred with day light. This indicates that light problem has low influence on the road traffic accident in the town.

Table 4.9 Road type in connection with road traffic accident

Road type	Casualty				
	Fatality	Serious	Slight	Total (%)	Property damage
Good asphalt	37	56	42	93.3	79
Worn out asphalt	1	1	2	2.7	9
Gravel	3	2	1	4	11
Total	41	59	45	100	99

Source: Hosanna Town Administration Police Office, 2017

Almost all the fatalities, injuries and property damages are caused on a good asphalt roads. The main causes of road traffic accidents in Hosanna town from 2013/14-2016/17 was not roads condition. It might be over speed in a good asphalt roads.

Table 4.10 Road condition and its relation with road traffic accident

Road surface condition	Causality				
	Fatality	Serious	Slight	Total (%)	Property damage
Dry	36	49	35	82.7	71
Wet	2	7	6	10.3	16
Muddy	-	-	-	-	-
Other	3	3	4	7	12
Total	41	59	45	100	99

Source: Hosanna Town Administration Police Office, 2017

As can be seen from table 4.10, majority of road traffic accidents of Hosanna town from 2013/14-2016/17 occurred on dry roads. This reveals road condition might not be the main cause of road traffic accidents in the town.

Table 4.11 Road accident characteristics and affected pedestrians

Pedestrian movement	Casualty type			Total (%)
	Fatal	Serious	Slight	
Crossing where there is zebra crossing	28	23	25	52.4
Crossing where there is no zebra crossing	1	10	3	9.7
Walking on the sidewalk	1	2	-	2
Walking along the road keeping the right rule (where there is no side walk)	1	5	6	8.2
Walking along the road keeping the left rule (where there is no side walk)	5	9	3	11.7
Fall from vehicle	2	-	-	1.4
other	2	6	3	7.6
Not stated	1	4	5	7
Total	41	59	45	100

Source: Hosanna Town Administration Police Office, 2017

As shown in table 4.11 about more than 50% of road accidents in Hosanna town is recorded pedestrians clashes while they are crossing asphalt roads where there are zebra crossings. This indicates there might be disciplinary problems of drivers as they fail to give priority for pedestrians and shortage of awareness creation among community and transport partners and low enforcement of traffic law.

Table 4.12 Job status of the victim pedestrians

Job status of victims	Casualty type			
	Fatal	Serious	Slight	Total (%)
Students	2	10	6	12.4
Civil servant	11	20	15	31.7
Farmers	8	15	7	20.7
jobless	7	3	3	8.9
Not stated	10	10	10	20.7
others	3	1	4	5.5
Total	41	59	45	100

Source: Hosanna Town Administration Police Office, 2017

The job status of victim pedestrians on road traffic accidents civil servants, farmers and students together made above 60% in Hosanna town from 2013/14-2016/17. This shows the accident attacked all portion of the society.

Table 4.13 Health and physical status of victim pedestrians

Health and physical status	Casualty type			
	Fatal	Serious	slight	Total (%)
Deaf	-	-	-	-
Blind	-	-	-	-
Handicapped	1	-	-	0.7
Healthy	33	54	41	88.3
Not stated	7	5	4	11
Total	41	59	45	100

Source: Hosanna Town Administration Police Office, 2017

According to the traffic police data on the table 4.13 above health status of almost all the victims of accident in Hosanna from 2013/14-2016/17 were healthy or with no defects. This reveals that the health problem might not be the main causes of the traffic accident in Hosanna in the years cited above.

Table 4.14 Road accidents and road division

Road division	Casualty type			
	Fatal	Serious	Slight	Total (%)
One way	38	47	38	84.8
Two way	3	11	5	13.1
Separated by island	-	1	-	0.7
Separated by solid line	-	--	-	-
Separated by broken line	-	-	2	1.4
Total	41	59	45	100

Source: Hosanna Town Administration Police Office, 2017

From table 4.14 about 85% accident occurred on the one way roads. This reveals that road division might not be the main causes of the traffic accident in Hosanna from 2013/14-2016/17.

Table 4.15 Service year of the vehicles involved in road accidents in Hosanna

Service year of vehicles	Casualty type			
	Fatal	Serious	slight	Total (%)
<1 year	3	19	9	21.4
1-2 years	10	14	18	28.9
2-5 years	19	8	9	31.7
5-10 years	2	2	2	4.1
>10 years	3	2	2	4.8
Not stated	4	14	5	15.8
Total	41	59	45	100

Source: Hosanna Town Administration Police Office, 2017

Traffic accident data on table 4.15 of Hosanna town from 2013/14-2016/17 indicates that new vehicles whose service years less than 5 caused about 81% accident. It is known that most of the time vehicles that served more years cause more accident than new ones. But surprisingly in Hosanna town the service year and an out datedness of vehicles was not the main cause of accident from 2013/14-2016/17. There might be over speed that causes accidents in new vehicles.

Table 4.16 Major vehicle involvements in road traffic accident

Accident severity	Vehicle types										Total
	Motor bike	Mini bus (12)	Public bus 13-45	Car	Station wagon	Pick-up	Truck 11-40qt	Truck 41-100qt	Taxi	Others	
Fatal	13	5	7	-	3	2	6	3	-	2	41
Serious	18	5	4	-	8	4	4	3	4	9	59
Slight	11	9	8	-	5	1	2	2	4	3	45
Damage only	14	19	6	2	9	8	8	13	5	15	99
Total (%)	23	15.6	10.2	0.8	10.2	6.2	8.2	8.6	5.3	11.9	100

Source: Hosanna Town Administration Police Office, 2017

As in table 4.16 motor bike was the leading vehicle in causing more accident with 23% followed by mini buses with 15.6%. This together made 38.6% of the total accident in the town. This might be affordable prices of motor bikes to be used by many individuals with lower driving experiences.

Table 4.17 Educational background of the drivers

Educational level	Casualty type			
	Fatal	Serious	slight	Total (%)
Basic education	-	-	-	-
Primary education	17	18	20	37.9
Junior secondary	13	22	12	32.4
Senior secondary	5	6	3	9.7
Above secondary	4	2	-	4.1
Not stated	2	11	10	15.9
Total	41	59	45	100

Source: Hosanna Town Administration Police Office, 2017

As presented in table 4.17 all the drivers had some levels of primary education. Education is basic necessity for drivers to easily understand what is to be trained. An accident data reveals that as educational level increases, the level of accident decreases from 37.9% of accident caused by drivers with primary education level to 4.1% of accident caused by drivers with above secondary education level. Lower educational background seems to be the cause for road accident in Hosanna from 2013/14-2016/17.

Table 4.18 Driving experience and road accident

Service year of vehicles	Casualty type			
	Fatal	Serious	Slight	Total (%)
Driving with no license	-	-	-	-
<1 year	4	7	9	13.8
1-2 years	13	13	11	25.5
2-5 years	17	16	14	32.4
5-10 years	4	6	5	10.3
>10 years	1	-	-	0.7
Not stated	2	17	6	17.2
Total	41	59	45	100

Source: Hosanna Town Administration Police Office, 2017

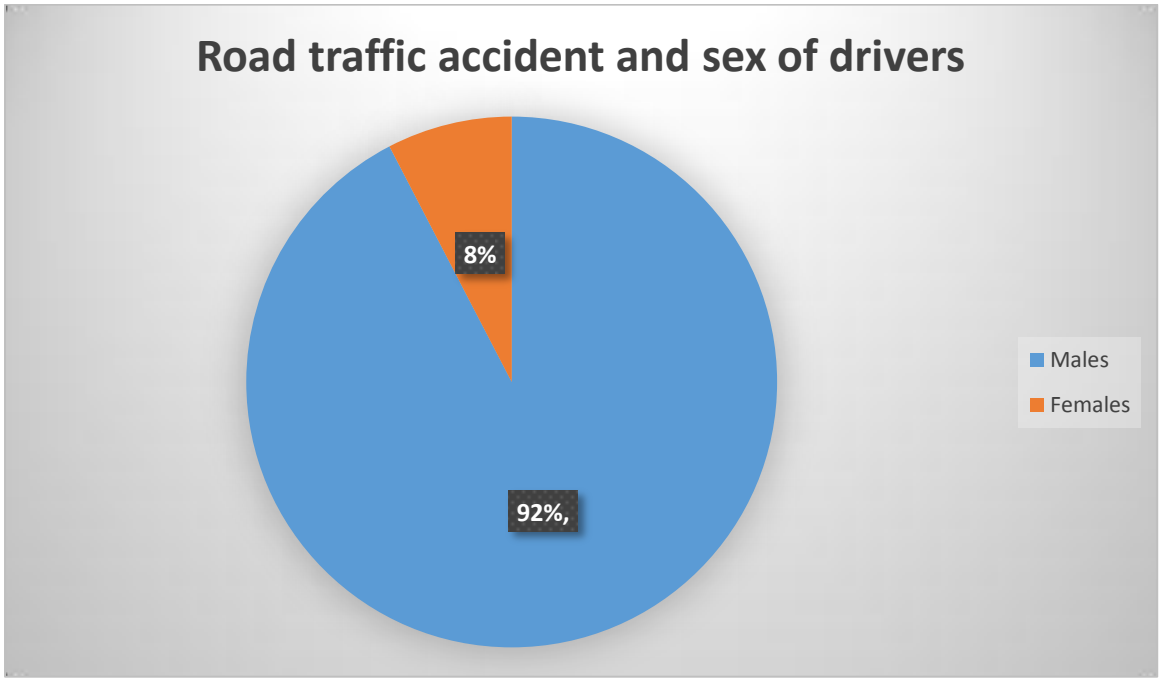
It is clear that experience makes man perfect. As shown in table 4.18 drivers with the experiences below 5 years together made 71.7% of total traffic accidents and those drivers whose experiences greater than 5 years caused only about 11% accident in Hosanna town from 2013/14-2016/17. Lesser driving experiences might be one of the main causes for the accident in Hosanna town.

Table 4.19 Age of drivers and road traffic accident

Age of drivers	Casualty type			
	Fatal	Serious	slight	Total (%)
<18 years	3	2	3	5.5
18-30 years	29	48	36	77.9
31-50 years	8	7	4	13.1
>50 years	-	-	-	-
Not stated	1	2	2	3.4
Total	45	59	45	100

Source: Hosanna Town Administration Police Office, 2017

From the above traffic accident data drivers within the age group between18-30 were responsible for the occurrence of more than three-fourth of total casualty. This might be the involvement of more number of drivers whose age category was in between 18-30 years.



Source: Hosanna Town Administration Police Office, 2017

Figure 7: Road traffic accidents and sex of drivers

According to the traffic data available almost all the casualties are caused by male drivers. Only less than 3% of the accident are caused by female drivers. This might be better involvement of males in driving activities than females.

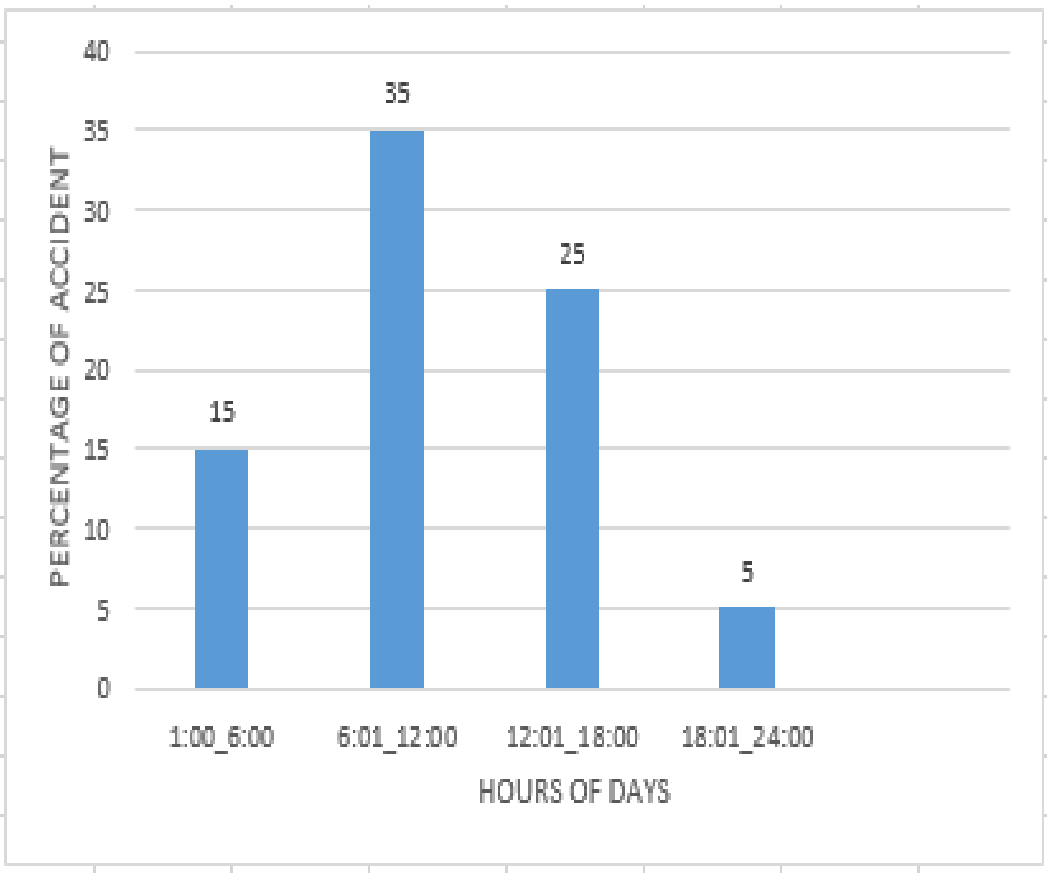
Table 4.20 Road traffic accidents and days of a week

Days of the week	Casualty type			
	Fatal	Serious	Slight	Total (%)
Monday	11	8	5	16.5
Tues day	4	8	5	11.7
Wednesday	4	10	7	14.5
Thursday	1	5	6	8.3
Friday	2	5	8	10.3
Saturday	17	16	11	30.3
Sunday	2	7	3	8.3
Total	41	59	45	100

Source: Hosanna Town Administration Police Office, 2017

Based on the traffic data presented above on Saturdays about 30% of the accidents occurred followed by on Mondays 16.5%. This may be in Hosanna town there is big local market on Saturdays on which the town becomes very crowded resulting in traffic accidents.

Digram2.0 Road traffic accidents and its relation with hours days

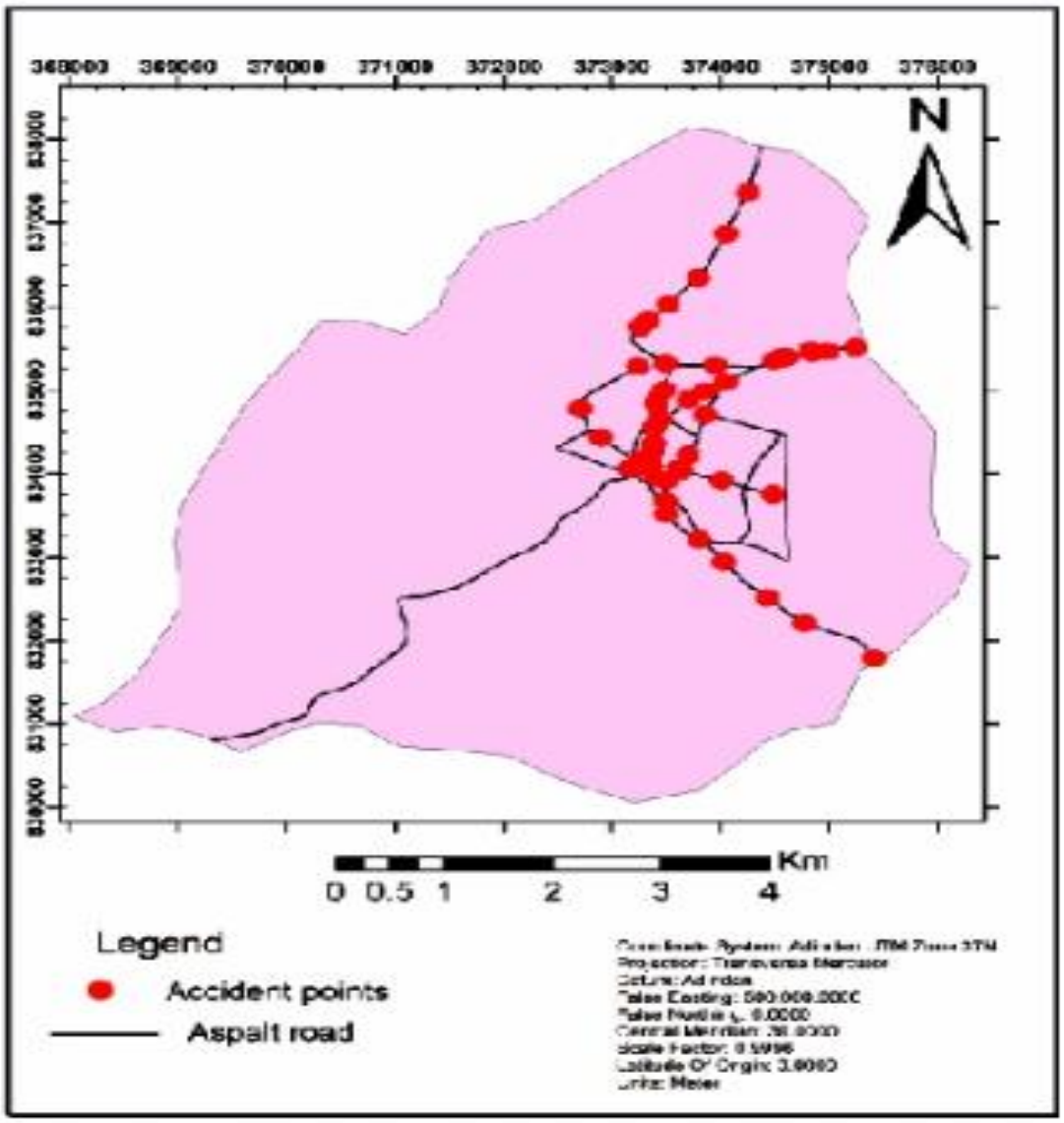


Source: Hosanna Town Administration Police Office, 2017

Figure 8: Accident and hours of days

According to the data greater accident occurred in the afternoon and in the morning. Because in these hours there might be high traffic movements in the town as civil servants go to their offices and children to schools in the morning and back to their home in the afternoon. These moments are the main causes of the traffic accidents in Hosanna Town from 2013/14-2016/17.

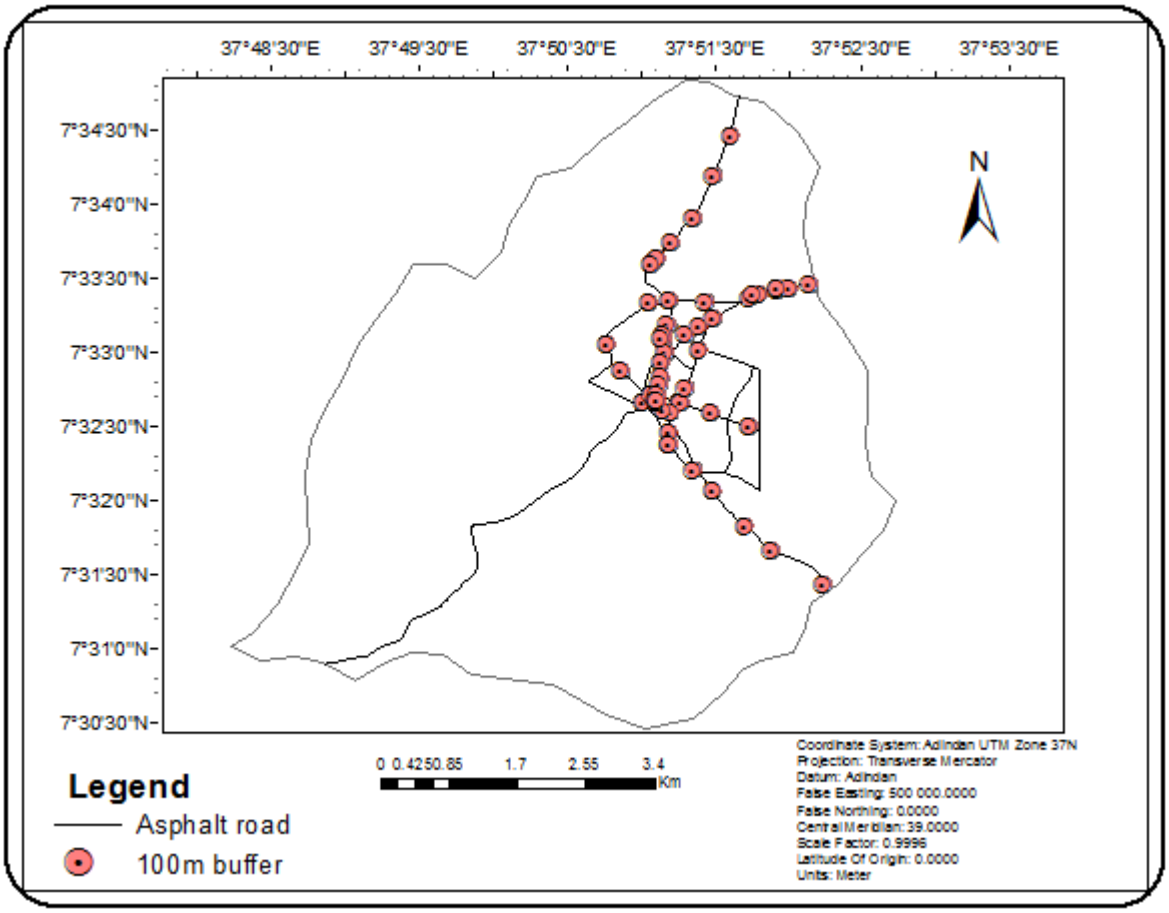
Road traffic accident data of Hosanna town was collected from the Hosanna Town Administration Police Office. After the accident places of the study years were identified, GPS points were collected and ovrlaid on the roads where points coincide with places where accidents previously happened. There were about 113 accidents occurred from 2013/14 to 2016/17 in 52 places with certain frequency. These accident places were overlaid on asphalt road except for only two accident points that fall on the gravel roads. Based on the secondary data obtained from the traffic police there were some acccident data that doesnot indicate exact places of accidents. These incomplete data were not included in this projec work. The gravel roads were not shown on this map because no accdent fall on them other than two cases. Accident points of GPS data are presented as follows:



Source: Hosanna Town Adminstration Police Office

Figure 9 accident points of Hosanna Town

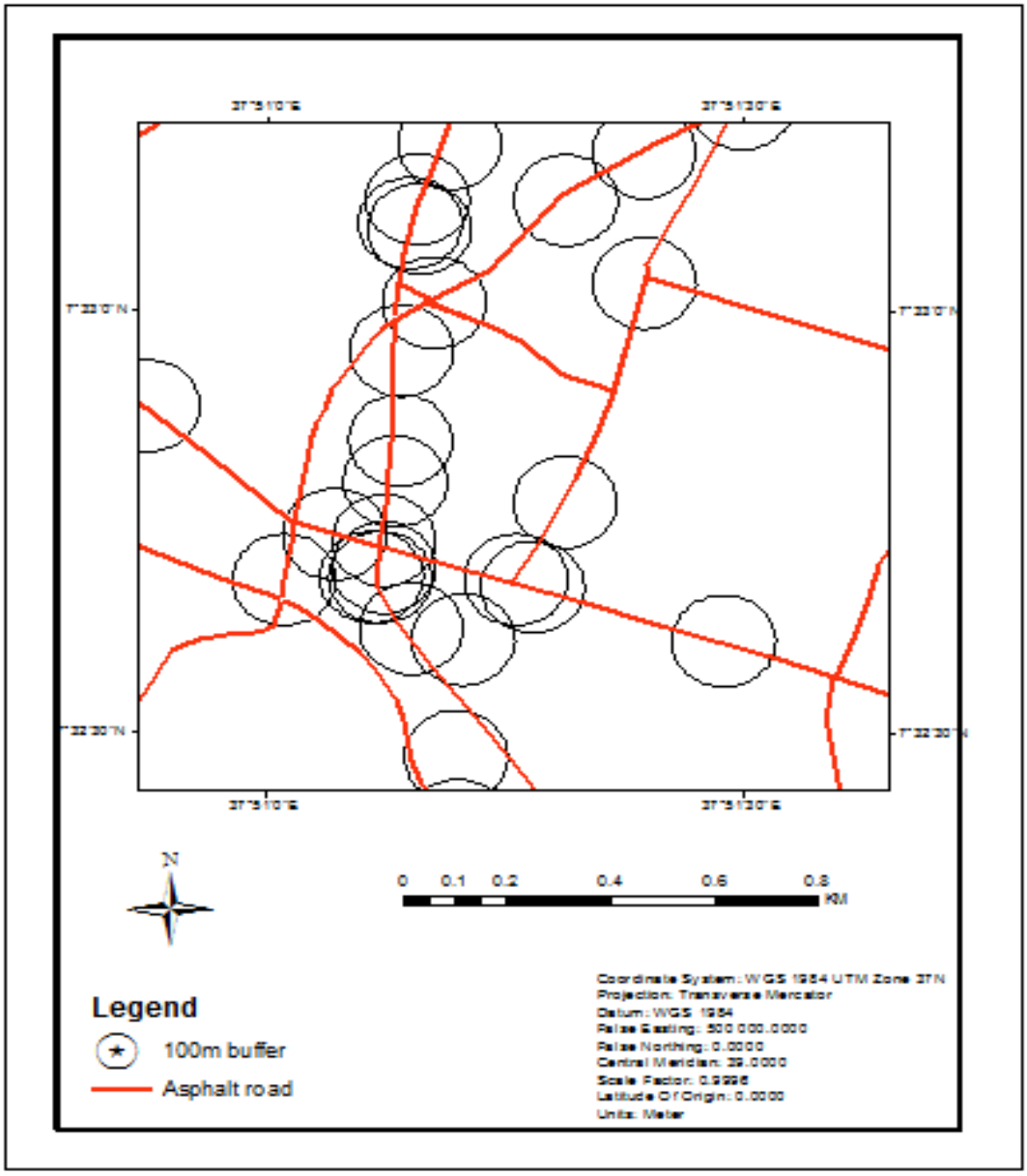
In this section all the traffic accident points were buffered within one hundred meters distances. This GPS points or accident places were buffered to identfy which accident places fall under the blackspots (accident prone location) in order to answer the question of the occurences of accidents within the radious of 100 meters. According to Gregory and Jarrett (1994), traffic accident places are cosidered to be blackspots as long as three accidents occur in certain place for three years and less than three years period within the 100 meters radious with personal accident.



Source: Hosanna Town Adminstration Police Office

Figure 10 shows accident areas buffered by 100m distances

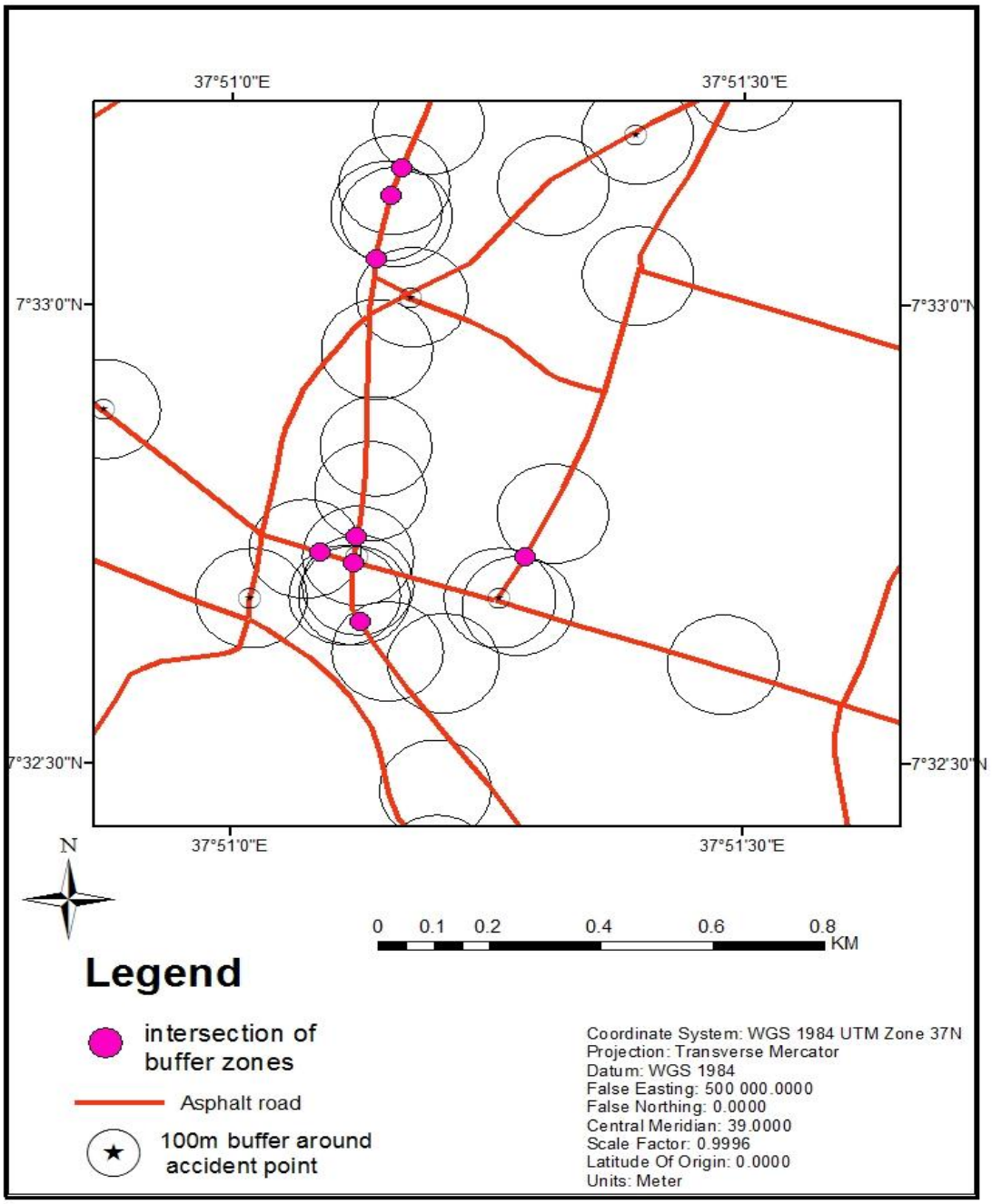
In this section buffered accident points were zoomed in to make them vivid and clear for the readers. These zoomed places are important to identify and select places that make rings and overlap to each other. As places overlap to each other automatically when zoomed in and if three and more than three rings or accident places overlap and intersect each other. These areas are taken as black spots traffic accident prone location) according to researchers (Gregory and Jarrett, 1994).



Source: Hosanna Town Adminstration Police Office

Figure 11 shows buffered GPS points of accident areas zoomed

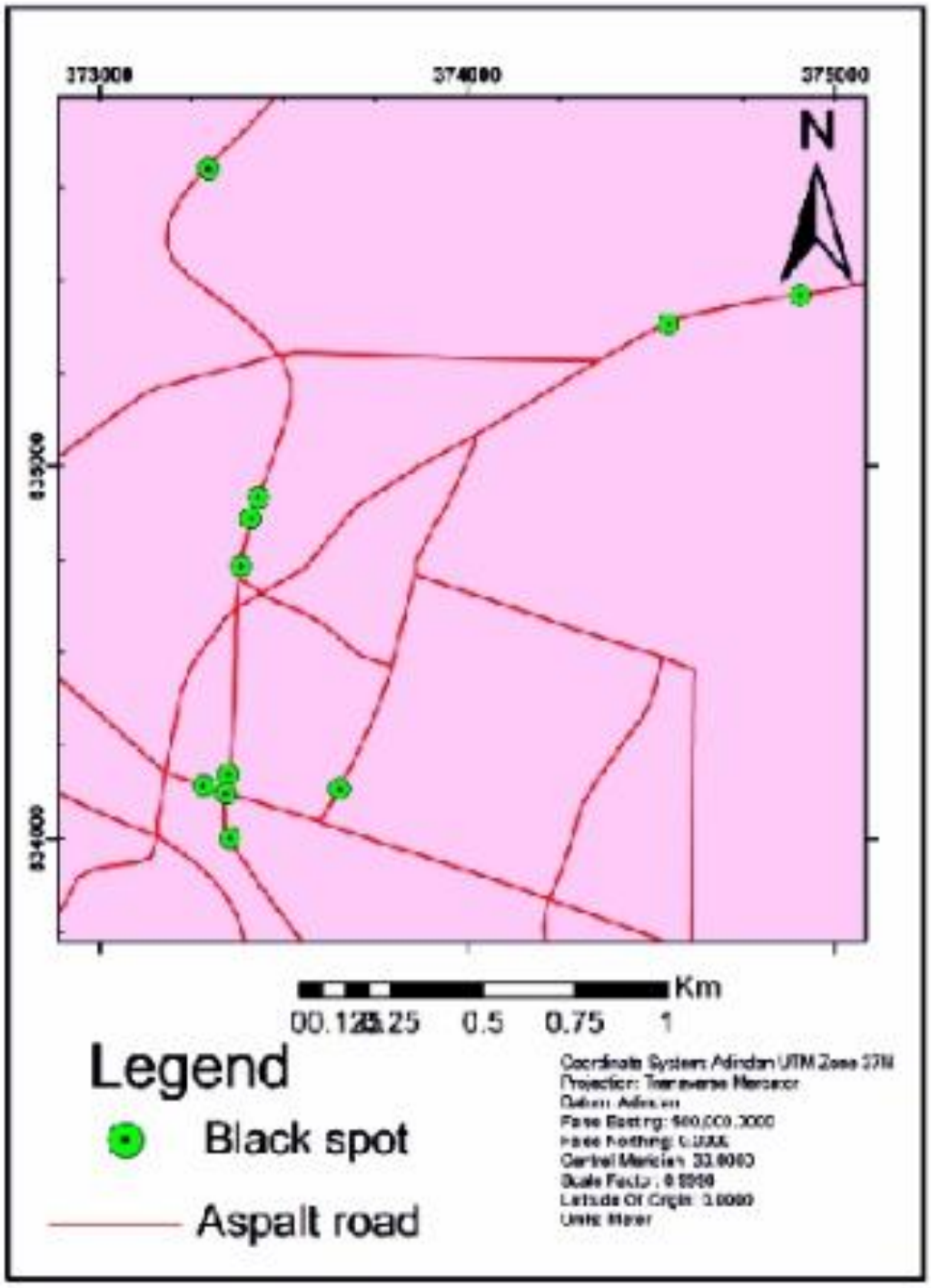
This project in the following map tried to show areas of intersections. Accident points overlaid on zoomed circles of accident points. It is clearly visible and identified so that to the extent everybody may understands. As three and above circular buffered rings intersect to a point by the specified buffer zones, they are automatically selected as the black spots. Some of the sample points are depicted as follows:



Source: Hosanna Town Adminstration Police Office

Figure12 indicates intersections of buffer zones

In this layer of a map accident points are identified as vulnerable areas. Selected vulnerable areas or points are indicated after they are identified in zoomed in manner. Spatial locations of areas of vulnerabilities are located along the asphalt roads of the town. Some of the portions of black spot accident points are shown as follows:

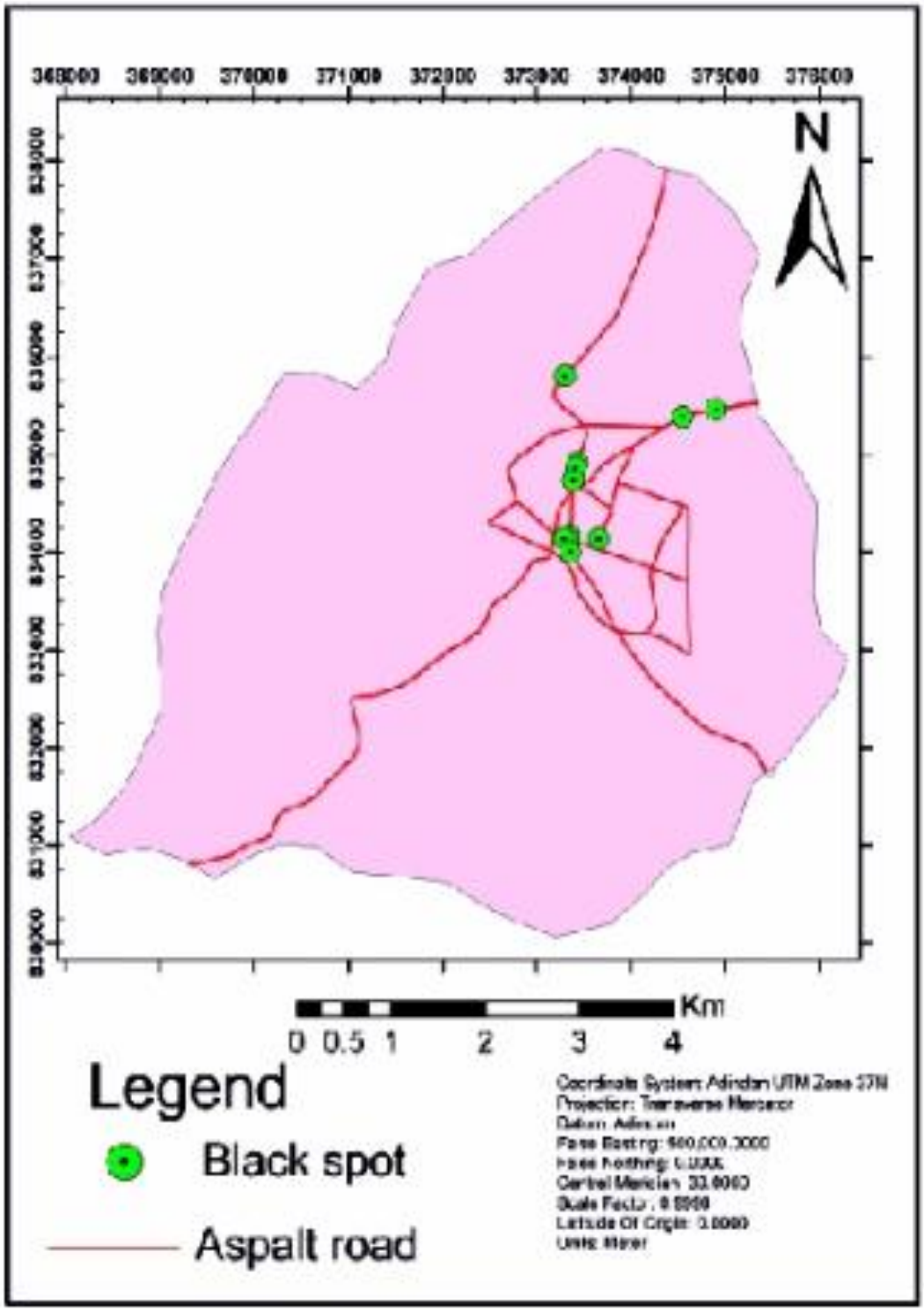


Source: Hosanna Town Adminstration Police Office

Figure 13 map showing zoomed portion of blackspot

This map is the final output of the project. In Hosanna Town one hundred and thirteen accidents occurred during the study periods. This accidents were identified to have occurred in fifty_two places. Based on the secondary data collected by the Hosann Administration Police office traffic accident records, places of accident obtained. Then, GPS points of one hundred and thirteen places taken with cetain frequently accidents occuring in same places. These all the GPS points brought to RS excel software and changed to kml in arc tool box. Then after, overlaid to the digitized asphalt road layer. GPS points were buffered by the distance of 100 meters to idntify accident prone locations whether they are intersecting to each other three and more rings in one intersecting point. After the areas of intersections are identified according to gregory and jarrett (1994), these places taken in a map. Then, these points are termed as accident prone locations or blackspot areas. These areas are taken as very important because they can indicate places along the asphalt road to be dangerious for traffic. Then, government and other stakeholders may take actions to work on preventive measures or traffic safety activities. Safety measures and mass promotion enables society to take care in those identified sites. Then after, diversified causes of traffic accidents are identified along with the nature of specific areas. within one hundred meters buffer inetrsect to each other in ten (10) points. These points are refered as blackspots of the study period in Hosanna Town. Almost all the accidents were happened along the asphalt roads. Black spot sites were identified in areas where crossroads, squares and zebra crossings. The final output map of this project work is presented below:-

In the following map, only asphalt road is depicted because all the accident points ovraid and fall on to asphalt road other than two accidents that fall on gravel roads.



Source: Hosanna Town Adminstration Police Office

Figure 14: Black spot Sites of Hosanna Town

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

The main causes of road traffic accidents in Hosanna within the study time were (1) driver's errors like negligence to give priority to pedestrians and other vehicle, over speed, less driving experiences (2) less attention being given for promotion and awareness among society (3) low enforcement of road traffic law and (4) absence of pedestrian's walkways.

Most of the black spots are found near the zebra crossings, cross roads and squares. Therefore, Civil servants were affected by the accidents followed by farmers.

5.2 RECOMMENDATION

This project reveals that how much road traffic accident is severe and increasing from time to time. Therefore, the government ought to:-

(1) Give greater concern in promotion and awareness creation among society

(2) Allocate enough budget to alleviate the problem

(3) Check an enforcement of road traffic law

(4) Absence of pedestrian's walkways.

(5) Special attention for the identified vulnerable areas have to be given by the concern body

(6) Traffic safety in road transport and police sectors in collaboration with the other stakeholders is needed

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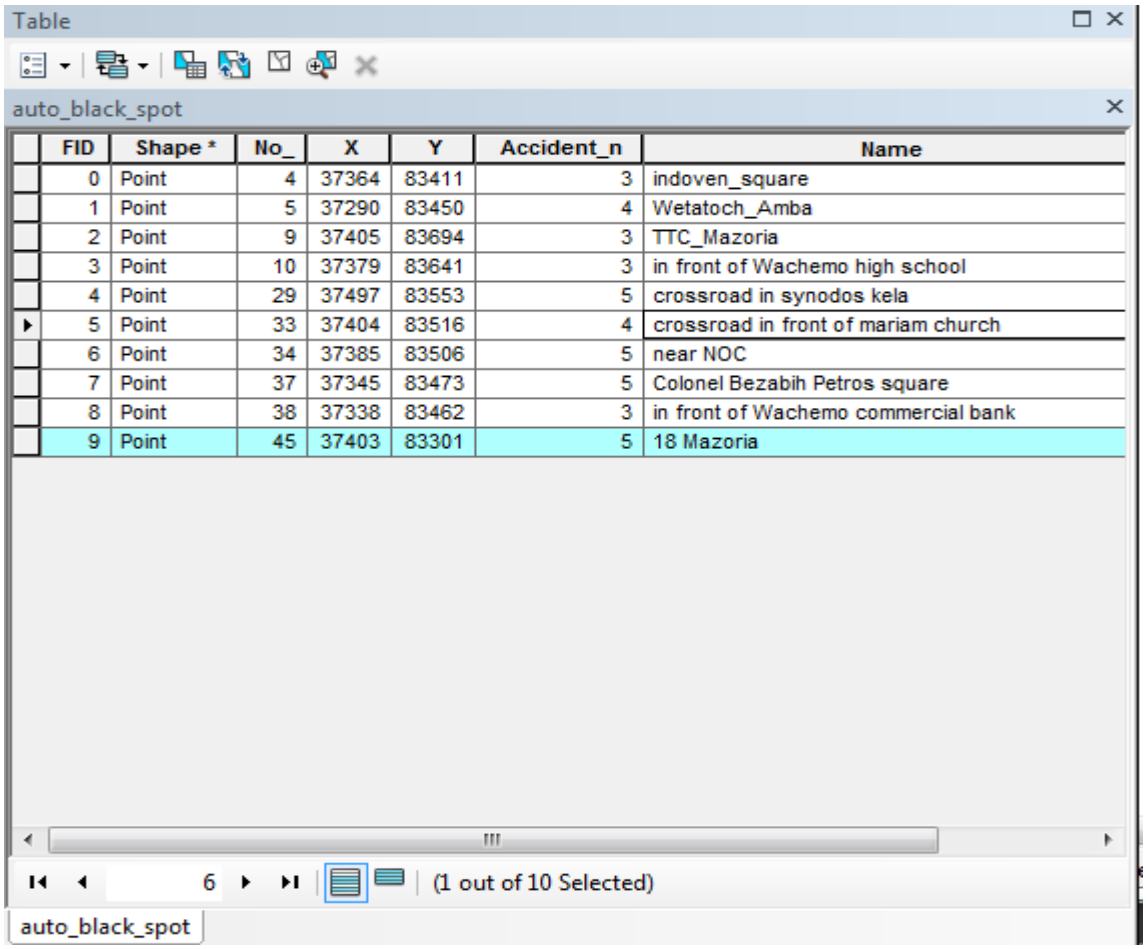
Appendix

GPS data shown in RS excel data

No.	X	Y	Name
1	374487	833823	Lucidy
2	374011	833993	Wana
3	373610	834127	Indoven front
4	373642	834111	indoven_square
5	372900	834507	Wetatoch_Amba
6	372715	834852	in front of Hospital
7	374255	837438	Naremu_Mazoria
8	374050	836944	TTC_Mazoria
9	373797	836414	in front of Wachemo
10	373517	836100	Bobicho_taxi_Mazoria
11	373294	835866	in front of Gombora_Hotel
12	373494	835390	eyerusalem_square
13	373482	835079	in front of Canal_Hotel
14	373424	834894	in front of Hadiya Zone police department
15	373508	833996	in front of WSO(JNAD)
16	373858	834775	Mariam church_stadium Mazoria
17	373705	834296	in front of Ehil Megazen
18	373805	833284	Arada
19	373494	833741	in front of Municipality
20	373497	833590	Back side of Municpality
21	373497	833590	Soro_ber
22	373163	834127	in front of Yekatit25/67 school
23	373954	835368	square near Sport-Hotel
24	373260	834226	in front of Menaharia
25	375247	835584	in front of synodos Mekana mekabir
26	374979	835537	synodos kela
27	374848	835516	in front of school for deaf
28	374608	835470	infront of Wuha_Limat
29	374497	835424	in front of Mebrat_Haile
30	374046	835167	in front of mariam church
31	373857	835060	near NOC
32	373706	834956	OMEDAD
33	373452	834732	Colonel Bezabih Petros square
34	373389	834627	in front of Wachemo commercial bank
35	373387	834432	Yabsira_Hotel
36	373377	834342	in front of picolo Hotel
37	373355	834212	in front of Gebre-Tsadik building
38	373331	834133	in front of Dashen Bank
39	373408	834020	In front of my counrty Cafteria
40	374030	833017	18 Mazoria

41	374429	832586	near Adinew flour factory
42	374772	832284	Roma_ber Kela
43	375418	831860	Shesha Mekane Mekabir
44	374829	835546	Hosanna Mekaneyesus Church
45	374548	835461	crossroad between mebrat hail & Wuhalimat
46	373420	834958	Hadiya Zone PoliceDepartment
47	373406	834906	in front of Hosanna telecommunication
48	373340	835916	Gombora Hotel
49	373239	835359	Roads and Transport Office
50	373266	835828	commercial Bank of Ethiopia, Bobicho branch
51	373348	834132	Dashen Bank
52	373355	834153	Bereket International Hotel

Attribute table of Areas of Black spot



Snipping shot of black spot sites

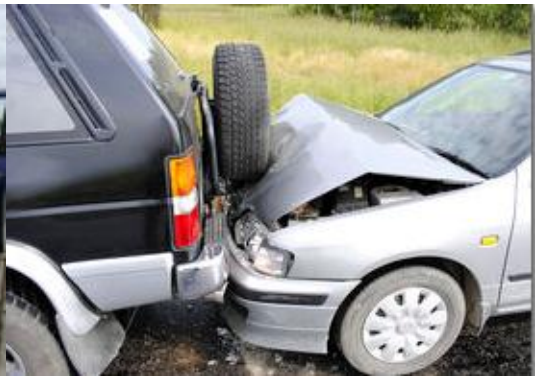
Samples of types of car accidents taken from web site address

Rear end collision

collision with a pole

Front collision

Side collision



Rear end collisions

Heads on collision

Collision with a tree

Rollover

head on collision

Front collision

Source: http://photobucket.com/images/car%20accident