JIMMA UNIVERSITY

SCHOOL OF GRADUATE STUDIES

JIMMA INSTITUTE OF TECHNOLOGY

FACULTY OF CIVIL AND ENVIRONMENTA ENGINEERING

HIGHWAY ENGINEERING STREAM

ASSESSMENT ON THE SPATIAL AND TEMPORAL CONDITION OF ROAD TRAFFIC ACCIDENT AND ITS REMEDIAL MEASURE IN MEKELE CITY

A Research Submitted to the School of Graduate Studies of Jimma University in Partial Fulfillment of the requirements for the degree of Master of Science in Highway Engineering.

By

Kbrom Knfe

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Main advisor: Eng. Elmer C.Agon (Asso.Prof.)

Co-advisor: Eng. Salem Habe Kristos (MSc.)

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Post Graduate Studies

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Faculty of Civil and Environmental Engineering

Highway Engineering Stream

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DECLARATION

I declare that this is my original work and has been presented as in entitles **"Assessment on The Spatial and Temporal Condition of Road Traffic Accident and Its Remedial Measure in Mekele City'':** and it has not been presented for award of degree in any other university.

Kbrom Knfe _____ _____/ _____/_____

Name of Student Signature Date

This research work has been submitted for examination with my approval of my university advisors:

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Eng. Salem Habekristos (MSc.) _____ _____/_____/_____

Co-Advisor Signature Date

ABSTRACT

Currently, it is obvious that road traffic accidents reach at the worst stage and ranked ninth globally among the leading causes of burden of death. The rank is foreseen to rise in the future and it is expected to rank in third position up to 2030. Road traffic accidents kill about 1.3 million people worldwide every year and causes for an estimated of up to 50 million non-fatal severity injuries. In Ethiopia, in the second half of GTP period it increased by 97.98% of property cost loss, 40% of fatal and 36% non-fatal injuries from the first GTP period.

This study has been assessed place and time condition of road traffic accident related issues of Mekele city from 2007-2010 E.C (2014/15-2017/2018). It quantified and described the general characteristics of RTA temporal variations. It also identified major types and causes of the accidents, RTA spots was plotted, examined the trend of RTA and also it has been analyzed the direct socio-economic impacts of RTA and lastly, appropriate intervention which can help to reduce traffic accidents have been recommended.

The necessary secondary data were collected from the daily traffic accident records of the city. Additional information was also collected through interviewing traffic police officers and inspectors.

Most accidents occur along dry, good asphalt, two-way lane undivided, straight and plain roads. In addition to this, most of the accidents occurred at roads with no junctions and +-type (cross-shaped) junctions. The accidents are spatially varied in different land uses types, such as residential areas, government offices, commercial areas, around schools and factory areas.

In the city, 1296 RTAs were recorded in 479 RTA spots found in different places of the city. The accidents on the city are causing for almost more than 12.65%, 38.50%, 7.02% and 41.82% deaths, serious, slight injuries and property damages respectively out of the total RTAs and it was estimated that the economic loss of 26,464,635.20 ETB which means there was 6,616,158.80 ETB average economic loss every year. Finally, awareness about consequence of RTA should be provided for all road users like as meetings or short-term trainings.

Key Words: Chi-Square test, Spatial & Temporal Variations, Road Traffic Accident Spot

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ACRONYMS

CSA	Central Statistics Agency
ECA	Economic Commission for Africa
ECE	Economic commission for Europe
DALY	Disability Adjusted Life Year
ETB	Ethiopian Birr
GDP	Gross Domestic Product
GIS	Geographic Information System
GNP	Gross National Product
GPS	Global Positioning System
GTP	Growth and Transformation Plan
IRTAD	International Road Traffic and Accident Database
NHTSA	National Highway Traffic Safety Administration
OECD	Organization of Economic Co-operation and Development
RTA	Road Traffic Accident
SPSS	Statistical Package for Social Science
TRL	Transport Research Laboratory
UK	United Kingdom
UN	United Nations
USD/US$	United States Dollar
WHO	World Health Organization

CHAPTER ONE

INTRODUCTION

1.1 Background

Transportation is one of the basic necessities for the appropriate functioning of societies as its demand is greatly related to the movement of people from one place to another. Since every movement of human being has its own consequences (positive or negative) transport is not an exception to this circumstance. According to (Rallis, 1997) have stated that the constraints associated with transport include the risk of traffic crowding, traffic accident, pollution, noise, and the like. RTAs are among the most damaging environmental effects, which have caused from transportation development. Road safety, therefore, urges serious concern worldwide.

Any movement of people for any perseverance using different means is known as transportation. As indicated in (Bamford and Robinson, 1978),"Transport by definition infers a movement, and each individual from an early age owns his own "built-in" capability to travel, although with in a restricted area". Moreover, to express the crucial part of transport (Bamford and Robinson, 1978) generalized that it is difficult to conceive of a situation where transport does not play a major role in the life of an individual. It is obvious that, among all modes of transportation, road transport is the nearby means of conveyance. In Africa over 80% of goods and people are transported by roads, while in Ethiopia road transport accounts for over 90% of all the inter-urban freight and passenger movement in the country (Kifle, 1996).

As study conducted by (Ajit and Ripunjoy, 2004), RTAs have turned out to be a huge global public health and development problem killing about 1.2 million people a year and wounding or disabling about 20-50 million people more. Moreover, in similar manner, (WHO, 2004) reports that; road traffic injuries are major but neglected global public health disruptive, necessitating concerted sweats for actual and sustainable prevention. Of all the systems that people have to deal with on a daily basis, road transport is the most composite and the most dangerous. The catastrophe behind these figures regularly attracts less media courtesy than other, less recurrent but more unusual types of tragedy. Road traffic accidents constitute major health, economic, and development challenges of developing

countries, especially adversely affected sub Saharan African countries (Chen, 2009). In 1999, for instance, 750,000-880,000 people died in road traffic crashes of which, about 85% of these occurred in developing countries (Downing, Jacobs, Aeron-Thomas & Sharples, 2000) and in 2002 an estimated 1.2 million people were killed in road traffic crashes (WHO,2009;UNECA,2009) ; 90% of the traffic accidents occurred in low and middle income countries of which Sub-Saharan countries had faced the highest fatality rate (28.3 per 100,000 population), which is substantially higher than any continent in the world. Current and projected trends in motorization indicated that the problem of road traffic accident will get worse, leading to a global public health crisis. It has been indicated that, accordingly, by 2020 traffic accident is expected to be the third major killer after HIV/AIDS and TB (Peden et al, 2004).

As (WHO, 2013), Road traffic accidents are unquestionably one the many scourges afflicting the world with greater impact on developing countries. Over 1.25 million people die as a result of RTAs annually in the world and as many as 50 million of people are injured on the world's roads. Over 90% of the deaths occur in low and middle income countries. While traffic injuries are one of the three principal causes of death worldwide for those with in the age group 5-44 years, many of whom are children, adolescents, and young adults (WHO, 2010). Likewise, RTAs hold the third position on the list of causes of mortality in Africa (Chidoka, 2009). The risk of road traffic death is the highest in Africa and especially in Ethiopia.

Also as previous year report, road crashes kill about 1.3 million people worldwide every year and severely injure an estimated 50 million. Out of ten lives lost in traffic, nine are lost in low- and middle-income countries. But the number of road deaths is on the rise again even in some countries with impressive road safety improvements. The increasing share of vulnerable road users such as seniors, pedestrian, cyclists and motorcyclists that become victims of road traffic raises particular concerns (Forum, 2017).

Ethiopia, one of the poorest countries in the world, loses at least 400 million Birr each year due to road accidents which was 12 million Ethiopian Birr per year on average, 15 years ago and was the third killing vector (Fanueal, 2006). According to Federal Police Commission report, this figure increases to 600 million property damages, 3,200 fatal, 11,000 non-fatal injuries during the first GTP.

Consequently, in the half of second GTP period it reaches to 1,187,486,802 ETB of property damage it increased by 97.98%, to 4,479 of fatal increased by 40% and to 14,921 of non-fatal injuries increased by 36% (Federal Police Commission Report, 2010).

According to a report by Tigray traffic police in the year 2002-2010 E.C; 9,759 total number of road traffic accident were occurred and recorded in the region. Also, the report of road traffic accident show the situation of accidents on Mekele city is higher than other zones. Out of all traffic accident occurred in Tigray regional state in the recent years between 2007-2010 E.C 28.82% of them occurred in Mekele city and then followed by southeast, southern and eastern zones having percentages of 18.46%, 15.70% and 10.45% respectively (summarized data in Appendix Table A2).

A study conducted in Mekele city describes from the year 2007-2015 over 1,675 road traffic accidents occurred. Out of which, over 315 people were died, over 780 people were suffered with easy and series non-fatal accidents and a property damage which accounts over 10,876,512 ETB & concludes The traffic unit should implement standard traffic accident investigation to reduce doubts and improve future road safeties (Meresa, et al., 2016).

Though the above researches focused on the entire nature and disastrous effect of RTA at a global scale, this study was focused on assessing the general characteristics of RTA, places of frequent RTA occurrence, trend, causes and impacts of RTAs in Mekele City.

1.2 Statement of the Problem

Now a day, it is obvious that road traffic accidents reach at the worst stage everywhere in our world. The impact of road transport accident over the socio-economic aspects of Africa is even much worse. (UN, 2011) shows that RTA costs Africa $10 million annually and remains the second leading causes of death for 5-44 ages group around the continent. Ethiopia contributes much to the misery of RTA in Africa. At least one person is killed from every five car coincidences occurring in Ethiopia.

Eventually the most shocking and terrible impact of RTA in Ethiopia is also stated in (UN, 2009), as over half of RTA deaths in Ethiopia involve pedestrians, of whom 20% are children younger than 18 years old. Road traffic accident in Ethiopia is a cause of significant losses of human and economic resources. According to WHO reports in 2015; 23,837 road traffic fatalities occurred in Ethiopia. Children and pedestrians are among the most vulnerable road users in Ethiopia. Unfortunately, road traffic accidents in Ethiopia are predicted to rise in the coming years.

Thus, RTA is a big problem in Tigray region specifically in Mekele City which is long been threatening the socio-economic endeavor. This research is set out to assess the RTA spatially and temporally considering its relevance to planners, policy makers, stakeholders and the community at large.

The basis of this study therefore was described the characteristics of RTA variations, identify major causes and types of the accidents, assess RTA occurrence spots, examine the trend of RTA and analyzed the socio-economic impacts of RTAs in the society and thereby offer possible suggestions which could help to minimize the disaster in the study area.

1.3 Research Questions

The basic questions that have been answered through this research were the following.

1. What is the general characteristic of road traffic accident variations in Mekele City?

2. What are the major types and causes of road traffic accidents in the City?

3. In what area do frequent road traffic accidents occur in the City?

4. What is the trend of RTA occurrence condition in Mekele City?

5. What socio- economic impacts have been incurred due to RTA and what appropriate suggestions be recommended to reduce RTA occurrence?

1.4 Objective of the Study

1.4.1 General Objective

The main objective of the research was the assessment on the spatial and temporal conditions of road traffic accident and its remedial measure in Mekele City.

1.4.2 Specific Objectives

The specific objectives of the research were:

- To quantify and describe the general characteristics of road traffic accident variations in Mekele City.
- To identify the major types and causes of road traffic accidents in Mekele City.
- To assess spatial distribution of road traffic accident spots in Mekele City.
- To examine the trend of road traffic accident condition in Mekele City.
- To analyze the socio-economic impacts of RTA and suggest appropriate recommendations which could help to reduce the RTA occurrence.

1.5 Significance of the Study

Road traffic accident problem in Ethiopia is now a major concern of the government, its organs and other institutions working on road safety and the public at large. This research study was mainly concerned with the assessment on the spatial and temporal conditions of RTA and its counter measure in Mekele City. Emphasis is given to representing; quantify and describe general characteristics of RTA variations, identifying RTA causes and types, assess the spatial distribution of RTA spots, examining trend of RTA, and impact of RTA in the city respectively. Therefore, the study is significant for the following reasons:

- The results obtained from the research will be helpful in launching initiations in studying the complex problems of urban road transport RTA.
- The findings attained from the study will be helpful to gain valuable data and information about the RTA black spots, trend, cause and impact of RTA in the city, which in turn, could help to develop possible solutions that could reduce the frequency and severity of road traffic accidents.
- The research will have vital importance to the community and responsible government authorities in the city to determine the need for various improvements and inspections relating to RTAs.
- The research can be used as one source of information for those organizations and authorities concerned with road safety management and help to improve the quality of decision-making in urban road transport safety planning.
- The study will be used as bench mark information for scholars who want to conduct future detailed studies on RTA, road safety and other related issues in the specified area.

1.6. Scope of the Study

This particular research focuses on the issues and implications on the spatial and temporal assessment of road traffic accidents in all of the seven sub-cities of Mekele City. The results, findings, discussions and generalizations of the study were therefore be preliminarily for the study area only. This research study was mainly use Mekele City RTA data and yearly recorded information's which collected from the RTA archives of Mekele City road traffic accident and Inspections office and other offices and stake holders concerned with the issues of RTA and road safety agencies. The yearly recorded data used are 4 years accident records which are from the years 2007-2010 E.C (2014/15-2017/8).

1.7. Limitation of the Study

During this study it was difficult to obtain fully completed data related to road traffic accidents. Some of the offices are not willing to provide the whole documents which are susceptible to personal judgment. Accident reports from different sources lack significant level of consistency and accuracy and the figures obtained are not enough. In nutshell, gathering information especially through observation is not feasible; this could be taken as the limitation of this research too.

However, several data was obtained from Mekele City Traffic Office, Tigray region police commission, Mekele City road transport and construction office. Some irregularities exist in the data. The main sources of inconsistence in the RTA data of the city were due to limitations and erratic reporting made by the traffic polices and RTA investigating officers at the data gathering and recording level mainly due to lack of knowhow.

Some RTA data of the city have lost part of their entities and others were totally lost. Furthermore, the data was available manually in hard copy and lack GPS coordinate data. However, the data contained names of approximate location of the RTA. The spots identify the location of the RTA sites were added to the routes digitized from satellite image of the city using GIS. Thus, the spatial locations of the RTA spots are approximate.

CHAPTER TWO

RELATED LITERATURE REVIEW

2.1 Definition of Road Traffic and Road Traffic Accident

As cited by Fikadu Admassie, WHO defines a transport accident as; "any accident involving a device designed primarily for, or being used at the time primarily for, conveying persons or goods from one place to another". On the other hand, road accidents on the basis of the following conditions; the death of a person within 30 days of the accident; or personal injury to the extent that the injured person was admitted to hospital; the accident occurred on any road, street, or any place open to public, the accident involved one or more road vehicles which were in motion at the time of the accident (Admassie, June 2015).

As defined in Webster's Seventh New Collegiate Dictionary "Traffic is pedestrians, animals (whether ridden, driven, herded or led), vehicles and other conveyances, either singly or together while using any road for purpose of travel or locomotion".

As the Encyclopedia Britannica puts it, traffic means "movement of vehicles, pedestrians and animals on the road or street" (Vol.18), where the main components of traffic are the road, vehicles, pedestrians and animals. Furthermore, "Traffic" is defined in broad sense as "the movement resulting from transport of people along roads, railways, sea lanes, navigable inland water ways and air routes". And road traffic is a continuous interaction between the three elements related to traffic itself, and the interaction within the three groups. Namely: man or the human factor, the vehicle and the road or simply the environmental factor (Goodall, 1987).

An "accident is generally an event or happening which is unexpected, undersigned with an element or chance or probability or unfortunate result" and sometimes an "accident" is defined as "the occurrence which usually produces injury, death or property damage"(Encyclopedia Britannica Vol. 18).

And the definition of road traffic accident is more related with the road traffic, in that road traffic is considered as a system in which the human, the vehicle, and the road interact with each other where the efficiency and safety of road traffic depends on the performance and interaction of these components. The definition by Economic Commission for Europe (ECE), which is widely accepted in most

countries of the world is, Road traffic accidents are those which occur or originate on a way or street open to traffic, which resulted in one or more persons being killed or injured and in which at least one moving vehicle was involved. These accidents, therefore, include collisions between vehicles, between vehicles and pedestrians, and between vehicles and animals or fixed obstacles (UN, 1999).

A road accident is defined in shortly as A rare, random, multiple factor event, always preceded by a situation in which one or more road users have failed to cope with the road and its environment. It is a random event from time and location (space) aspects (Ogden, 1996). It is not possible to predict accurately where and when the next road accident will occur. Moreover, there is rarely an accident situation where there is one sole cause of accident. Every accident is a unique event preceded by a chain of unique multiple factors. However, the contribution in each set of circumstances generally falls into the three components of the road traffic system: road, environment deficiencies, vehicle defects, and road user errors.

RTA is any vehicle accident occurring in a highway route that includes collision between vehicles and animals, vehicles and pedestrians or vehicles and stuck obstacles. Single vehicle accidents, which involve a single vehicle, which means without other road user, are also enclosed (Safecarguide, 2004).

In a similar manner (Ajit and Ripunjoy, 2004), have mentioned that accident is an occasion, occurring abruptly, unpredictably and inadvertently under unforeseen circumstances. Apparently (Segni, 2007) have also outlined that an accident is a rare, random, multi-factor event always preceded by a situation in which one or more road users have failed to cope with the road environment. Far from the above arguments, (Alister and Simon, 2011) stated that accident involves personal injury occurring on the public highway, including footways involving at least one road vehicle or a vehicle in collision with a pedestrian and which becomes known to the police within 30 days. In this regard, RTA can be defined as an accident that occurred on a way or street open to public traffic; resulted in one or more persons being killed or injured, and at least one moving vehicle was involved. Therefore, RTA is a crash between vehicles; between vehicles and pedestrians; between vehicles and animals; or between vehicles and fixed objects.

2.2 Concept of road traffic accident

Transport is the movement of people and goods from one place to another (Peters 1982; Khanna and Justo 1986; Goodall 1987). The type of transport which exhibits accident that drastically affects the wellbeing of the people and economy of the nations is the one which involve the movement of people and or goods from one place to the other. Several RTA incidences occur throughout the world at every fraction of times in a day. Whatever, the person, where ever the scene and whoever the victim is RTAs remain as the head ache of every one.

The manifestations of RTA are sporadic and random in space and time. The most shocking and emerging reality of RTA is that, it will continue affecting the survival of several lives across the planet. Accordingly, (UN, 2009) projected that road traffic injuries will be the 5th leading cause of death globally by 2030. However, (WHO, 2004), projected that, RTA crashes which were ranked at 9th leading cause of burden of diseases by 2002 could rank at the 3rd cause of burden of disease by 2020, if the current trend in motorization continues increasing in the same or similar manner for the coming decade.

2.3 Global and Regional Trends of Road Traffic Accidents and its vulnerability

According to (WHO, 2004), road traffic deaths have risen from approximately 999, 000 in 1990 to just over 1.1 million in 2002. Low-income and middle-income countries account for the majority of this increase. Although the number of road traffic injuries has continued to rise in the world as a whole, time series analysis reveals that road traffic fatalities and mortality rates show clear differences in the pattern of growth between high-income countries, on the one hand, and low-income and middle-income countries on the other. In general, since the 1960s and 1970s, there has been a decrease in the numbers and rates of fatalities in high-income countries such as Australia, Canada, Germany, Netherlands, Sweden, UK and the United States of America.

At the same time, there has been a pronounced rise in numbers and rates in many low-income and middle-income countries. The reductions in road traffic fatalities in high-income countries are attributed largely to the implementation of a wide range of road safety actions, including seat-belt use, vehicle crash fortification, traffic-calming interventions and traffic law enforcement. However, the reduction in the reported statistics for road traffic injury does not necessarily mean an improvement in road safety for everyone.

According to the International Road Traffic and Accident Database (IRTAD), pedestrian and bicyclist fatalities have decreased more rapidly than have fatalities among vehicle occupants. In fact, between 1970 and 1999, the proportion of pedestrian and bicyclist fatalities fell from 37% to 25% of all traffic fatalities, when averaged across 28 countries that report their data to IRTAD. These reductions could, however, be due, at least in part, to a decrease in exposure rather than an improvement in safety (WHO, 2004).

Road accident is one of the causes for the death of people and has been ranked as one of the top leading causes of death in the world. Over millions of people are killed each year. Every day, thousands of people are killed and injured on road by traffic accident. It is the leading cause of death, disabilities and hospitalization, sever socioeconomic costs, across the world. According to (WHO, 2013), it has been estimated that RTA takes the live of nearly 1.3 million each year, As a result ,nearly 3500 people die each day. In addition, the people who suffer serious injuries including disability are about 20 to 50 million worldwide. RTAs injuries are becoming public health issues, disproportionately affecting vulnerable group of the road users, including the poor. More than half the people who die in traffic crashes are young adults whose age is between 15 - 44.

World's first RTA is supposed to have occurred in 1896. Everybody concerned at that time reported to have said, "This should never happen again." But more than a century later, 1.2 million people were killed on roads every year and up to 50 million more are injured. For every one killed, injured, or disabled by RTA, there are countless others deeply affected by the cost of prolonged medical care, loss of a family bread winner, or the extra funds needed to care for the people with disabilities. RTA survivors, their families, friends, and other care givers often suffer adverse social, physical, and psychological effects. If the current trends continue, the number of people killed and injured on the world's roads will rise by more than 60% by 2020 (Gopalakrishnan , 2012 Jul-Dec).

In this regard, Some Facts on RTAs are;

1. Worldwide an estimated 3247 people are killed every day and it is the second leading cause of death among people aged 5−29 years.
2. RTA injures or disables between 20 million and 50 million people a year.
3. RTA ranks as the 11th leading cause of death and accounts for 2.1% of all deaths globally.

4. 90% of the RTA deaths occur in the low income and middle income countries.
5. More than half of all RTA deaths among young adults between 15 and 44 years of age and 73% of all the RTA fatalities are males.
6. The most vulnerable road users are pedestrians, cyclists, two-wheeler riders, and passengers on public transport.
7. RTA injuries are becoming the third largest contributor to the global burden of diseases by 2020.
8. RTA deaths are predicted to increase by 83% in developing countries and to decrease by 27% in the developed countries.
9. It is estimated that every year RTA costs billions of rupees globally and nationally. An RTA injury puts significant strain on health care budgets.

In the world, nearly half (46%) of all RTA involve pedestrians, motorcyclists and cyclists (vulnerable) road users. The economic consequences due to RTAs have been estimated between 1% to 3% of gross national product of the world countries. According to (WHO, 2004) RTAs were the 9th leading cause of death and the study forecasts that at current rates by 2030, the RTAs will rise to 2.4 million deaths each year and will be the third leading cause of death overtaking diabetes and HIV. Table 2.1 below shows the top leading cause of death by presenting what happened in 2004 and what will happen in 2030.

According to WHO study on (2008) Global Burden of Disease, in 2004, RTAs injures affect all age groups, but their impact is most striking among the young. The features of on people are descended. RTAs have become the second leading cause of death worldwide for age 5 to 14 year the leads cause of death for the age's 15-29 years (figure 2.1), and the third leading cause of death among the people whose age is 30-44. Also according to (WHO, 2015), globally road traffic crashes are a leading cause of death among young people, and the main cause of death among those aged 15–29 years.

Literature stated that between 2000 and 2020, deaths are expected to increase by as much as 80% in low income and middle-income countries, without increased efforts and new initiatives to improve traffic safety. The majority of such deaths are currently among "vulnerable road users" – pedestrians, pedal cyclists and motorcyclists (Peden, Scurfield et al. 2004). The severity of road traffic crashes is also likely to be much greater in Africa than anywhere else, because many vulnerable road users are

involved, poor reporting system, lack of pre-hospital and hospital emergency care after accidents makes the outcome of car accidents in Africa the worst. The African Region has the highest proportion of pedestrian and cyclist deaths at 43% of all road traffic deaths of the road users, (WHO, 2015) see figure 2.2 below.

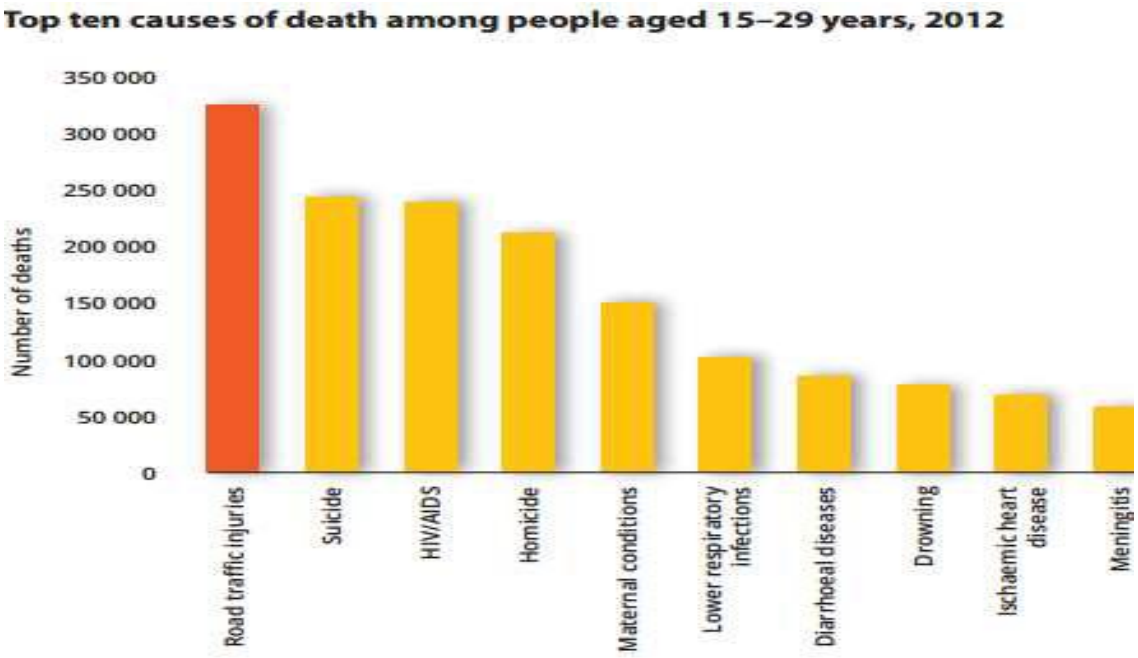

Figure 2.1 Top ten causes of death among people aged 15-29 (WHO, 2015)

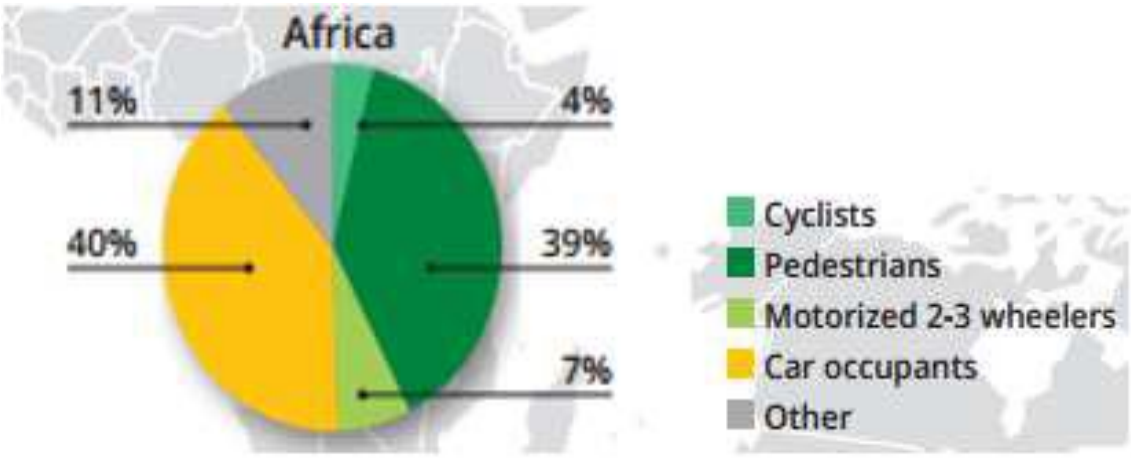

Figure 2.2 Road traffic fatality rates by type of Road user (WHO, 2015)

Table 2.1 Ten leading causes of burden of disease, world, 2004, and 2030

Ten leading causes of burden of disease, world, 2004 and 2030

2004 Disease or injury	As % of total DALYs	Rank	Rank	As % of total DALYs	2030 Disease or injury
Lower respiratory infections	6.2	1	1	6.2	Unipolar depressive disorders
Diarrhoeal diseases	4.8	2	2	5.5	Ischaemic heart disease
Unipolar depressive disorders	4.3	3	3	4.9	Road traffic accidents
Ischaemic heart disease	4.1	4	4	4.3	Cerebrovascular disease
HIV/AIDS	3.8	5	5	3.8	COPD
Cerebrovascular disease	3.1	6	6	3.2	Lower respiratory infections
Prematurity and low birth weight	2.9	7	7	2.9	Hearing loss, adult onset
Birth asphyxia and birth trauma	2.7	8	8	2.7	Refractive errors
Road traffic accidents	2.7	9	9	2.5	HIV/AIDS
Neonatal infections and other[a]	2.7	10	10	2.3	Diabetes mellitus
COPD	2.0	13	11	1.9	Neonatal infections and other[a]
Refractive errors	1.8	14	12	1.9	Prematurity and low birth weight
Hearing loss, adult onset	1.8	15	15	1.9	Birth asphyxia and birth trauma
Diabetes mellitus	1.3	19	18	1.6	Diarrhoeal diseases

Source: Study Global Burden of Disease undertaken by the World Health Organization (WHO)

Road traffic injuries in developing countries mostly affect pedestrians, passengers, and cyclists as opposed to drivers, in whom most of the deaths and disabilities in the developed world occur. In the United States, for example, more than 60% of road crash fatalities occur in drivers, whereas drivers make up less than 10% of the deaths due to road traffic injuries in the least motorized countries (As shown in figure 2.3).

In developing countries, where most injuries occur in urban areas, pedestrians, passengers, and cyclists combined account for around 90% of deaths due to road traffic injuries. Urban pedestrians account for 55-70% of deaths (Nantulya, Reich, & Takemi , 2002).

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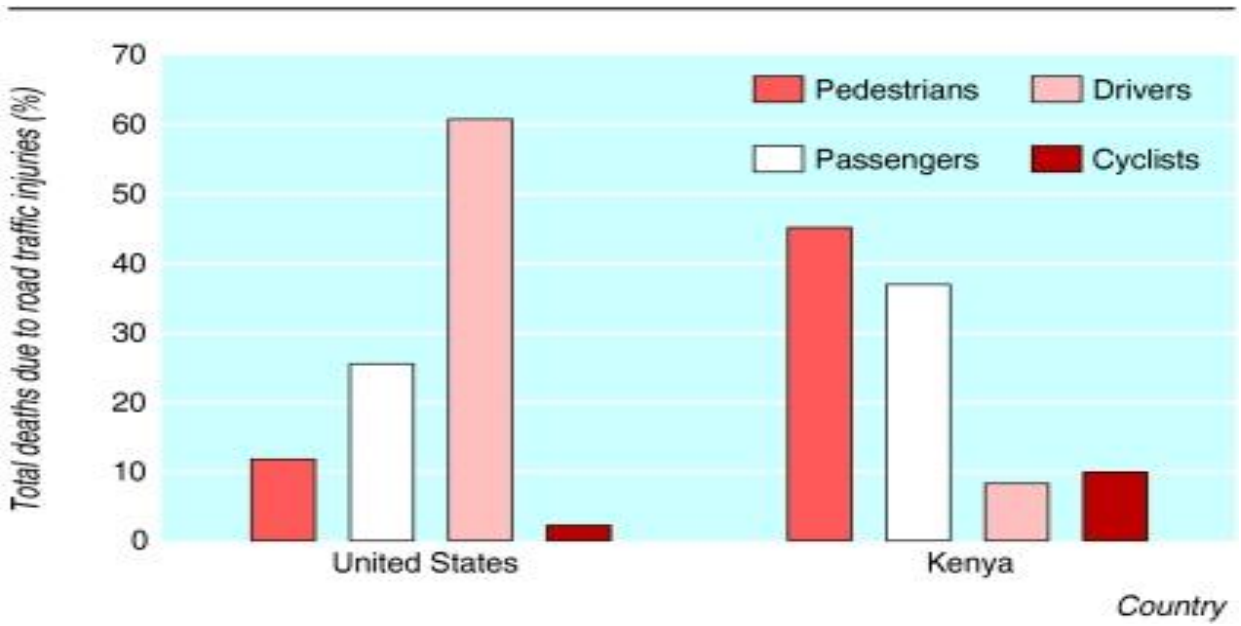


Figure 2.3 Traffic safety facts 1999. (Source: NHTSA)

The African region remains the least motorized in the world (it only has 2% of the world's registered vehicles), but suffers the highest rates of road traffic fatalities. Most countries in this region still lack policies for protecting vulnerable road users and promoting investment in public transportation. In addition, in most countries post-crash care is inadequate or lacking. Nigeria and South Africa have the highest fatality rates, and with five other countries (Democratic Republic of Congo, Ethiopia, Kenya, Tanzania, and Uganda) are responsible for 64% of all road deaths in the region (Schlottmann, Tyson, Cairns, Varela, & Charles, 2017).

The number of people dying and being injured as well as the amount of damaged to property is increasing with minor fluctuations as (WHO, 2009) report shows that Ethiopia is one of the ten countries with highest number of deaths by traffic accidents. Some study shows that according to federal police commission report, the death rate due to car accident is significantly increasing among pedestrians and passengers from time to time in Ethiopia.

2.4 Causes of Road Traffic Accident and Major Contributing factors

Every accident is not usually attributable to a single cause but to a chain of unique multiple factors or failures associated with the road and environment deficiencies, vehicle defects, and road user errors.

In most cases the traffic police associate traffic accident with a single most important cause on the spot of accident and do not list the multiple factors.

Among the main causes of road traffic accidents, the most important ones as indicated by (Hobbs, 1979), (Adler, 1987), (ECA, 1989) and (Tsumokawa and Hoban, 1997) are:

1. Driving under the influence of alcohol or/and drug

2. Driving carelessly, dangerously or without due regard for other road users and lack of experience.

3. Driving above the speed limit- (too fast)

4. Failing to observe traffic signs, misperception and panic reactions from the inexperienced driver

5. Negligent pedestrians crossing or walking on the wrong side of the road and rushing into the roadway.

6. Roads unsuitable for motor vehicles such as narrow road, low quality shoulder surfaces, lack of non-motorized lanes/ paths, undefined crossing sites, dangerous curves, intersections, etc.

7. Inadequate street illumination, poor visibility, lack of sidewalks, etc.

8. Lack of proper signs, signals, markings, intersection layout and control

9. Mechanical defects of vehicles such as brakes, lights, etc. and congestion.

Most scholars classify these causes into three major classes of error as road user's error, vehicle defects and road condition or environment. Among the most prominent factors, is the human factor of which drivers' errors takes the majority of the blames. Drivers' errors that are hazardous include driving too fast, failing to give way, improper over taking and following too close. All of which could result from aggressive or irresponsible behavior, deficient actions, perceptual errors or impairments. (TRL, 1995). And vehicle defects, which lead significantly to accidents, are mainly those related to the lack of regular maintenance, of which defective tires and brakes feature most frequently.

Generally, it is known that driver errors, often accompanied by violation of law, are in the chain of events leading to more than 90% of road accidents (Hobbs, 1979). This fact is also true even in the developed nations. For example, the study by (Evans, 1991), on two on-the-spot investigations, one in

USA and the other one in the UK, in the early 1970s show that road users, vehicles and roads are identified as the sole factor in 57%, 3%, and 2% of accidents in the USA. The corresponding values for the UK study are 65%, 2% and 2%. Generally, these studies found that road user errors are responsible for 93%-94%, roads and their environments for 28%-34%, and vehicles for 8%-12% of traffic accidents.

RTA results from a combination of factors related to the components of the system including roads, the setting, vehicles and road users, and the way they interact. Some factors contribute to the occurrence of accident and are therefore part of smash causality. Other factors aggravate the effects of the accident and thus contribute to suffering severity. Some factors may not appear to be directly related to road traffic injuries. Some causes are immediate, but they may be supported by medium-term and long-term structural causes. Identifying the risk factors that contribute to RTA is important in identifying interventions that can reduce the risks associated with those factors (Lisa, David et. al.2005). The main contributory and determinant factors for the problems, among which the most important ones are road users (drivers and pedestrians), vehicles and environmental factors.

2.4.1 Human Related Causes of Road Traffic Accident

Human factors are without doubt the most complex and difficult to separate, as they are virtually all very momentary in nature. What existed at the time of the crash may not exist some instants later. Consider sensory capabilities, knowledge, decision making, attitude, attentiveness, and fitness, health, driving skill, age, weight, strength and freedom of movement. Of these, the emotional dynamics are the greatest variable attributes and the most difficult to ascertain. They are also subject to the most adjustment with the least remaining evidence (Lisa, David et al. 2005). Human factors in vehicle collisions include all factors related to drivers and other road users that may contribute to a crash.

Examples include driver comportment, visual and auditory acuity, decision-making ability, and reaction speed. Some of the human related causes of RTA are drink Driving, non-Use of Seat Belts, Speed, driver's factors, use of hand-held mobile telephones and lack of road user information and operation. Driving is a skill, which requires training, and experience, and a driver who is in charge of a vehicle should be physically and mentally capable. The basic task of the driver should be determining and maintaining speed and direction in relation to the road by reference to the perceived or expected road

characteristics and also a driver should take into account traffic rules (such as observation of signs and signals) and the technical aspect.

A driver should also determine and maintain speed and direction in relation to road users. Otherwise the risk of being involved in traffic accident will be much high (OECD, 1978). Most of the time the major contributing factor in the majority of traffic accidents is the behavior of a driver. According to the (OECD, 1978), studies about 80-90% of the road traffic accidents were attributed to the faults of the driver. The common driving errors are lack of observation or ineffectiveness, driving too fast, failure to look, misperception and panic reaction from the inexperienced.

This will be severe if the driver is impaired due to alcohol, drugs, illness, fatigue and emotional stress. In the same study, young and inexperienced drivers were found to be more likely to cause traffic accidents than older and experienced drivers. In the USA, the age group 16-24 years contains 22% of the driver population and this group was involved in 35% of fatal and 39% of all injury accidents. And overall accident rates are lowest for those in the age groups 30-60 years (Hobbs, 1979). Drink driving is one of the most contributing factors to RTA occurrences in many countries of the world. For instance (WHO 2009; WHO 2010) reveals that, drink driving is responsible for between 10% and 32 % of fatal crashes. As discussed by (WHO, 2004) drivers and motorcyclists with any blood alcohol content greater than zero are at higher risk of a crash than those whose blood alcohol content is zero.

Moreover, many drivers are not realizing how much seat belts could save the lives of themselves and the life of their passengers. What makes this fact more complex is that, although it is the worst in most of the developing countries of the world, it is a usual phenomenon in some most developed countries to see drivers with no use of seat belts while driving on public roads.

(WHO, 2010) suggests that; In France, where the wearing rate is among the highest, it was estimated that, in 2007 if every passenger and driver had worn a seatbelt, 397 lives could have been saved (around 9% of total fatalities). Wearing a seat belt reduces the risk of a fatality by 40 – 50%. Another study by (Lisa, David et al. 2005) shows that, not wearing a seatbelt is the most common cause of fatality which contributes to fatality among 63% of all vehicle occupants.

In addition to this (WHO, 2004) have stated that Rates of seat-belt use vary greatly among different countries, depending upon the existence of laws mandating their fitting and use and the degree to which

those laws are enforced. In low-income and middle-income countries, usage rates are generally much lower. Seat-belt usage is substantially lower in fatal crashes than in normal traffic. Correctly used seat-belts reduce the risk of death in accidents by approximately 60%.

In absolute similarities, supporting the above studies, WHO (2009) added that if a seatbelt was correctly used, it would reduce the risk of fatality among front seat passengers by 40-50% and among the rear seat car occupants by 25-75%. Also, the speed of motor vehicles is at the core of the road injury problem. Speed affects to both crash jeopardy and crash magnitude. In accordance to this, recent studies have proved that as speeds increase, so do the number and severity of injuries.

For instance a study reported at (WHO, 2004) shows that the higher the impact speed, the greater the likelihood of serious and fatal injury. The same report (WHO, 2004) proved that the higher the speed of a vehicle, the shorter the time a driver has to stop and escape a crash. A car moving at 50 km/h will usually require 13 meters in which to stopover, while a car moving at 40 km/h will stop in less than 8.5 meters. An average increase in speed of 1 km/h is associated with a 3% higher risk of a crash involving an injury. In severe crashes, the increased risk is even greater.

In such cases, an average increase in speed of 1 km/h leads to a 5% higher risk of serious or fatal injury, travelling at 5 km/h above a road speed limit of 65 km/h results in an increase in the relative risk of being involved in a casualty crash. For car occupants in a crash with an impact speed of 80 km/h, the possibility of death is 20 times what it would have been at an impact speed of 30 km/h. Pedestrians have a 90% chance of surviving car crashes at 30 km/h or below, but less than a 50% chance of surviving impacts at 45 km/h or beyond. The likelihood of a pedestrian being killed increases by a factor of 8 as the impact speed of the car increases from 30 km/h to 50 km/h. To this end (WHO, 2009) summarized that, a 5% increase in average speed leads to an approximately 10% increase in crashes that cause injuries, and a 20% increase in fatal crashes.

The age, level of education, experience of drivers may affects to the behavior of their driving styles and to the level of Driver's attention. In similar sense (WHO 2004); (Lisa, David et al. 2005) argued that accident rates of male drivers aged 16–20 years were at least three times the estimated crash rate of male drivers aged 25 years and above. Teenagers are significantly more likely to be involved in a fatal crash than older drivers. At almost every blood alcohol level, the risk of crash casualty declines with

increasing driver age and experience. In addition to this a study on drivers killed in road crashes estimated that teenage drivers had more than five times the risk of a crash compared with drivers aged 30 and beyond, at all levels. The use of mobile telephones while driving could result in unexpected RTA risks. (WHO, 2004) suspects that, the use of hand-held mobile telephones can adversely affect driver behavior as regards physical as well as perceptual and decision-making tasks. The process of dialing influences a driver's ability to keep attentions on the road. Road users have to acquire the knowledge needed to travel safely by means of formal training and their own experiences. However, inadequate knowledge of traffic regulations, traffic signs, vehicles and other elements may be some of the factors contributing to unsafe behavior and road calamities.

Road user information and operations are intended to reduce accidents by promoting safer behavior in traffic, by giving road users better knowledge and more favorable attitudes towards such behavior. Another objective is increased understanding of restrictive measures which are introduced to increase safety, such as speed limits. (Elvic, Runee et al. 2005) evaluated a number of studies on the effects of information campaigns on the number of accidents.

2.4.2 Road Related Causes of Road Traffic Accident

Since the entire process of road transport is conducted on roads, the quality, size and engineering characteristics of the roads will have considerable contribution to the increase or decrease of RTA risks. (WHO, 2004) supports this idea by saying that, the road network has an effect on crash risk because it determines how road users perceive their environment and delivers instructions for road users, through signs and traffic panels, on what they should be doing. Many traffic management and road safety engineering measures work through their influence on human behavior. Some variables regarding the road related causes of RTA are like road surface conditions, roadway characteristics and road light conditions.

Road surface conditions have impacts on occurrences of road traffic accidents. In developed countries, there are continuous efforts to meet the safety standards of roads through safety audit during the planning, designing, and operation stage. (Terje, 1998) indicates that in Africa road network is mounting fast, preservation standards have started improving lately, and there is potential for improving the safety standards of the roads.

However, (Berhanu, 2000) reports that in Ethiopia, the police have limited road and traffic engineering skill in general and thus they underestimate the contribution of roads and environments to traffic accidents and especially they lack trainings on subject area.

In many developing countries due to limited financial resources road construction and maintenance is poor. In addition, roads are not bordered by sidewalks for pedestrians. Both the vehicles and pedestrians are forced to share the available roads or streets, which contributes to high traffic accidents in those countries. There is an intimate relationship between defect of roads and road traffic accidents. The design, lighting, and surfacing of roads can affect injury rate and well-designed roads allow greater margins of safety. Many accidents needlessly occur because the facilities provided do not adequately allow for the range of individual requirements of separate groups of road users particularly the pedestrians. The condition of road surface also contributes to the occurrence of traffic accidents. The theoretical basis is that damaged and uncomfortable road surface is most likely to increase the probability of incidence of traffic accidents. Road moisture condition is another contributory factor for the incidence of traffic accident. Road surfaces such as dry; wet and muddy have their own contributions to the traffic conditions (Hobbs, 1979).

Moreover, the roadway's conditions like the quality of pavements, shoulders, traffic control devices and intersections, can be a factor in a crash. Fewer traffic control devices and complex intersections with excessive signage lead to confusion. Highways must be designed for adequate sight distance for designed speed for the drivers to have sufficient perception-reaction time. The traffic signs and signals should provide enough time for decision sight distance when the signal changes from green to red. The super-elevation on highways and especially ramps should be carefully laid with correct radius and appropriate transition zones for the vehicle to negotiate curves safely. Another important factor is the frictional force between the pavement and tires. If the tires lose contact with the pavement then the vehicle starts fishtailing.

Road factors include, but are not limited to lighting, view obstructions, signals, surface character, dimension and shielding devices. All factors are subject to adjustments by outside influences such as road surface that become slippery from rainfall. Modifying each of the listed road factors are weather, lighting, roadside devices, activities, surface deposits, damage, deterioration and age (Lisa, David et al. 2005).

Moreover, road lights are intended to provide enough lighting for drivers to travel with comfort and safety during night periods or under low visibility conditions. This solution is commonly applied where there is the possibility of conflicts between vehicles and pedestrians or cyclists. In rural roads, the implementation of lighting on unlit roads may lead to a 64 per cent reduction in fatal accidents and 20 to 50 per cent of total accident reduction. In the other way round the absence of road lights will add up to the RTA occurrences by 20 to 50% (Sandra, 2000).

2.4.3 Vehicle Related Causes of Road Traffic Accident

It is not only the improvement in the standards and design of vehicles that matters, but also adequate maintenance of the vehicle during its working life. Older vehicles with mechanical defects and poor maintenance cause higher fatal injuries and property damage. For instance, studies in Britain show that about 20-30 percent of personal injury accidents involve a vehicle having some deficiency (Hobbs, 1979).

In most cases, defects associated with the break, tire, light and other mechanical defects are associated with accident. Size difference between colliding vehicles also affects the severity of injury, particularly in cases when heavy vehicles impact light vehicles. As indicated in many studies such as in (Garner and Deen, 1973), (Evans, 1991), and (Downing et al., 1991), vehicle defects rank after driver and environmental deficiencies as a major cause of road traffic accidents.

While vehicle design can have considerable influence on crash injuries, it must be studied in accordance to its contribution to RTA. Prior studies to this one like (WHO, 2004) have proved that Vehicle related factors contribution to crashes, through vehicle defects, is generally around 3% in high-income countries, about 5% in Kenya and 3% in South Africa. (Lisa, David et al. ,2005) have argued that a small percentage of crashes are caused by mechanical failure of a vehicle, such as some form of tire failure, brake failure, or steering failure. The vehicle and roadway interaction like skid resistance play a major role in stopping the vehicle from encroaching the off road features like shoulder, median and other traffic signage. Improvements have been made in the manufacture of tires and vehicle design however defects can still occur or be the product of poor vehicle maintenance. Similarly, (Ung, 2007) stated that Vehicles have caused road accident because their owners did not properly maintain and regularly inspect the vehicle during the maneuver.

2.4.4 Environmental Condition Related Causes of Road Traffic Accident

The climatic and environmental conditions can also be a factor in transportation crashes. Supporting this idea (Lisa, David et al. 2005); (Alister and Simon, 2011) argued that, Weather on roads can contribute to crashes: for example wet pavement reduces friction and flowing or standing water greater than 1/8"deep can cause the vehicle to hydroplane. Many several crashes have occurred during conditions of smoke or fog, which can reduce visibility. Vehicles travelling at high rate of speed are unable to see the slowing and or stopped vehicles in front of them which can lead in to multi – vehicle pileup. Glare can reduce driver visibility especially on east-west road way during the hours of sun rise and sun set. During foggy conditions glare off of street lights and stop lights can also affect visibility. Wind gusts can affect vehicle stability.

The occurrence of an accident is not usually attributable to a single cause but to the combined effects of a number of deficiencies or failures associated with the user, his vehicle and the road layout. Environmental conditions such as weather and time of day will be of influence. Out of the total road accidents (as studies show) about 1%, 2% and 15% occur in a foggy, snowy and rainy weather respectively.

Night-time accident rates for unlit streets are about twice that of day time, and even under average street lighting conditions they are about 50% greater (Hobbs, 1979).

2.5 Spatial and Temporal Variations in Road Traffic Accidents

The fundamental per-condition for safe traffic is that the road users have sufficient information about road conditions, traffic characteristics and traffic regulations. The road layout and design should be improved. If it is not the case, traffic accidents will tend to increase. It is well known that, most road accidents occur in urban areas than in rural.

Severe road traffic accidents are associated with those areas, where there is lack of information, overload of information and when the information is difficult to perceive as well as at intersections where traffic is not regulated and with complex geometry (design). Moreover, roads with heavy traffic volumes, with mix of local and through traffic, road users traveling at different speed levels and/or in different directions as well as in busy shopping streets where the high complexity makes it difficult to select sufficient information about the road and the traffic.

Most road traffic accidents take place at junctions, on curves, at gaps in dual carriageways, at pedestrian crossings, private driveways and bus stops. Also accidents more likely occur at junctions than elsewhere and in urban areas (Hobbs, 1979).

According to (Ogden, 1996), for example, in the USA, over 50% of urban and over 33% of rural total reported accidents occur at intersections. The corresponding figures in Australia are 43% and 11%, respectively. Again in the United Kingdom, 60% of all reported accidents are intersection accidents (Jacobs et al., 1986). Therefore, intersections and urban areas especially in the central places of cities are the areas of traffic accident and focus of road safety works. Intersections have different configurations such as the T, X and Y junctions which have different influence on the safety performance of intersections (Ogden, 1996).

Occurrences of road traffic accidents obviously vary with time. This variation occurs between hours in a day, days in a week, and months in a year closely following the variation of traffic volume. Even though nighttime driving is normally low, the rate and severity of the accident is higher during the nighttime. According to (Hobbs, 1979), nighttime accident rates are about 50% greater than daytime accidents.

2.6 Road Traffic Accident in Ethiopia

Ethiopia is one of the developing countries with a very low motorization level, 1.7 Vehicles per 1000 people in 1996/7 (Berhanu, 2000), and the most recent data show 2 vehicles per 1000 people in 2001 (UN, 2001). Despite having a very low road network density and vehicle ownership level, Ethiopia has a relatively high accident record. Even though the fatality rate is decreasing, it is still very high compared to the rates of many countries in the world.

Most of the road deaths in developing countries involve vulnerable road users such as pedestrians and cyclists. In Ethiopia, pedestrian injuries account for 84% of all road traffic fatalities compared with 32% in Britain and 15% in the United States of America. In contrary, in the heavily motorized countries, drivers and passengers account for the majority of road deaths involving children (Bunn, Collier et al. 2003). Similarly, (Mekonnen, 2007) quoted that, RTA in Ethiopia is a serious problem. The RTA death rate is estimated to be 130 per 10,000 vehicles. Of the total victims of RTA who lost their lives, over half are pedestrians, out of whom 30% are children. In Ethiopia, one among five people

injured dies due to RTA. Based on a five-year average records, of the personal injury accidents, 81% are caused due to drivers error, 5% due to vehicle defect, 4% due to pedestrian error, 1% due to road defects and 9% due to other problems in Ethiopia.

The main underlying reasons for the frequent RTA occurrences and severe impacts of RTA in Ethiopia are Improper behavior or lower skill of drivers, Poor vehicle technical conditions, Animals and carts using the highways, Pedestrians not taking proper precautions, Poor traffic law enforcement, Poor emergency medical services and Insufficient safety considerations given in road development.

In addition to this (Segni, 2007) added another responsible reasons of RTA occurrences in Ethiopia like driving without respecting right-hand rule, failure to give way for vehicles and pedestrians, overtaking in snaky horizontal curves, following too close to the vehicle in front, improper turning and speeding. These causes contribute to 73% of the total accident in the year 2004/05 in Ethiopia but the other possible reasons accounted for less than 27%.

In another attitude, (Mohammed, 2011) Put his findings of the cost of RTA in Ethiopia on the basis of the Ethiopia's data and economic figure of 2009/10, as the cost of damage only, slight, serious and fatal road traffic crashes were 327.12 million, 204.65 million, 619.38 million, and 716.02 million ETB respectively.

This represents the total national economic loss resulting from road accidents to be estimated as ETB 1.867 Billion which is equivalent to 145.07 million USD considering the exchange rate of the same year, or approximately 0.49% of the GDP of the country in the same year. Another study conducted by Ethiopian Roads Authority stated that, RTA costs Ethiopian economy between 350-430 million Birr annually, and loses almost 1860 lives each year with another 8,690 people reported injured (CSA, 2007).

2.6.1 Road Traffic Accident Reporting System in Ethiopia

The existing system of accident reporting classifies accidents into four accident severity classes in Ethiopia, namely: fatal, serious injury, slight injury and property damage. But the distinction between serious and slight is not well established where it mainly depends on the personal judgment of the traffic police on the spot (Mebrahtu, 2002).

As stated by (UN, 2009), similar to most countries of the world, police is responsible for traffic accident investigation and reporting in Ethiopia. According to the Ethiopian transport regulation (Negarit Gazeta, 1963, which is still in use with amendments), a driver of a vehicle involved in a road accident shall notify the nearest police station immediately if the accident involves personal injury and within twenty-four hours if it involves property damage only. According to the regulation, all accidents are reportable. In practice, however, the police are notified only when the accident involves serious injury, agreement cannot be reached between parties involved or if police accident report is required for insurance.

Because of this, the reporting of nonfatal accidents is uncertain. Thus; the under-reporting of road accidents in Ethiopia is expected to be quite considerable. In response to notification of an accident, a traffic police investigator attends the scene of the accident. Based on the information obtained from observations, the parties involved in the accident, and other evidences, police prepares a factual report and makes the sketch of the site on a plain sheet of paper.

The police, who are inadequately equipped and trained, understandably, primarily see their role to take action if the law has been broken and give much attention to get evidence for prosecution rather than to investigate the many factors involved in the accident. The accident statistics, although not complete and with all sorts of limitations, can, however, be used by interested stakeholders to make a broad accident analysis for various purposes. Moreover, the existing data can be used to create awareness and define policy and mobilize human and financial resources towards alleviating the problem (Kindaya, 2014).

2.7 Impacts of Road Traffic Accident

The social and economic impact of road traffic accident is a very sensitive issue. The impact is not only on individual life or his family but also on the government and on the society at large. All countries in the world are currently affected by RTA. Although the effects of RTA vary from one country to the other, from nation to nation, it should be every body's concern.

Some of the specific social and economic impacts of road traffic accident we can are:

- ✓ Disability of many people
- ✓ Long period of hospitalization and Cost of Medical care and insurance
- ✓ High economic losses, even loss of lives and loss of household productivity

- ✓ Create high dependency burden
- ✓ Jobless too many people
- ✓ Increase in number of widows and female headed households
- ✓ Unable many children to complete their education or acquire skill for life making
- ✓ Hampers economic growth and backwardness of the country.

Some of the major impacts of RTA discussed by different organizations and scholars are discussed in the following.

2.7.1 Economic Impact

RTAs are currently weakening the financial wealth of many nations. In this regard, (WHO 2004); (Naci, Chislom et al. 2008) urges that, in economic terms, the cost of road crash injuries is estimated at roughly 1% of GNP in low-income countries, 1.5% in middle-income countries and 2% in high-income countries. The direct economic costs of global road crashes have been estimated $518 billion, with the costs in low-income countries is estimated as $ 65 billion – exceeding the total annual amount received in development assistance.

In addition to this, in terms of regional disparities of cost of RTA (Naci, Chislom et al. 2008) indicated that, the economic cost of road crashes have been estimated to be as much as $ 24.5 Billion in Asia, $19 Billion in Latin America and Caribbean, $ 9.9 Billion in Central and East Europe, $ 7.4 Billion in the Middle East and $ 3.7 Billion in Africa.

When we come to Ethiopia, RTA's economic impact is even worse. As far as the economic impact of RTA in Ethiopia is concerned, (Persson, 2008) have discussed that, the economic impact of RTAs is substantial for Ethiopians as the annual cost is estimated to be around £40 million.

2.7.2 Social Impact

The RTA impacts are also shown with their influence on the social aspects of the livelihood. To this regard, (WHO, 2004) claims that, over 50% of the global mortality due to road traffic injury occurs among young adults aged between 15 and 44 years, and the rates for this age group are higher in low-income and middle-income countries. In 2002, males accounted for 73% of all road traffic deaths, with

an overall rate almost three times that for females: 27.6 per 100, 000 population and 10.4 per 100, 000 population, correspondingly.

Road traffic mortality rates are higher in men than in women in all regions regardless of income level, and also across all age groups. On average, males in the low-income and middle-income countries of the WHO Africa Region and the WHO Eastern Mediterranean Region have the highest road traffic injury mortality rates worldwide. The gender difference in mortality rates is probably related to both exposure and risk-taking behavior.

The risk of dying as a result of a road traffic injury is highest in the African Region (24.1 per 100, 000 population), and lowest in the European Region (10.3 per 100, 000).

Young adults aged between 15 and 44 years account for 59% of global road traffic deaths. More than three-quarters (77%) of all road traffic deaths occur among men.

In an absolute similar manner (Naci, Chislom et al.2008) supports this argument by stating that, Road crashes kill and maim the most productive segments of the population; globally, in 1998, 51% of fatalities and 59% of disability-adjusted life years lost as the result of road traffic injuries occurred in the most productive age groups.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 Study Area

The research was conducted in Mekele City, which is found in Northern part of Ethiopia. It is located around 783 km from the capital Addis Ababa, at $13^0$26’ to $13^0$36’ North latitudes and $39^0$25’ to $39^0$33’ East longitudes with an average elevation of 2084 meters above mean sea level. Administratively, Mekele is considered a Special Zone, which is divided into seven sub-cities. These are Adi-Haqi, Ayder, Haddinet, Hawelti, Qedamay-Weyyane, Quiha, and Semen.

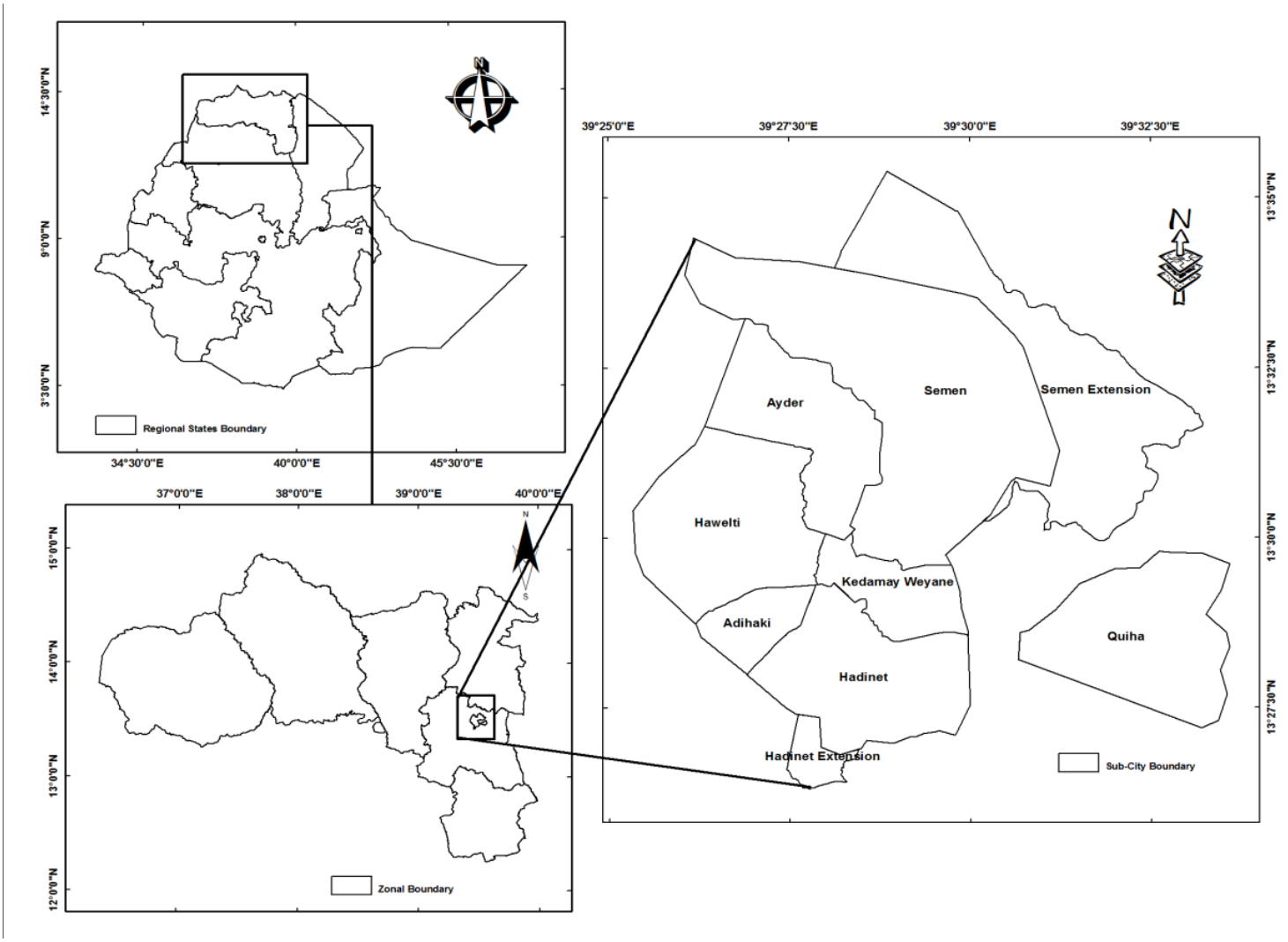


Figure 3.1: Map of the Study Area (Arc Map: Mekele City Administration)

3.2 Study Design

The research study was conducted by using analytical methods. Qualitative and quantitative studies were employed in this research study. This research has been assessed road traffic accidents in terms of their space and time of occurrence condition. Quantitative study was used for quantitative assessment of the characteristics of road traffic accidents in the city. Previously recorded road accidents data in terms of space-time cross tabulation analysis have been used to achieve the research objectives. The accidents data were collected from reported by traffic police and hospitals recorded manually in different times. For assessment of spatial and temporal conditions of road traffic accidents excel and SPSS have been used. Yearly recorded RTA data involving personal injury (including fatal, severe, and slight injuries), and property damages have been collected from police reports archives.

3.3 Populations

The study has been highly concerned on assessment of road traffic accidents based on space and time condition and their counter measurements. Therefore, the four year accident data and the routes were the main populations of this study.

3.4 Sample size and sampling procedures

3.4.1 Sampling Technique

Since Non-probability sampling represents a group of sampling techniques (e.g. purposive sampling) and has free distribution that help researchers to select a unit sample from a population, this sampling method is adopted.

3.4.2 Sampling Size

For assessment of Space and temporal conditions of road traffic accidents, A yearly recorded accident data involving personal injury (including fatal, severe, and slight injuries), and property damages for seven sub-cities have been collected from file records or police reports. Therefore, for this research to achieve its objectives the sample size that have been used was 1296 road traffic accidents which are resulted from 479 RTA spots in different locations of the city.

3.5 Study Variables

3.5.1 Dependent Variable

- Road traffic accident

3.5.2 Independent Variable

- Accident time of day, day of week, month of a year.
- Accident place or accident location.
- Causes of accident
- Type of accident
- Driver's age, sex, experience, level of education and relationship with the vehicle.
- Vehicle service age and Vehicle type.
- Weather condition in the time of accident.

3.6 Data Collection Process

3.6.1. Primary Data Collection

The primary data was collected through necessary visual observation at the field and locating the traffic accident spots using GPS, through interviews (with seven traffic police officers of the seven sub-cities, and with one traffic police officer of the city).

3.6.2. Secondary data collection

The secondary data of road traffic accidents were obtained from the daily recorded RTA files of Tigray Regional Government Traffic office, and Mekele city traffic office and from all sub cities. Moreover, different books, proceedings, reports, international organization publications, and internet waves have been referred to fill all necessaries related with this study.

3.7 Data processing, analysis and presentation

The study conducted was both quantitative and qualitative research. For the processing and analysis of data of Satellite map of the area, route layers and x-y co-ordinates, GIS, Excel, SPSS version 20 have been used. The RTA data that have been collected from Mekele City Traffic Office archives and through interviews have been processed and accordingly, the data were organized and presented in the form of tables, pie charts, bar charts and percentages. Data interpretation was done using Chi–square test for goodness of fit and P values were calculated. $P < 0.05$ was considered statistically significant. Based on these results, discussion, conclusion and recommendation have been forwarded accordingly.

3.8 Relationship Method and Data Analysis

This study seeks to find answers to the problems through the analysis of statistical relationships between road traffic accident and RTA variations in time, driver's condition, road surface type and accident locations.

The general procedure followed for the analysis of the data, primarily consists of performing descriptive statistics, which is the cross tab chi-square test analysis evaluation. Chi-square test (χ^2) analysis was adopted to determine whether the relationship of the dependent variable (road traffic accident) was significantly related to the independent variables using the relative importance of these factors. Descriptive data analyses were conducted using Microsoft Excel to investigate interactions and checking of assumptions underlying the use of Pearson chi-square test analysis , and specifically using confidence interval of 95% and the significance level has been 5% (p=0.05). Thus, from Pearson chi-square test result, the relationship between variables that was $p \leq 0.05$ was considered as significant relationship. But, if $p > 0.05$ means there was no different between the variables or there was no significant relationship between the variables.

$$\chi^2 = \frac{\text{Sum of (Counted Frequency – Expected Frequency)}^2}{\text{Expected Frequency}} \quad \text{……Equation (1)}$$

The expected count in any cell of a two-way table is calculated

$$\text{Expected Count} = \frac{\text{Row Total * Column Total)}}{\text{Grand Total}} \quad \text{……Equation (2)}$$

CHAPTER FOUR

ANALSIS, RESULTS AND DISCUSSION

4.1 General Characteristics of RTA Variations

4.1.1 Road Traffic Accidents Variations Based on Time

4.1.1.1 Hourly Temporal Variation of Road Traffic Accidents

The occurrence of Road Traffic Accident varies within the 24 hours of a day. Road Traffic Accidents vary by hours of a day, with a maximum crashes when mobility of pedestrian, passengers, and drivers frequency increases.

The environmental factors like the availability of light, the high movement of pedestrians and passengers from different directions, such as private institution workers, students and the like have a greater impact in the variation of RTAs distribution within a day. (See The Detail in the Appendix A, Table A5.).

The time between 6 PM to 9 PM divulges the highest proportion (25.54 %) of all the RTA scenes in Mekele City between the years 2007 – 2010 E.C (2014/2015 – 2017/2018). 331(25.54 %) accident records were observed in this time interval. In nearly similar context, Segni (2007) have discussed that the time between 3 PM to 6 PM contributes for the majority of RTA occurrences in the roads found between Addis Ababa and Shashemene.

The frequency of occurrence of RTA in the time between 3 PM to 6 PM exhibited a continuous increase in the study period.

Table 4.1 Hour of a day * RTA Cross tabulation

Hour of a day		Accident year				Total
		2007	2008	2009	2010	
9 AM - 12 AM	Count	2	0	0	1	3
	% of Total	0.2%	0.0%	0.0%	0.1%	0.2%
12 AM - 3PM	Count	74	61	59	63	257
	% of Total	5.7%	4.7%	4.6%	4.9%	19.8%
3 PM - 6 PM	Count	47	63	70	74	254
	% of Total	3.6%	4.9%	5.4%	5.7%	19.6%
6 PM - 9 PM	Count	80	86	91	74	331
	% of Total	6.2%	6.6%	7.0%	5.7%	25.5%
9 PM - 12 PM	Count	64	62	66	69	261
	% of Total	4.9%	4.8%	5.1%	5.3%	20.1%
12 PM -3 AM	Count	20	27	33	23	103
	% of Total	1.5%	2.1%	2.5%	1.8%	7.9%
3 AM -6 AM	Count	11	19	35	22	87
	% of Total	0.8%	1.5%	2.7%	1.7%	6.7%
Total	Count	298	318	354	326	1296
	% of Total	23.0%	24.5%	27.3%	25.2%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	27.510[a]	18	.070
Likelihood Ratio	28.271	18	.058
Linear-by-Linear Association	2.739	1	.098
N of Valid Cases	1296		

Since the p-value is .070 thus, the accident levels were not significantly associated with time of the day. The time between 12 AM to 12 PM, which is half of the day contributes the highest proportion 85.11%. Generally, road traffic accidents in Mekele City are commonly occurred from the mid-day up to the mid-night. About 782 (60.34%) of all the accidents in the study period have been occurred in the night time, whereas the rest 514 (39.66 %) accidents have been recorded in the day time between 6 AM to 6 PM.

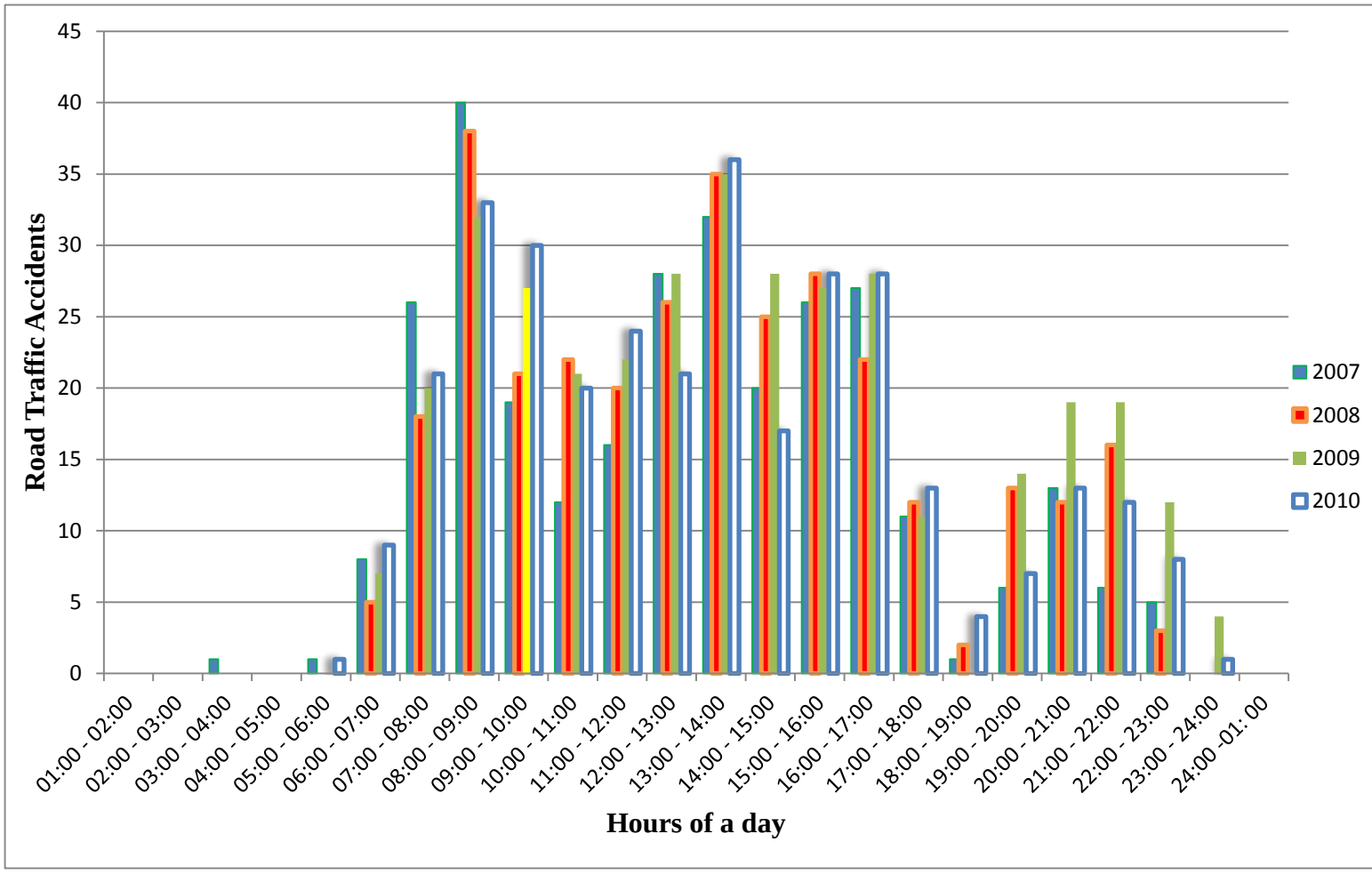


Figure 4.1 Variation of road traffic accidents on hours of a day in Mekele City.

As luck would have it, the time between 6 AM to 9 AM have 0 % contribution of RTA records in the city with the study years. According to the data recorded, driving or travelling on the city roads between 6 PM to 12 PM is 197 times more risky for being involved in accident than driving or travelling between 6 AM to 12 AM. This occurrence is apparently due to the fact that the high movement of pedestrians and passengers from different directions, such as private institution workers, students, some are walking and refreshing around along the routes after 6 PM in the afternoon. This result is quite different from the study made by (Addis, 2003), which stated that about 51% of RTAs in Bahir Dar City are frequently exhibited during the day time and 49% in the night time. Therefore, the temporal occurrence of RTAs in Mekele city between day and night times proves or supports the idea stated by (Hoobs, 1979) reveals that, night time accident rates are about 50% greater than day time accidents.

4.1.1.2 Road Traffic Accidents Variation based on day of a week in Mekele City

Table 4.2, describes that there is a slight difference in the occurrence of RTAs among the days of the week. The data shows that there were greater proportions of accidents on Monday, Friday, and Thursday. The main cause for the high traffic accidents on Monday and Friday is, these are the days most civil servants, students and other business people restart their work, and thus they want to move to their work place, schools and shopping place; and also a day of rest for most civil servants and they often spend the day by visiting parents, friends, families and recreating outside homes respectively. Hence, the p-value is .043; this indicates the RTA has significant relation with the days of the week.

Table 4.2 Day of week * RTA Cross tabulation

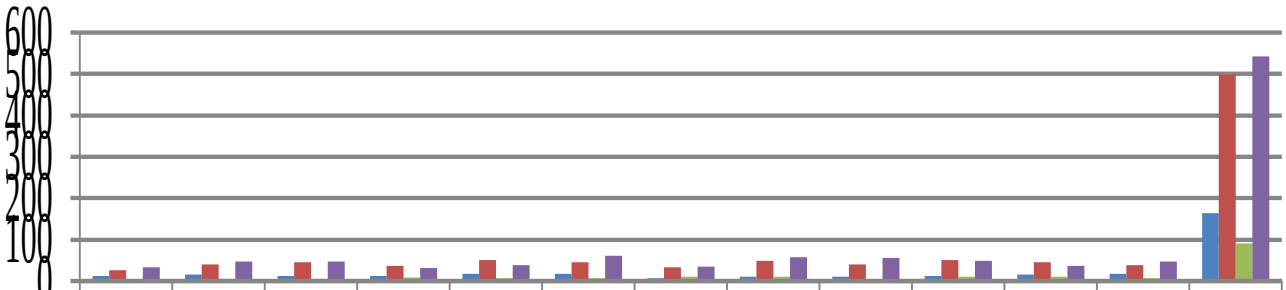
Day of week		Year				Total
		2007	2008	2009	2010	
Monday	Count	68	52	65	45	230
	% of Total	5.2%	4.0%	5.0%	3.5%	17.7%
Tuesday	Count	37	49	49	52	187
	% of Total	2.9%	3.8%	3.8%	4.0%	14.4%
Wednesday	Count	33	44	55	31	163
	% of Total	2.5%	3.4%	4.2%	2.4%	12.6%
Thursday	Count	37	39	63	52	191
	% of Total	2.9%	3.0%	4.9%	4.0%	14.7%
Friday	Count	48	47	40	59	194
	% of Total	3.7%	3.6%	3.1%	4.6%	15.0%
Saturday	Count	37	51	41	42	171
	% of Total	2.9%	3.9%	3.2%	3.2%	13.2%
Sunday	Count	38	36	41	45	160
	% of Total	2.9%	2.8%	3.2%	3.5%	12.3%
Total	Count	298	318	354	326	1296
	% of Total	23.0%	24.5%	27.3%	25.2%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	29.509[a]	18	.043
Likelihood Ratio	29.526	18	.042
Linear-by-Linear Association	1.672	1	.196
N of Valid Cases	1296		

4.1.1.3 Road Traffic Accidents Variation based on Months of the year

Like the variation in the distribution of RTAs within 24 hours of a day or /and the variation within the days of a week, the occurrence of RTAs are varying within the different months of a year.



	September	October	November	December	January	February	March	April	May	June	July	August	Sum
Fatal	13	16	13	12	17	18	8	11	11	12	16	17	164
Serious	26	41	45	36	50	46	33	49	40	50	45	38	499
Slight	4	6	5	9	7	7	10	10	4	10	11	8	91
PDO	33	47	47	32	39	61	35	58	56	49	37	48	542

Figure 4.2 Variation of RTA severities on different months of years in Mekele City.

As shown in Table 4.3, it described that there is some differences in the occurrence of RTAs among the months in the city. Relatively, February, April and June are the months of highest RTA scene in the city from 2007 to 2010 E.C, where they contribute 132 (10.19%), 128 (9.88%) and 121 (9.34%) respectively of the total incidents during the specified study period. Supporting this idea (Addis, 2003) reported that, December, January and February to have the most common RTAs in Bahir Dar City.

Table 4.3 Months * RTA Cross tabulation

Months		Accident Year				Total
		2007	2008	2009	2010	
September	Count	11	24	19	22	76
	% of Total	0.8%	1.9%	1.5%	1.7%	5.9%
October	Count	27	27	28	28	110
	% of Total	2.1%	2.1%	2.2%	2.2%	8.5%
November	Count	26	26	23	35	110
	% of Total	2.0%	2.0%	1.8%	2.7%	8.5%
December	Count	21	29	24	15	89
	% of Total	1.6%	2.2%	1.9%	1.2%	6.9%
January	Count	39	23	26	25	113
	% of Total	3.0%	1.8%	2.0%	1.9%	8.7%
February	Count	30	40	33	29	132
	% of Total	2.3%	3.1%	2.5%	2.2%	10.19%
March	Count	23	23	19	21	86
	% of Total	1.8%	1.8%	1.5%	1.6%	6.6%
April	Count	26	23	48	31	128
	% of Total	2.0%	1.8%	3.7%	2.4%	9.88%
May	Count	19	30	37	25	111
	% of Total	1.5%	2.3%	2.9%	1.9%	8.6%
June	Count	26	20	42	33	121
	% of Total	2.0%	1.5%	3.2%	2.5%	9.34%
July	Count	30	25	25	29	109
	% of Total	2.3%	1.9%	1.9%	2.2%	8.4%
August	Count	20	28	30	33	111
	% of Total	1.5%	2.2%	2.3%	2.5%	8.6%
Total	Count	298	318	354	326	1296
	% of Total	23.0%	24.5%	27.3%	25.2%	100.0%

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	47.186[a]	33	.052
Likelihood Ratio	46.733	33	.057
Linear-by-Linear Association	1.427	1	.232
N of Valid Cases	1296		

As seen from the above table 4.3 the p-value is .052. This indicates the accident level doesn't significantly associate with the months of year.

4.1.2 Road Traffic Accident Variations Based on Drivers Age, Sex, Experience, their relationship with the vehicle and their level of education

4.1.2.1 Road Traffic Accidents Based on Drivers Age

Several studies have witnessed that the age of drivers has a greater impact over the occurrence of RTA scenes. This is due to the fact that, the age of drivers affects their driving behavior, concentration, sense of responsibility and persistence.

Table 4.4 Variation of RTAs based on driver's age in Mekele City (2007-2010)

Age of Drivers	Accident Year				Total	%
	2007	2008	2009	2010		
< 18	1	2	1	0	4	0.31
18-30	134	151	199	158	642	49.54
31-50	109	119	110	106	444	34.26
> 51	51	46	43	60	200	15.43
Unknown	3	0	1	2	6	0.46
Sum	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

Table 4.4, illustrates drivers between the age group of 18 and 30 are more frequently involved in road traffic accidents than drivers in the other age groups. This age group contribute 642 (49.54%) of all the RTA crashes in the study period and it is followed by age groups between 31 and 50 which contributes 444 (34.26%) to the events, and above 51 years which contributes 200 (15.43%) road traffic accidents in Mekele during the study period. The underage drivers contribute for 4 (0.31%) of total crashes during the study period. Drivers found in the age group between 18 and 30 (young drivers) in the city are 1.446 times more frequently involved in RTAs than drivers aged 31 to 50 in Mekele City. As shown in table 4.5, drivers in the age group 18-30 had contributed 50% of fatal, 47.09% of

serious injury, 52.75% of slight injury and 51.11% of property damages out of the total fatal, serious, slight and damage to property respectively. Drivers in the age group between 31-50 are responsible for 42.07%, 35.47%, 34.07% and 30.81% of the fatal, serious, slight and damage to property respectively.

Table 4.5 age of drivers * RTA Severity Cross tabulation

Age of drivers		RTA Severity				Total
		fatal	serious	slight	PDO	
< 18	Count	1	2	0	1	4
	% within RTA Severity	0.6%	0.4%	0.0%	0.2%	0.3%
	% of Total	0.1%	0.2%	0.0%	0.1%	0.3%
18-30	Count	82	235	48	277	642
	% within RTA Severity	50.0%	47.09%	52.75%	51.11%	49.5%
	% of Total	6.3%	18.1%	3.7%	21.4%	49.5%
31-50	Count	69	177	31	167	444
	% within RTA Severity	42.07%	35.47%	34.07%	30.81%	34.3%
	% of Total	5.3%	13.7%	2.4%	12.9%	34.3%
> 51	Count	7	84	12	97	200
	% within RTA Severity	4.3%	16.8%	13.2%	17.9%	15.4%
	% of Total	0.5%	6.5%	0.9%	7.5%	15.4%
Unknown	Count	5	1	0	0	6
	% within RTA Severity	3.0%	0.2%	0.0%	0.0%	0.5%
	% of Total	0.4%	0.1%	0.0%	0.0%	0.5%
Total	Count	164	499	91	542	1296
	% within RTA Severity	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	12.7%	38.5%	7.0%	41.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	50.926[a]	12	.000
Likelihood Ratio	46.086	12	.000
Linear-by-Linear Association	.081	1	.775
N of Valid Cases	1296		

Finally, from chi-Square test the age of drivers is high significantly associated with the occurrence of road traffic accident because the p-value is 0.00.

4.1.2.2 Road Traffic Accidents Based on Drivers Sex

The occurrence of RTAs in Mekele City indicates a greater disparity in terms of drivers' sex.

As shown in Table 4.6, the number of male drivers involvement in RTAs was greatly be more numerous than females in Mekele City.

The outstrip number of male drivers could result in more frequencies of engaging in RTA events. In a very similar result (Mekonnen, 2007) have proved that, male drivers are the main contributors to RTAs than females in Addis Ababa City. However, with this, convincing remarks cannot be made due to the different proportions of male against female drivers.

Table 4.6 Variation of RTAs based on driver's sex in Mekele City (2007-2010)

Sex of Drivers	Accident Years				Total	%
	2007	2008	2009	2010		
Male	294	308	349	310	1261	97.30
Female	1	10	4	14	29	2.24
Unknown	3	0	1	2	6	0.46
Sum	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

During the specified study period male drivers' causes 1261 (97.30%) road traffic accidents in the city. In contrary, female drivers caused 29 (2.24%) road traffic accidents and the remaining 6 (0.46%) RTAs were caused by unknown bodies.

As illustrated in table 4.7, Male drivers were responsible for 159 (97%), 490 (98.20%), 80 (87.90%), 532 (98.20%) and 1261(97.30%) out of the total fatal, serious, slight and property damages only and total traffic accidents respectively.

Table 4.7 Sex of drivers * RTA Severity Cross tabulation

Sex of drivers		RTA Severity				Total
		fatal	serious	slight	PDO	
Male	Count	159	490	80	532	1261
	% within sex of drivers	12.6%	38.9%	6.3%	42.2%	100.0%
	% within RTA Severity	97.0%	98.2%	87.9%	98.2%	97.3%
	% of Total	12.3%	37.8%	6.2%	41.0%	97.3%
Female	Count	4	8	9	8	29
	% within sex of drivers	13.8%	27.6%	31.0%	27.6%	100.0%
	% within RTA Severity	2.4%	1.6%	9.9%	1.5%	2.2%
	% of Total	0.3%	0.6%	0.7%	0.6%	2.2%
Unknown	Count	1	1	2	2	6
	% within sex of drivers	16.7%	16.7%	33.3%	33.3%	100.0%
	% within RTA Severity	0.6%	0.2%	2.2%	0.4%	0.5%
	% of Total	0.1%	0.1%	0.2%	0.2%	0.5%
Total	Count	164	499	91	542	1296
	% within sex of drivers	12.7%	38.5%	7.0%	41.8%	100.0%
	% within RTA Severity	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	12.7%	38.5%	7.0%	41.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	33.894[a]	6	0.000
Likelihood Ratio	20.582	6	0.002
Linear-by-Linear Association	.015	1	.903
N of Valid Cases	1296		

Since (p-value =0.000 <0.05), this Chi-Square test result shows that there is significant relationship between sex of drivers and road traffic accident.

4.1.2.3 Road Traffic Accidents Based on Drivers Experience

The distributions of road traffic accidents in Mekele City are also affected by the driving experience. It is believed that the experience of drivers play a paramount role in road traffic accidents.

Table 4.8 summarizes the difference in RTA occurrences in relation to driving experience. Thus, it is indicates that 355 (27.39%) RTAs occurrences have been revealed by drivers whose driving experience is between 2 to 5 years. Also the drivers with driving experience between 5 and 10 years have caused 335 (25.85%) road traffic accidents in the study period.

Table 4.8 Variation of RTAs based on driver's driving experience in Mekele City (2007-2010)

Experience in years	**Accident Years**				**Total**	**%**
	2007	2008	2009	2010		
No license	29	37	39	42	147	11.34
<1 year	15	11	17	23	66	5.09
1-2 year	55	30	50	54	189	14.58
2-5 year	83	98	92	82	355	27.39
5-10 year	75	90	95	75	335	25.85
>10 year	38	52	60	48	198	15.28
Unknown	3	0	1	2	6	0.46
Sum	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

The results in the table 4.8, shows that the frequencies of RTA occurrences decrease with increasing in driving experience in Mekele City except with those who have no license and those who have driving experience less than 1 year. This result found in the City becomes conflicting with the association between driving experience of drivers and occurrence of their involvement in road traffic accidents in Addis Ababa city. This is because, as stated by (Mekonnen, 2007), the highly experienced drivers are engaged in frequent RTA scenarios than the least experienced ones in Addis Ababa. As shown from the table 4.9, drivers having driving experience between 2-5, 5-10 and drivers with no license are responsible for 28.05% of fatal, 29.26% of serious injury, 35.16% of slight injury and 24.17% of property damages; 28.05% of fatal, 22.85% of serious, 21.98% of slight and 28.60% of property damages; and 17.68% of fatal, 14.03% of serious, 6.59% of slight and 7.75% traffic accidents

causalities respectively. Thus, more than 68.98% of the traffic accidents in the city are attributed to those drivers having more than 2 years of driving experience.

Table 4.9 drivers driving experience * RTA severity Cross tabulation

Drivers driving experience		RTA Severity				Total
		fatal	serious	slight	PDO	
No license	Count	29	70	6	42	147
	% within RTA severity	17.68%	14.03%	6.59%	7.75%	11.34%
	% of Total	2.2%	5.4%	0.5%	3.2%	11.3%
<1 year	Count	8	23	5	30	66
	% within RTA severity	4.9%	4.6%	5.5%	5.5%	5.1%
	% of Total	0.6%	1.8%	0.4%	2.3%	5.1%
1-2 year	Count	25	69	17	78	189
	% within RTA severity	15.2%	13.8%	18.7%	14.4%	14.6%
	% of Total	1.9%	5.3%	1.3%	6.0%	14.6%
2-5 year	Count	46	146	32	131	355
	% within RTA severity	28.05%	29.26%	35.16%	24.17%	27.39%
	% of Total	3.5%	11.3%	2.5%	10.1%	27.4%
5-10 year	Count	46	114	20	155	335
	% within RTA severity	28.05%	22.85%	21.98%	28.60%	25.85%
	% of Total	3.5%	8.8%	1.5%	12.0%	25.8%
>10 year	Count	5	76	11	106	198
	% within RTA severity	3.0%	15.2%	12.1%	19.6%	15.3%
	% of Total	0.4%	5.9%	0.8%	8.2%	15.3%
Unknown	Count	5	1	0	0	6
	% within RTA severity	3.0%	0.2%	0.0%	0.0%	0.5%
	% of Total	0.4%	0.1%	0.0%	0.0%	0.5%
Total	Count	164	499	91	542	1296
	% within RTA severity	100.0%	100.0%	100.0%	100.0%	100.0%
	% of Total	12.7%	38.5%	7.0%	41.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	78.151[a]	18	.000
Likelihood Ratio	75.306	18	.000
Linear-by-Linear Association	19.556	1	.000
N of Valid Cases	1296		

Since (p-value =0.000 <0.05), this Chi-Square test result shows that there is significant relationship between drivers driving experience and road traffic accident.

4.1.2.4 Road Traffic Accidents Based on Drivers relationship with vehicles

The events of RTAs were evaluated against driver and vehicle ownership or relationships. Table 4.10 illustrates that how far the drivers and vehicle ownership relationship contributes to RTAs occurrences and their variations in the City.

About 1086 (83.80%) of RTAs are recorded from hired drivers. However, 190 (14.66%) of traffic accidents were go with by owners of the vehicle while driving their own vehicles.

Similar previous study to this finding, (Mekonnen, 2007) argued that hired drivers were involved in repeated RTAs in Addis Ababa when compared to the vehicle owners. The low accident caused by own drivers' is mainly attributed to the strong sense of ownership feeling, belongingness and responsibility.

Table 4.10 RTAs based on driver's and vehicles relationship in the City (2007-2010)

Relation Ship Between drivers & vehicles	**Accident Years**				**Total**	**%**
	2007	2008	2009	2010		
Owner	54	41	45	50	190	14.66
Hired	241	271	306	268	1086	83.80
Other	0	6	3	6	15	1.16
Unknown	3	0	0	2	5	0.39
Sum	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

Therefore, as illustrates in table 4.10, it is clearly see that; the relationship of the driver and the vehicle he/she drives and its magnitude is varied.

Accordingly, it is possible to say, the relationship of the driver and the vehicle is a possible contributory factor for road traffic accidents.

Table 4.11 Driver and vehicle relationship * RTA severity Cross tabulation

Diver & vehicle relation		RTA severity				Total
		fatal	serious	slight	PDO	
Owner	Count	25	87	20	58	190
	% within RTA severity	15.2%	17.4%	22.0%	10.7%	14.66%
Hired	Count	130	406	69	481	1086
	% within RTA severity	79.3%	81.4%	75.8%	88.7%	83.8%
Other	Count	5	5	2	3	15
	% within RTA severity	3.0%	1.0%	2.2%	0.6%	1.16%
Unknown	Count	4	1	0	0	5
	% within RTA severity	2.4%	0.2%	0.0%	0.0%	0.39%
Total	Count	164	499	91	542	1296
	% within RTA severity	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	43.345[a]	9	.000
Likelihood Ratio	34.643	9	.000
Linear-by-Linear Association	.628	1	.428
N of Valid Cases	1296		

From the summarized and analyzed data, it was found that about 79.30% of fatal, 81.40% of serious, 75.80% of slight injury and 88.70% of damage to property are caused by hired drivers. In addition to that, about 80.24% of accidents of the total casualties (fatal, serious and slight injuries) and 79.3% of fatal casualties only are caused by employed drivers. Thus, the Chi-Square test result above shows that there is significant relationship between drivers with vehicle relationship and road traffic accident because p-value =0.000 <0.05.

4.1.2.5 Road Traffic Accidents Based on Drivers Level of Education

Table 4.12 shows a very weak relationship between road traffic accidents and the level of education of the drivers. Therefore, when the education level of drivers increases the number of accidents increases from illiterate one up to junior secondary levels and also decreases to some amount in the next levels

compared to junior levels but still high number of accidents than the illiterate, adult education and elementary levels.

Table 4.12 Variation of RTAs based on driver's level of education (2007-2010 E.C).

Level of education	**Accident Year**				**Total**	**%**
	2007	2008	2009	2010		
Illiteracy	0	0	1	0	1	0.08
Adult Educ.	5	0	0	0	5	0.39
Ele.School	43	49	55	55	202	15.59
Junior Secondary	93	108	125	111	437	33.72
Senior Secondary	103	106	112	100	421	32.48
> Secondary	50	54	60	58	222	17.13
Unknown	4	1	1	2	8	0.62
Sum	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

As indicated in Table 4.12, drivers' with junior, senior and greater than secondary educational levels contributes 437(33.72%), 421 (32.48%) and 222 (17.13%) road traffic accidents respectively.

This indicates that drivers whose educational level is above junior secondary took the greater proportion of accidents which covers 83.33%, and the remaining 16.67% was contribute by elementary and below, by some unknowns.

As shown in table 4.13, drivers with their education level of Junior Secondary contributes the higher portion in fatal, serious and slight injuries; which are 61(37.20%), 165 (33.07%) and 38 (41.76%) out of the total accidents of fatal, serious injury and slight injury respectively.

Table 4.13 Drivers level of education * RTA severity Cross tabulation

			RTA severity				Total
			fatal	serious	slight	PDO	
drivers level of education	Illiteracy	Count	1	0	0	0	1
		% within RTA severity	0.6%	0.0%	0.0%	0.0%	0.1%
		% of Total	0.1%	0.0%	0.0%	0.0%	0.1%
	Adult Educ.	Count	1	1	0	3	5
		% within RTA severity	0.6%	0.2%	0.0%	0.6%	0.4%
		% of Total	0.1%	0.1%	0.0%	0.2%	0.4%
	Ele.School	Count	31	88	16	67	202
		% within RTA severity	18.9%	17.6%	17.6%	12.4%	15.6%
		% of Total	2.4%	6.8%	1.2%	5.2%	15.6%
	Junior Secondary	Count	61	165	38	173	437
		% within RTA severity	37.2%	33.07%	41.76%	31.9%	33.7%
		% of Total	4.7%	12.7%	2.9%	13.3%	33.7%
	Senior Secondary	Count	49	154	32	186	421
		% within RTA severity	29.9%	30.9%	35.2%	34.3%	32.5%
		% of Total	3.8%	11.9%	2.5%	14.4%	32.5%
	>Secondary	Count	16	89	5	112	222
		% within RTA severity	9.8%	17.8%	5.5%	20.7%	17.1%
		% of Total	1.2%	6.9%	0.4%	8.6%	17.1%
	Unknown	Count	5	2	0	1	8
		% within RTA severity	3.0%	0.4%	0.0%	0.2%	0.6%
		% of Total	0.4%	0.2%	0.0%	0.1%	0.6%
Total		Count	164	499	91	542	1296
		% within RTA severity	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	12.7%	38.5%	7.0%	41.8%	100.0%

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	53.869[a]	18	.000
Likelihood Ratio	48.343	18	.000
Linear-by-Linear Association	9.078	1	.003
N of Valid Cases	1296		

Therefore, the Chi-Square test result above shows that there is significant statistical relationship between drivers level of education and road traffic accident because p-value =0.000 <0.05.

4.1.3 Road Traffic Accident Conditions Based on Vehicles service age, types, ownerships and their problems

4.1.3.1 Road Traffic Accident Conditions Based on Vehicles service age

The service age of vehicles can determine the providence of the vehicles to be engaged in RTAs conditions. The RTA data collected from the City Traffic office, as shown in Table 4.14 tells that the vehicle service age governs the variation in the distribution of RTA throughout the study period except for those who have service greater than 10 years that shows some percentage decrease than its preceding group.

Table 4.14 Variation of RTAs based on Vehicles service age in Mekele City (2007-2010)

Service Year	Accident Year				Total	%
	2007	2008	2009	2010		
<1year	10	12	4	6	32	2.47
1-2 years	38	38	31	42	149	11.50
3-5 years	88	89	85	77	339	26.16
6-10 years	99	102	129	106	436	33.64
>10 years	60	77	104	93	334	25.77
Unknown	3	0	1	2	6	0.46
Sum	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

As shown in the table above, the number of RTAs increases with the vehicles service age starting <1 year up to 6-10 years caused RTA 32 (2.47%), 149 (11.50%), 339 (26.16%) and 436 (33.64%) respectively. As the service age of vehicles is high, for example, for those vehicles their service age >10 years, the probability of road accident in the city decreases. This is because; vehicles of old age have low speed compared to the new ones. Also, most of their break system is comfort during driving and self-confidence on controlling the vehicles are some of the reasons.

The over confidence driving of drivers on relatively newer vehicles and the lesser dedication they gave to the vehicle scrutiny of new vehicles could result in greater rate of recurrence of involvement of the vehicles in RTAs condition. If the service age of the 6 (0.46%) of the vehicles was known, the probability of vehicles service age contribution to RTA in the city would be have a very little bit different variation.

Table 4.15 Vehicles service years * RTA severity Cross tabulation

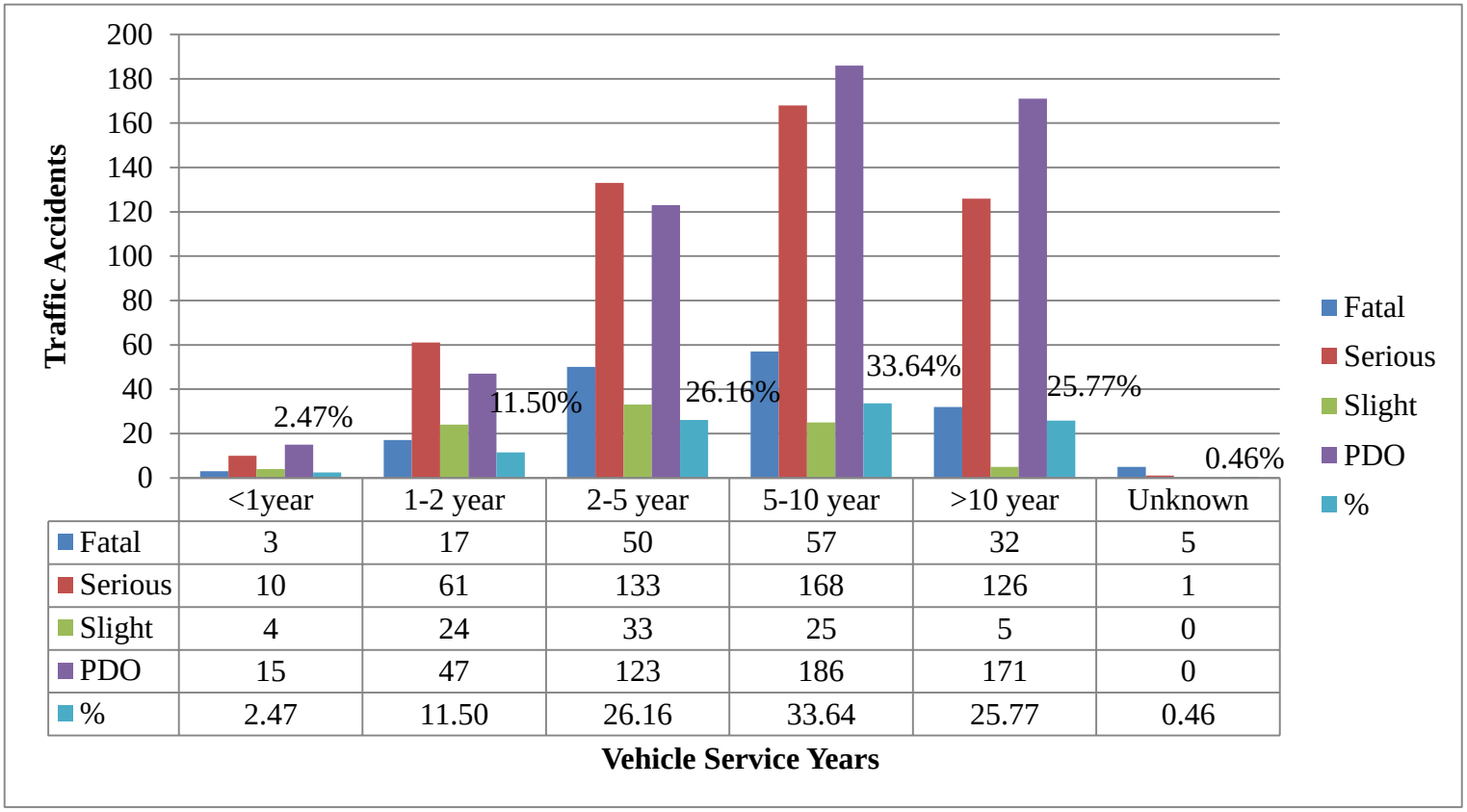
			RTA severity				Total
			fatal	serious	slight	PDO	
Vehicles service years	<1year	Count	3	10	4	15	32
		% within RTA severity	1.8%	2.0%	4.4%	2.8%	2.5%
	1-2 year	Count	17	61	24	47	149
		% within RTA severity	10.37%	12.2%	26.4%	8.7%	11.5%
	2-5 year	Count	50	133	33	123	339
		% within RTA severity	30.49%	26.7%	36.3%	22.7%	26.16%
	5-10 year	Count	57	168	25	186	436
		% within RTA severity	34.76%	33.7%	27.5%	34.3%	33.64%
	>10 year	Count	32	126	5	171	334
		% within RTA severity	19.51%	25.3%	5.5%	31.5%	25.77%
	Unknown	Count	5	1	0	0	6
		% within RTA severity	3.05%	0.2%	0.0%	0.0%	0.5%
Total		Count	164	499	91	542	1296
		% within RTA severity	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	83.836[a]	15	.000
Likelihood Ratio	75.485	15	.000
Linear-by-Linear Association	3.716	1	.054
N of Valid Cases	1296		

As described here in Table 4.15 and Figure 4.3 below, in terms road traffic accident severity vehicles with their service years 5-10 years, 2-5 years, >10 years and 1-2 years causes for 33.64%, 26.16%, 25.77% and 11.50% of accidents out of the total road traffic accidents and, 34.76%, 30.49%, 19.51%

and 10.37% fatal causalities respectively out of their total fatal crash accidents. If the unknown service age of the vehicles which causes 5 (3.05%) of the vehicles was known, the probability of vehicles service age contribution to fatal causalities in the city would be have a very little bit different variation but not to that much. Thus, statistically there is significant relationship between vehicle service years and road traffic accident since p-value =0.000 <0.05.



	<1year	1-2 year	2-5 year	5-10 year	>10 year	Unknown
Fatal	3	17	50	57	32	5
Serious	10	61	133	168	126	1
Slight	4	24	33	25	5	0
PDO	15	47	123	186	171	0
%	2.47	11.50	26.16	33.64	25.77	0.46

Figure 4.3 Variation of RTA severity based on vehicles service years in Mekele City

Likewise, In addition to the above explanation, it is similar in serious injury also vehicles with 5-10 years, 2-5 years and >10 years' service age causes for 33.67%, 26.65% and 25.25% out of total serious injury respectively.

4.1.3.2 Road Traffic Accident Conditions Based on Vehicle Types

Numerous vehicle types have been intricate in RTA consequences in the city in the last four years of the study period. Table 4.16 illustrates that, vehicles of public transports (three wheel vehicles or Bajaj's (68), taxis (113), minibuses (107) and buses (80) contributes 368 (28.40%) road traffic accidents during the four year study period. In addition, among the public transport vehicles, taxi encounters more road traffic accidents frequently, then followed by minibuses, buses and three wheel vehicles (Bajaj's) respectively. Vehicles serving for public transport are more usually intricate in RTAs than other vehicles individually. Vehicle which includes automobiles, land cruisers, pickups, others (loaders, cranes, liquid cargos) together contribute for 526 (40.59%) of the total road traffic accidents in Mekele city.

Table 4.16 Variation of RTAs based on Vehicles types in Mekele City (2007-2010)

Vehicle Types	**Accident Year**				**Total**	**%**
	2007	2008	2009	2010		
Bicycle	9	9	2	1	21	1.62
Motor cycle	7	6	9	9	31	2.39
Bajaj	11	16	17	24	68	5.25
Automobile	20	19	25	21	85	6.56
Land cruiser/ Station Wagon	31	41	38	42	152	11.73
Pick up	41	38	40	29	148	11.42
Isuzu(npr)	11	20	22	16	69	5.32
Isuzu(fsr)	47	48	61	59	215	16.59
Lorry	6	3	12	10	31	2.39
Taxi	22	30	33	28	113	8.72
Minibus(Upto15 Seat)	25	29	27	26	107	8.26
Bus(>15 Seat)	18	19	21	22	80	6.17
Cart	10	9	7	3	29	2.24
Other	37	31	39	34	141	10.88
Unknown	3	0	1	2	6	0.46
Sum	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

Moreover, the vehicles of freight transport which includes Isuzu (npr), Isuzu (fsr), trucks or lorry and carts also adds up 344 (26.54%) road traffic accident events. The main reason for this is due to loading and unloading of market commodities, loading and unloading of different construction materials in various most areas, and daily movements of these from one place to another places.

Separately, of all vehicle types the Isuzu (fsr) has been relatively higher frequency of involvement in the road traffic accident of the city, which causes for 215 (16.59%) road traffic accidents out of the total accidents in the specified period of time.

Table 4.17 Variation of RTA Severity based on Vehicles types in Mekele City (2007-2010)

Vehicle Types	**RTA Severity**									
	Fatal	%Share	Serious	%Share	Slight	%Share	PDO	%Share	**Total**	**%**
Bicycle	5	3.05	14	2.81	1	1.10	1	0.18	21	1.62
Motor cycle	7	4.27	20	4.01	2	2.20	2	0.37	31	2.39
Bajaj	8	4.88	28	5.61	14	15.38	18	3.32	68	5.25
Automobile	4	2.44	29	5.81	8	8.79	44	8.12	85	6.56
Land cruiser/ Station Wagon	15	9.15	54	10.82	12	13.19	71	13.10	152	11.73
Pick up	18	10.98	61	12.22	10	10.99	59	10.89	148	11.42
Isuzu(npr)	9	5.49	27	5.41	5	5.49	28	5.17	69	5.32
Isuzu(fsr)	31	18.90	67	13.43	15	16.48	102	18.82	215	16.59
Lorry	2	1.22	4	0.80	2	2.20	23	4.24	31	2.39
Taxi	17	10.37	60	12.02	6	6.59	30	5.54	113	8.72
Minibus(Upto12 Seat)	18	10.98	36	7.21	5	5.49	48	8.86	107	8.26
Bus	7	4.27	21	4.21	4	4.40	48	8.86	80	6.17
Cart	2	1.22	9	1.80	2	2.20	16	2.95	29	2.24
Other	16	9.76	68	13.63	5	5.49	52	9.59	141	10.88
Unknown	5	3.05	1	0.20	0	0	0	0	6	0.46
Sum	**164**	**100**	**499**	**100**	**91**	**100**	**542**	**100**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

As shown in table 4.17, in terms of severity conditions the Isuzu (fsr), Pick up, Minibus (Upto12 Seat) and Taxi vehicle types contributes the highest loss of lives respectively. Accordingly, these vehicle types covers 18.90%, 10.98%, 10.98% and 10.37% fatal causalities out of the total fatal accidents.

4.1.3.3 Road Traffic Accident Conditions Based on Vehicles Ownership

As indicated in table 4.18, the ownership of the vehicles that are involved in the accident occurrences has a great variation. Thus most of the crashes, almost to 89.58% accidents were caused by private vehicles.

Table 4.18 Variation of RTAs based on Vehicles Ownership in Mekele City (2007-2010)

Ownership	**Accident Year**				**Total**	**%**
	2007	2008	2009	2010		
Gov't	19	30	31	22	102	7.87
Public	0	1	1	0	2	0.15
Private	270	278	319	294	1161	89.58
Ngo	1	4	1	0	6	0.46
Others	8	5	2	10	25	1.93
Sum	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

4.1.3.4 Road Traffic Accident Conditions Based on Vehicles types of problems

The vehicle problem in Ethiopia is one of the problems of car accidents causality. But, in Mekele city most of the time the problems arise from the aspect of no problem. Adequate maintenance of vehicle during its working years is of paramount importance for safe driving and protects accidents that may cause due to various defects. Because, older vehicles with mechanical defects and poor maintenance are frequently exposed to accident. The majority of traffic accidents in general are associated with vehicles of haven't any problems or defects and few of them are related to brakes, steering problem, other (tires, mechanical problems), lights and some unknowns. But in Mekele city, these problems account for the lowest number of accidents. Vehicles with such defects are causes for only 10 accidents (0.77%) of the total accidents, whereas 1286 accidents (99.23%) of the accidents go to vehicles with no problems.

Table 4.19 Variation of RTAs based on types of problems of vehicles in the City (2007-2010)

Vehicles Problems	Accident Year				Total	%
	2007	2008	2009	2010		
Brake failure	1	0	0	0	1	0.08
Steering wheel Problem	0	1	1	0	2	0.15
Light system problem	0	0	1	0	1	0.08
Others	0	2	1	0	3	0.23
No Problem	295	315	351	325	1286	99.23
Unknown	2	0	0	1	3	0.23
Sum	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

As shown in table 4.19 and table 4.20, vehicles with no problem took the greater proportion, which is 99.23% of road traffic accidents out of the total accidents. Similarly, In terms of the severity class these also contributes 97.56% fatal, 99.80% serious injury, 94.51% slight injury and 100% property damages out of the totals of fatal, serious injury, slight injury and property damages only.

Table 4.20 Variation of RTAs based on types of problems of vehicles in the City (2007-2010)

Vehicles Problems	RTA Severity								Total	%
	Fatal	%Share	Serious	%Share	Slight	%Share	PDO	%Share		
Brake failure	1	0.61	0	0	0	0	0	0	1	0.08
Steering wheel Problem	0	0	1	0.20	1	1.10	0	0	2	0.15
Light system problem	0	0	0	0	1	1.10	0	0	1	0.08
Others	0	0	0	0	3	3.30	0	0	3	0.23
No Problem	160	97.56	498	99.80	86	94.51	542	100	1286	99.23
Unknown	3	1.83	0	0	0	0	0	0	3	0.23
Sum	**164**	**100**	**499**	**100**	**91**	**100**	**542**	**100**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

4.1.4 Road Traffic Accident Conditions Based on Road Way Characteristics

4.1.4.1 Road Traffic Accident Conditions Based on Road divides (Median) and Junction Types

Based on the RTA data collected in the study period, the two way road division types (2 Lane undivided) contributes 811 (62.58%) of all the road traffic accidents, while the two way roads (2 Lane divided) didn't contribute any accident in the study period. The remaining traffic accidents 485(37.42%) recorded at or near the road junction occurred at island divide types. The frequency of RTAs in two-way roads (2 Lane undivided) is by far higher than the divided and island.

This is because two-way roads (2 Lane undivided) host the movement of vehicles from opposite directions in the same stream and are usually characterized by congestion of traffic. However, the two-way roads (2 Lane divided) have a divide line marked which separates vehicles in to two and enables them to move only in one direction and allows vehicles to move in a relatively safer route than in the two -way roads (2 Lane undivided). Due to this reason, two way roads (2 Lane undivided) are more risky to RTA occurrences than two way roads (2 Lane divided) in Mekele City. The squares of the city are also places of some RTA occurrences.

Table 4.21 Variation of RTAs based on Road divides condition in Mekele City (2007-2010)

Road divide	**Accident Year**				**Total**	**%**
	2007	2008	2009	2010		
2 Lane divided	0	0	0	0	0	0
2 Lane undivided	185	191	225	210	811	62.58
Island	113	127	129	116	485	37.42
Sum	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

In Mekele city, roads with two-ways undivided have high incidence of traffic accidents in all severity classes. Consequently, they account for 62.20%, 61.52%, 59.34% and 64.21% of the fatal, serious injury, slight injury and property damages respectively. In addition to this, the accidents in roundabouts or islands accounts for 37.80%, 38.48%, 40.66% and 35.79% of the fatal, serious injury, slight injury and property damages respectively.

Table 4.22 Road Divide Type * RTA severity Cross tabulation

			RTA severity				Total
			fatal	serious	slight	PDO	
Road Divide Type	2 Lane undivided	Count	102	307	54	348	811
		% within RTA severity	62.2%	61.52%	59.34%	64.21%	62.58%
	Island	Count	62	192	37	194	485
		% within RTA severity	37.8%	38.48%	40.66%	35.79%	37.42%
Total		Count	164	499	91	542	1296
		% within RTA severity	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.269[a]	3	.737
Likelihood Ratio	1.267	3	.737
Linear-by-Linear Association	.615	1	.433
N of Valid Cases	1296		

The main reasons of accidents around roundabout is the over speed driving of vehicles, failure to respect traffic rules and not giving priority to pedestrian's at pedestrian crossing's which are around the islands. Thus, from the statistical analysis above there is no significant relationship between road divide types and road traffic accident since p-value =0.737 >0.05.

According to the shape of the junctions of roads about 58.10% of traffic accidents occurred in those straight roads which means in roads without junctions and in these roads the accidents shows an increasing order from year to year in the study period.

Roads with "+" and "T" shaped junctions ranked second and third contributing about 18.36% and 12.35% of all the traffic accidents.

Table 4.23 RTA variations on different shape of road junctions in Mekele City (2007-2010)

Junction Type	Accident Year				Total	%
	2007	2008	2009	2010		
No Junction	180	183	194	196	753	58.10
Y-type	0	0	0	4	4	0.31
T-type	29	38	48	45	160	12.35
O- type (Round)	30	34	44	32	140	10.80
+-type	58	63	68	49	238	18.36
X-type	0	0	0	0	0	0
Other	1	0	0	0	1	0.08
Sum	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

Table 4.24 Junction Type * RTA severity Cross tabulation

			RTA severity				Total
			fatal	serious	slight	PDO	
Junction Types	No Junction	Count	104	288	45	316	753
		% within RTA severity	63.41%	57.72%	49.45%	58.30%	58.1%
	Y-type	Count	0	0	1	3	4
		% within RTA severity	0.0%	0.0%	1.1%	0.6%	0.31%
	T-type	Count	27	60	17	56	160
		% within RTA severity	16.5%	12.0%	18.7%	10.3%	12.35%
	Round	Count	7	60	17	56	140
		% within RTA severity	4.3%	12.0%	18.7%	10.3%	10.8%
	+-type	Count	26	91	11	110	238
		% within RTA severity	15.9%	18.2%	12.1%	20.3%	18.36%
	Other	Count	0	0	0	1	1
		% within RTA severity	0.0%	0.0%	0.0%	0.2%	0.08%
Total		Count	164	499	91	542	1296
		% within RTA severity	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	31.481[a]	15	.008
Likelihood Ratio	33.705	15	.004
Linear-by-Linear Association	1.490	1	.222
N of Valid Cases	1296		

As shown in table 4.24, roads with no junction are the most frequently accident occurring junctions. Therefore, roads with no junctions contribute 63.41%, 57.72%, 49.45% and 58.30% out of total fatal injury, serious injury, and slight injury and property damages respectively.

The main reasons is that, roads without junctions do not have most of the time either traffic police or signals and signs, which in turn encourages drivers to drive fast, and this would definitely result in traffic accident especially when someone or something is crossing the road. The +-type and T-type shaped junctions also ranked second and third contributing about 18.36% and 12.35% of the total accidents respectively. From the chi-square statistical analysis above there is significant relationship between road junction types and road traffic accident since p-value =0.008 <0.05.

4.1.4.2 Road Traffic Accidents Variations based on Road Pavement Surface Type

The condition of road surface condition is a contributory factor for the incidence of traffic accident. In theoretical basis in damaged and uncomfortable road surfaces most likely increase the incidence of accident. Road traffic accidents occurrences would have been varied based on different road surface types in Mekele City. That is because of; the speed of the vehicles is directly related to surface condition of the roads. Drivers have a great desire to drive in higher speeds and move hastily in smoother road pavements like in asphalt roads. Drivers have high precaution at risk locations compared to low hazard locations. This is to mean in places where drivers recognize a location as hazardous, they take more care. Accidents may be more likely to happen when hazardous road or traffic conditions are not clear at a glance, or where the conditions are too complicated to recognize and respond in the time and distance available.

Table 4.25 RTA variations based on road surface conditions in Mekele City (2007-2010)

Surface Type	**Accident Year**				**Total**	**%**
	2007	2008	2009	2010		
Asphalt	236	267	301	278	1082	83.49
Gravel road	47	40	39	40	166	12.81
Cobblestone	15	11	14	8	48	3.70
Sum	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

As a result, almost 1082 (83.49%) of all the road traffic accidents have been occurred on asphalt roads. Gravel and cobblestone surfaced roads have been contribute 166 (12.81%) and 48 (3.70%) between the years 2007 E.C to 2010 E.C respectively in the stud period.

Table 4.26 Road Surface Types * RTA severity Cross tabulation

			RTA severity				Total
			fatal	serious	slight	PDO	
Road Surface Types	Asphalt	Count	137	420	69	456	1082
		% within RTA severity	83.54%	84.17%	75.82%	84.13%	83.49%
		% of Total	10.6%	32.4%	5.3%	35.2%	83.5%
	Gravel road	Count	20	63	17	66	166
		% within RTA severity	12.2%	12.6%	18.7%	12.2%	12.81%
		% of Total	1.5%	4.9%	1.3%	5.1%	12.8%
	Cobblestone	Count	7	16	5	20	48
		% within RTA severity	4.3%	3.2%	5.5%	3.7%	3.7%
		% of Total	0.5%	1.2%	0.4%	1.5%	3.7%
Total		Count	164	499	91	542	1296
		% within RTA severity	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	12.7%	38.5%	7.0%	41.8%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	4.638[a]	6	.591
Likelihood Ratio	4.261	6	.641
Linear-by-Linear Association	.001	1	.975
N of Valid Cases	1296		

As indicated in Table 4.26 in conflicting to the theoretical explanation about 83.54% of fatal, 84.17% of serious injury, 75.82% of slight injury and 84.13% of property damages out of total road traffic accidents occur on asphalt roads. The main reasons are due to the heavy volume of traffic on asphalted roads and also the high tendency to drive too fast on the asphalt roads. On the other hand, driving on the gravel roads and cobble surfaced roads forces drivers to take care of their vehicles and drive slowly, which contributes to low traffic incidence opportunities. Thus, from the statistical analysis above there is no significant relationship between road surface types and road traffic accident since p-value =0.591 >0.05.

4.1.4.3 Road Traffic Accidents Variations based on variation of Road moisture condition

The roads environments such as dryness, moistness and others can affect the occurrence of roads traffic accidents. As stated by Lisa, David et al. (2005), the condition of road weather strongly affects the occurrence of road traffic accidents. This may be due to the short wet season (little number of rainy days) in a year, the dry season or dry weather which shields the extensive number of days in a year in the city therefore produces greater number of road traffic accidents.

Table 4.27 RTAs based on road moisture conditions in Mekele City (2007-2010)

Road Condition	**Accident Year**				**Total**	**%**
	2007	2008	2009	2010		
Dry	293	302	339	294	1228	94.75
Moist	5	16	15	32	68	5.25
Sum	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

Table 4.28 Road Moisture Condition * RTA severity Cross tabulation

			RTA severity				Total
			fatal	serious	slight	PDO	
Road Moisture Condition	Dry	Count	155	468	87	518	1228
		% within RTA severity	94.51%	93.79%	95.60%	95.57%	94.75%
		% of Total	12.0%	36.1%	6.7%	40.0%	94.75%
	Moist	Count	9	31	4	24	68
		% within RTA severity	5.5%	6.2%	4.4%	4.4%	5.25%
		% of Total	0.7%	2.4%	0.3%	1.9%	5.25%
Total		Count	164	499	91	542	1296
		% within RTA severity	100.0%	100.0%	100.0%	100.0%	100.0%
		% of Total	12.7%	38.5%	7.0%	41.8%	100.0%

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	1.818[a]	3	.611
Likelihood Ratio	1.815	3	.612
Linear-by-Linear Association	1.241	1	.265
N of Valid Cases	1296		

Accordingly as indicated in table 4.27 and table 4.28, out of the total 1296 road traffic accident records of the study period in the city 1228 (94.75%) have occurred on dry road surfaces while 68 (5.25%) on wet roads in Mekele City. In addition to this, in terms of accident severity the dry road environment took the great proportion of i.e. 94.51% of fatal causalities, 93.79% of serious injuries, 95.60% of slight injuries and 95.57% property damages out of the total incidents of total fatal, serious, slight and property damages only respectively. Thus, from the statistical analysis above there is no significant relationship between road moisture condition and road traffic accident since p-value =0.611 >0.05.

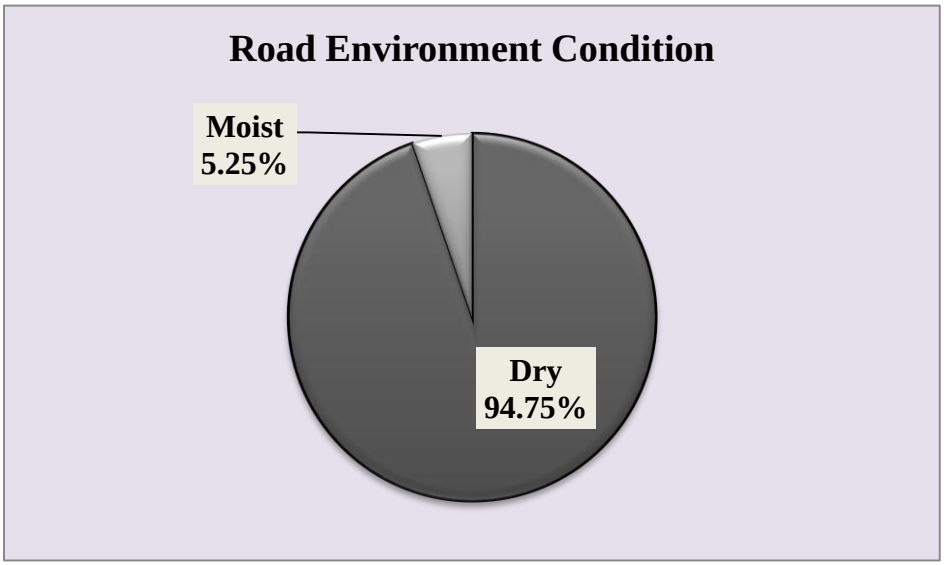


Figure 4.4 RTA Variations based on road environment conditions in Mekele City

4.1.5 Road Traffic Accidents Variations based on Weather and Light Condition

The weather conditions of the environment also have an influence on the traffic accidents of the roads in which the study sites are concentrated and other places.

The weather condition of the moment in RTAs plays an important role in varying the frequency and risk of road crashes. Several studies shows that traffic accidents occur during different conditions like fog, which reduces visibility, rainy, drizzle conditions.

Table 4.29 Variations of RTA based on weather conditions in Mekele City (2007-2010)

Weather Condition	**Accident Year**				**Total**	**%**
	2007	2008	2009	2010		
Good	297	301	349	308	1255	96.84
Foggy	1	4	2	5	12	0.93
Cloudy	0	5	1	5	11	0.85
Drizzle	0	7	1	7	15	1.16
Rainy	0	1	1	1	3	0.23
Others	0	0	0	0	0	0
Sum	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

According to the data collected, road traffic accidents in Mekele city frequently occur during good weather conditions than during foggy, cloudy, rainy and drizzle dropping occasions. As a result, 1255 (96.84%) traffic accidents in the city have been recorded in good weather conditions. In contrary, only 15 (1.16%), 12 (0.93%), 11 (0.85%) and 3 (0.23%) accidents recorded in drizzle, foggy, cloudy and rainy falling weather conditions respectively.

Table 4.30 Weather Condition * RTA severity Cross tabulation

			RTA severity				Total
			fatal	serious	slight	PDO	
Weather Condition	Good	Count	160	483	85	527	1255
		% within RTA severity	97.56%	96.79%	93.41%	97.23%	96.84%
	Foggy	Count	2	3	5	2	12
		% within RTA severity	1.2%	0.6%	5.5%	0.4%	0.93%
	Cloudy	Count	2	4	1	4	11
		% within RTA severity	1.2%	0.8%	1.1%	0.7%	0.85%
	Drizzle	Count	0	9	0	6	15
		% within RTA severity	0.0%	1.8%	0.0%	1.1%	1.16%
	Rainy	Count	0	0	0	3	3
		% within RTA severity	0.0%	0.0%	0.0%	0.6%	0.23%
Total		Count	164	499	91	542	1296
		% within RTA severity	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	32.539[a]	12	.001
Likelihood Ratio	25.839	12	.011
Linear-by-Linear Association	.341	1	.559
N of Valid Cases	1296		

As shown here in table 4.30, road traffic accidents are mostly occurred in good weather condition. Accordingly, 97.56% of fatal, 96.79% of serious, 93.41% of slight injury and 97.23% of property damages out of total fatal, serious injury, slight injury and property damages respectively are happened in good weather condition. Thus, from the statistical analysis above there is significant relationship between weather condition and road traffic accident since p-value =0.001<0.05.

The light condition of the environment and the vehicles are very important for the reduction accidents. But in the study, the lightening time has faced the highest percentage of accidents. In the figure below, we can notify that about 80.09% of the injuries occurred due to the day light or good light condition. Therefore in this sense we can say that the roads accident occurred are not due to the problem of light. The main reason is that the drivers drive in high speed during the day time and/or good light condition than the other time conditions.

Table 4.31 RTA variations based on light conditions in Mekele City (2007-2010)

Glow Condition	**Accident Year**				**Total**	**%**
	2007	2008	2009	2010		
Day and good light	257	243	264	274	1096	80.09
During sunset	6	17	17	4	5	3.40
During sunrise	3	14	10	4	7	2.39
Night	32	44	63	44	188	14.12
Sum	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

As illustrated in table 4.32, in terms of severity conditions, 78.05% of fatal, 77.56% of serious injuries, 76.92% of slight injuries and 83.58% of property damages were happened in day time condition.

Table 4.32 Glow Condition * RTA severity Cross tabulation

			RTA severity				Total
			fatal	serious	slight	PDO	
Glow Condition	Day & good light	Count	128	387	70	453	1038
		% within RTA severity	78.05%	77.56%	76.92%	83.58%	80.09%
	During sunset	Count	7	21	9	7	44
		% within RTA severity	4.3%	4.2%	9.9%	1.3%	3.4%
	During sunrise	Count	3	12	9	7	31
		% within RTA severity	1.8%	2.4%	9.9%	1.3%	2.39%
	Night time	Count	26	79	3	75	183
		% within RTA severity	15.9%	15.8%	3.3%	13.8%	14.12%
Total		Count	164	499	91	542	1296
		% within RTA severity	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	54.451[a]	9	.000
Likelihood Ratio	47.131	9	.000
Linear-by-Linear Association	2.921	1	.087
N of Valid Cases	1296		

Therefore, from the statistical analysis above there is significantly high relationship between weather condition and road traffic accident since p-value =0.001<0.05.

4.2 Identify Major Types and Causes of Road Traffic Accident Occurrences

4.2.1 Major Types of Road Traffic Accidents Occurred in the city

Accidents can be committed on the roads by vehicles may be face to face, side to side, face to side, face to back, turning over, collision with pedestrian, failing from running vehicle, collision with fixed object, collision with animals and so on. Road Traffic Accidents can happen in various ways. Safecarguide (2004) indicated the type of RTAs may include collision between vehicles and animals, vehicles and pedestrians or vehicles and fixed obstacles. This shows that RTA can have a varied ways. The major types of road traffic accidents in Mekele City are as shown in the table below.

Table 4.33 Types of crashes occurred in Mekele City (2007-2010)

Crash Types	Accident Year				Total	%
	2007	2008	2009	2010		
Head to head	30	34	36	33	133	10.26
Rear-End	52	62	70	53	237	18.29
T-Bone	58	58	69	63	248	19.14
Side-Swipe	4	2	6	9	21	1.62
Rollover	21	27	25	21	94	7.25
Collision with Pedestrians	108	102	99	100	409	31.56
Collision with Animals	4	4	1	1	10	0.77
Fall from Vehicles	3	3	2	3	11	0.85
Collision with road side parked vehicles	1	2	0	5	8	0.62
Collision with fixed objects	17	24	46	38	125	9.65
Sum	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

As shown here in table 4.33, the accidents happened in the city during the study periods are of diverse types and their impacts to the total road crashes are also vary significantly.

Accordingly, the vehicle to pedestrians collision come to be take the prevalent proportion which contributes about 409 (31.56%) of the all road traffic accident crash types in the city followed by vehicles T-Bone and Rear-End crashes which endorses 248 (19.14%) and 237 (18.29%) accident prospects respectively from 2007 to 2010 E.C in the study area.

The left over coincidence types contributes relatively insignificant amount to the total of road traffic accident with the exception of Head to Head collision, Collision with fixed objects , Rollover and Side-Swipe crash types which affords 133 (10.26%), 125 (9.65%), 94 (7.25%) and 21 (1.62%) of the total road crashes respectively.

Table 4.34 Crash Types and RTA severity in Mekele City (2007-2010)

Crash Type	RTA Severity								Total	%
	Fatal	%Share	Serious	%Share	Slight	%Share	PDO	%Share		
Head to head	4	2.44	39	7.82	13	14.29	77	14.21	133	10.26
Rear-End	9	5.49	57	11.42	26	28.57	145	26.75	237	18.29
T-Bone	13	7.93	79	15.83	25	27.47	131	24.17	248	19.14
Side-Swipe	0	0	1	0.20	2	2.20	18	3.32	21	1.62
Rollover	10	6.10	26	5.21	9	9.89	49	9.04	94	7.25
Collision with Pedestrians	123	75	275	55.11	11	12.09	0	0	409	31.56
Collision with Animals	0	0	0	0	0	0	10	1.85	10	0.77
Fall from Vehicles	1	0.61	9	1.80	0	0	1	0.18	11	0.85
Collision with road side parked vehicles	3	1.83	1	0.20	0	0	4	0.74	8	0.62
Collision with fixed objects	1	0.61	12	2.40	5	5.49	107	19.74	125	9.65
Others	0	0	0	0	0	0	0	0	0	0
Sum	**164**	**100**	**499**	**100**	**91**	**100**	**542**	**100**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

According to their severity condition, the collision with pedestrians ranked the first from other collisions which killed so many people and took greatest share; 75% of fatal causalities, 55.11% of serious and 12.09% slight injuries out of the total of fatal, serious and slight injuries respectively. This occurs due to lack of traffic light at junction, because of violating the rule of moving at right distances and not given priority to the pedestrians at pedestrian crossing sections of the road.

4.2.2 Major Causes of The Road Traffic Accidents occurred in the city

There are a lot of causes that could be consequences for road traffic accidents across all roads in the land. Previous studies accordingly, as (Mebrahtu, 2002); Addis (2003); (Segni, 2007) studied that the major causes of RTA in Ethiopia and its cities includes the lack of driving skills, poor knowledge of both drivers and pedestrians over traffic rules and regulations, violating speed limits by drivers, insufficient traffic law enforcements, lack of timely vehicle maintenance, driving under the influence of drugs and alcohol, failure to observe and respect road traffic signs, failure to give way for pedestrians, failure to give way for vehicles, lack of sidewalks, lack of road traffic signs, improper overtaking, improper turning and excessive loading.

In similar manner, the common and frequently observed causes of traffic accidents in Mekele city are also as the abovementioned reasons. Apparently, with some additional variables of causes of RTA, the table shown below describes the current main reasons of RTA occurrences in the city.

As Table 4.35 illustrates, failure to give priority to pedestrians, not giving priority to vehicle, over speed driving, driving too close with another vehicle, failure to respect right hand drive and improper turning are the major causes of RTAs in Mekele City in the study period from 2007-2010 E.C.

Failure to give priority to pedestrians created 416 (32.10%) road traffic accidents in the study period. Moreover to this, over speed driving, failure to give priority to vehicle, driving too close with another vehicle, failure to respect right hand drive and improper turning subsidized to 233(17.98%), 230 (17.75%), 172(13.27%), 163(12.58%) and 28 (2.16%) accidents respectively out of the total traffic accidents in the city during the specified study period.

This shows that the road traffic accidents in the city are mainly characterized with the involvement of vehicles and pedestrians. This phenomenon results in a huge property damages and severe consequences in the life of the city people.

Table 4.35 Major Causes of road traffic accidents occurred in Mekele city (2007-2010 E.C)

Causes	Accident Year				Total	%
	2007	2008	2009	2010		
Drunk driving	1	1	1	0	3	0.23
Driving under influence of drug	0	4	0	0	4	0.31
Failure to respect right hand drive	44	36	45	38	163	12.58
Not giving priority to vehicle	64	44	60	62	230	17.75
Not giving priority to pedestrian	99	111	107	99	416	32.10
Driving too close with another	36	41	56	39	172	13.27
Over speed	38	61	63	71	233	17.98
Illegal overhaul	5	3	6	5	19	1.47
Illegal turning	4	8	8	8	28	2.16
Violation of give first sign	2	1	2	0	5	0.39
Incidental starting from stop	1	1	3	1	6	0.46
Illegal parking	0	1	0	1	2	0.15
Over loading	2	3	2	1	8	0.62
Faulty of pedestrian in Crossing	0	3	0	0	3	0.23
Others	0	0	0	0	0	0
Unknown	2	0	1	1	4	0.31
Sum	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

In addition to those causes listed in the table above, key information's collected from some traffic officers have added that, drivers' carelessness, failure of pedestrians in using zebra crosses while crossing ways and lesser awareness of the society about road traffic accidents are the major causes of RTA occurrences in the city. Besides, the officers have further identified that, lack of road traffic lights, insufficient number of road traffic signs, limited number and size of side walkways of the roads played critical role in provoking the occurrence of road traffic accidents in the city.

Table 4.36 Major Causes of RTAs based on severities in Mekele city (2007-2010 E.C)

Causes	RTA Severity								Total	%
	Fatal	%Share	Serious	%Share	Slight	%Share	PDO	%Share		
Drunk driving	0	0.0	1	0.20	2	2.20	0	0	3	0.23
Driving under influence of drug	0	0.0	2	0.40	1	1.10	1	0.18	4	0.31
Failure to respect right hand drive	18	10.98	48	9.62	14	15.38	83	15.31	163	12.58
Not giving priority to vehicle	11	6.71	47	9.42	21	23.08	151	27.86	230	17.75
Not giving priority to pedestrian	106	64.63	278	55.71	32	35.16	0	0	416	32.10
Driving too close with another	5	3.05	27	5.41	11	12.09	129	23.80	172	13.27
Over speed	17	10.37	75	15.03	10	10.99	131	24.17	233	17.98
Illegal overhaul	0	0	4	0.80	0	0	15	2.77	19	1.47
illegal turning	0	0	7	1.40	0	0	21	3.87	28	2.16
Violation of first give sign	0	0	2	0.40	0	0	3	0.55	5	0.39
Incidental starting	0	0	0	0	0	0	6	1.11	6	0.46
illegal parking	0	0	0	0	0	0	2	0.37	2	0.15
Overloading	1	0.61	7	1.40	0	0	0	0	8	0.62
Faulty of pedestrians	2	1.22	1	0.20	0	0	0	0	3	0.23
Others	0	0	0	0	0	0	0	0	0	0
Unknown	4	2.44	0	0	0	0	0	0	4	0.31
Sum	**164**	**100**	**499**	**98**	**91**	**100**	**542**	**100**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

Most of the time the main contributing factor in the majority of traffic accident is the behavior of the driver. As it has been discussed worldwide studies such as those of the OECD, show that about 80-90% of the road traffic accidents are attributed to the fault of the driver. Here in in this study also, the inattention of drivers is the main feature of traffic accident in Mekele city.

As calculated using the traffic accident data from the traffic police, (2014/15-2017/18) or 2007-2010 E.C driver faults account for almost of 93.68% of the causes.

Refusing priority to pedestrians (32.10%) and to other vehicles (17.75%), over speed (17.98), driving too close (13.27%) and failure to respect the right hand drive (12.58%) respectively are some of the causes that are the prominent problems of drivers.

As shown in table 4.36, among these faults of the drivers, refusing priority to pedestrians, failure to respect the right hand rule and driving too fast causes for 64.63%, 10.98% and 10.37% fatal out of the total fatal, 55.71%, 9.62% and 15.03% of serious injuries out total serious injuries respectively.

Table 4.37 Movements of pedestrians and RTA severities in Mekele city (2007-2010 E.C)

Movement of Pedestrians	RTA Severity						Total	%
	Fatal	%Share	Serious	%Share	Slight	%Share		
Crossing cross road where there is traffic light	0	0	0	0	0	0	0	0
Crossing cross road where there is no traffic light	3	2.46	1	0.37	0	0	4	0.98
Crossing at cross roads diagonally	0	0	4	1.50	0	0	4	0.98
Crossing at pedestrian crossing roads	1	0.82	3	1.12	0	0	4	0.98
Crossing at where no pedestrian crossing	94	77.05	214	80.15	17	94.44	325	79.85
Crossing hiding himself at the vehicle	1	0.82	0	0	0	0	1	0.25
Moving on pedestrian walk roads	5	4.10	0	0	0	0	5	1.23
Moving on the left &no pedestrian roads	10	8.20	24	8.99	1	5.56	35	8.60
Moving on right & no pedestrian roads	2	1.64	21	7.87	0	0	23	5.65
Outside the vehicle or pedestrian roads	2	1.64	0	0	0	0	2	0.49
Others	0	0	0	0	0	0	0	0
Unknown	4	3.28	0	0	0	0	4	0.98
Sum	**122**	**100**	**267**	**100**	**18**	**100**	**407**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

Movements of pedestrians on roads also have great contribution to the incidence of traffic accidents, which is magnified at road crossings. In Mekele City, 79.85% of the traffic accidents occurs while moving pedestrians at roads with no zebra crossings, and 14.25% when traveling on both sides of the road in the absence of sidewalks. Accordingly, about 86.89% of fatal, 97.01% of serious injury and 100% of slight injury out of the total fatal, serious and slight injury accidents had occurred when pedestrians tried to cross roads at no pedestrian crossing, and at roads which do not have sidewalks for pedestrians.

4.3 Spatial Distribution of Road Traffic Accidents and their Spots in Mekele City

4.3.1 Road Traffic Accident Occurrence Location Areas in Mekele City

As we all know, we people make journeys for different purposes such as for recreation, business, education, and go into working places.

Likewise the distribution of traffic accidents in Mekele city in relation to land use shows that most accidents (28.78%) occur around residential areas followed by office areas (22.38%), market areas and school areas accounting for 13.43%, 11.42% respectively. The highest number of traffic accidents seems as they are shown around residential areas. But, mostly they refer the prominent or the most known buildings around the accident spot areas for the sake of easy identification.

Table 4.38 RTAs distribution in different land-uses of Mekele City (2007-2010 E.C)

Places	**Accident Year**				**Total**	**%**
	2007	2008	2009	2010		
Around School	33	36	41	38	148	11.42
Factory	23	38	39	39	139	10.73
Religious Areas	0	6	11	10	27	2.08
Market Area	40	38	51	45	174	13.43
Luxury Areas	3	8	15	8	34	2.62
Hospital	9	30	36	36	111	8.56
Office Areas	80	71	69	70	290	22.38
Residential Areas	110	91	92	80	373	28.78
Sum	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

Table 4.39 Places * RTA severity Cross tabulation

			RTA severity				Total
			fatal	serious	slight	PDO	
Places	Around School	Count	24	69	11	44	148
		% within RTA severity	14.6%	13.8%	12.1%	8.1%	11.4%
	Factory	Count	8	51	11	69	139
		% within RTA severity	4.9%	10.2%	12.1%	12.7%	10.7%
	Religious Areas	Count	4	5	2	16	27
		% within RTA severity	2.4%	1.0%	2.2%	3.0%	2.1%
	Market Area	Count	15	71	19	69	174
		% within RTA severity	9.1%	14.2%	20.9%	12.7%	13.4%
	Luxury Areas	Count	7	11	1	15	34
		% within RTA severity	4.3%	2.2%	1.1%	2.8%	2.6%
	Hospital	Count	8	43	8	52	111
		% within RTA severity	4.9%	8.6%	8.8%	9.6%	8.6%
	Office Areas	Count	38	101	17	134	290
		% within RTA severity	23.2%	20.2%	18.7%	24.7%	22.4%
	Residential Areas	Count	60	148	22	143	373
		% within RTA severity	36.59%	29.66%	24.18%	26.38%	28.78%
Total		Count	164	499	91	542	1296
		% within RTA severity	100.0%	100.0%	100.0%	100.0%	100.0%

Chi-Square Tests			
	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	42.534[a]	21	.004
Likelihood Ratio	44.479	21	.002
Linear-by-Linear Association	.086	1	.769
N of Valid Cases	1296		

As shown in the Table 4.39 depending on the accident severity conditions the residential land use type took the greater proportion than the other types. Thus, it contributes 36.59% of fatal, 29.66% of serious injury, 24.18% of slight injury and 26.38% of property damages out of the totals of fatal, serious injuries, slight injuries and property damages respectively. Therefore, from the statistical analysis table above there is significant relationship between location areas of RTAs and road traffic accident since p-value =0.004<0.05.

4.3.2 Spatial Distribution of Road Traffic Accidents among all Sub-Cities of Mekele City

The occurrence of RTAs happened in the city from 2007 to 2010 E.C exhibits some variations among the seven sub-cities.

Table 4.40, Illustrates that, Semen sub-city lead the other sub-cities in the amounts of road traffic accidents in the city in all years of the study period. Out of the total 1296 accidents, 482 (37.19%) have occurred in this sub-city from 2007 to 2010 E.C. Kedamay Weyane, Hawelti, Hadinet, Quiha sub-cities contributes 198 (15.28%), 195 (15.05%), 184 (14.20%) and 142(10.96%) of RTAs respectively in the city in the study period. The remaining 63 (4.86%) and 32 (2.47%) road traffic accident incidences have recorded in Adihaki and Ayder sub-cities respectively.

Table 4.40 Spatial distribution of RTAs in Mekele City Sub-Cities (2007-2010 E.C)

Mekele/Sub-City	**Accident Year**				**Total**	**%**
	2007	2008	2009	2010		
Adihaki	11	16	19	17	63	4.86
Ayder	8	10	9	5	32	2.47
Hadinet	40	44	51	49	184	14.20
Hawelti	44	46	57	48	195	15.05
Kedamay Weyane	49	41	55	53	198	15.28
Quiha	35	37	36	34	142	10.96
Semen	111	124	127	120	482	37.19
Total	**298**	**318**	**354**	**326**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

When we compare Semen sub-city and Ayder sub-city based on their RTA occurrences, the RTA incidences in Semen sub-city is about 15.06 times much higher than the RTAs occurrences in Ayder sub-city in the study period. The larger size of the sub-city, the nature of its roads and its function serving as a place of many service areas, almost all garages in the city which used the roads as places of vehicle maintenance are the main reasons for Semen sub-city to be the most susceptible area of frequent road traffic accidents.

4.3.3 Spatial Distribution of Road Traffic Accident Spots in Mekele City

It is well known that, traffic accidents contain a lot of information. Some are to measure the loss from traffic accidents: the number of deaths, serious injuries, minor injuries, economic loss, accident type etc. One is the time of traffic accidents: year-month-day. Others are the key information of traffic accidents: accident location, district number, accident number, etc. Spatial information of traffic accidents is important for traffic safety analysis. However, the spatial information of traffic accidents is generally in Mekele city described as address with text. So they cannot be displayed on a map and analyzed spatially.

Therefore, in order to spatially display the traffic accident spots it is necessary to collect the X and Y co-ordinates of the approximate accident locations by using some well-known reference buildings and different land use types of the city. Thus, the total 1296 road traffic accidents recorded by traffic police from 2007-2010 E.C in the city were happened in a total of 479 spots found in different areas of the city as shown in table 4.41.

Table 4.41 Spatial distribution of RTA spots in Mekele sub cities (2007-2010 E.C)

Sub City	**No. RTA Spots**	**% RTA Spots**
Adihaki	20	4.18
Ayder	12	2.51
Hadinet	66	13.78
Hawelti	74	15.45
Kedamay Weyane	73	15.24
Quiha	38	7.93
Semen	196	40.92
Total	**479**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

As shown in table 4.41, the most road traffic accident spots are expected to found in the semen sub city, which contains 196 (40.92%) spots out of the total spots.

Table 4.42 Spatial distribution of RTA spots in Mekele City (2007-2010 E.C)

Year	Fatal Spots	Serious injury Spots	Slight injury Spots	PDO Spots	Total RTA Spots
2007	29	59	13	6	107
2008	37	65	11	5	118
2009	40	69	10	5	124
2010	41	71	11	7	130
Total	**147**	**264**	**45**	**23**	**479**
% Share	**30.69%**	**55.11%**	**9.39%**	**4.80%**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

As indicated here in table 4.42, out of the total spots 30.69% of them are fatal spots and these spots becomes for 164 fatal victims of drivers, passengers and pedestrians in the study period. Moreover, 55.11% of the spots were recorded as serious injury spots and these spots causes for 499 serious injury road users.

As shown from table 4.43, the distributions of the spots were exactly referenced by their locations of their sub cities and their level of severity. But, the accurate position of some of the spots are difficult to identify instead it is better to use approximate references around their occurrence spaces to take the co-ordinates of the spots.

Table 4.43 Spatial distribution of RTA spots in Mekele City (2007-2010 E.C)

Sub City	Fatal Spots	Serious injury Spots	Slight injury Spots	PDO Spots	Total RTA Spots	% RTA Spots
Adihaki	8	9	2	1	20	4.18
Ayder	4	6	1	1	12	2.51
Hadinet	13	41	9	3	66	13.78
Hawelti	15	45	8	6	74	15.45
Kedamay Weyane	13	48	7	5	73	15.24
Quiha	12	23	2	1	38	7.93
Semen	82	92	16	6	196	40.92
Total	**147**	**264**	**45**	**23**	**479**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

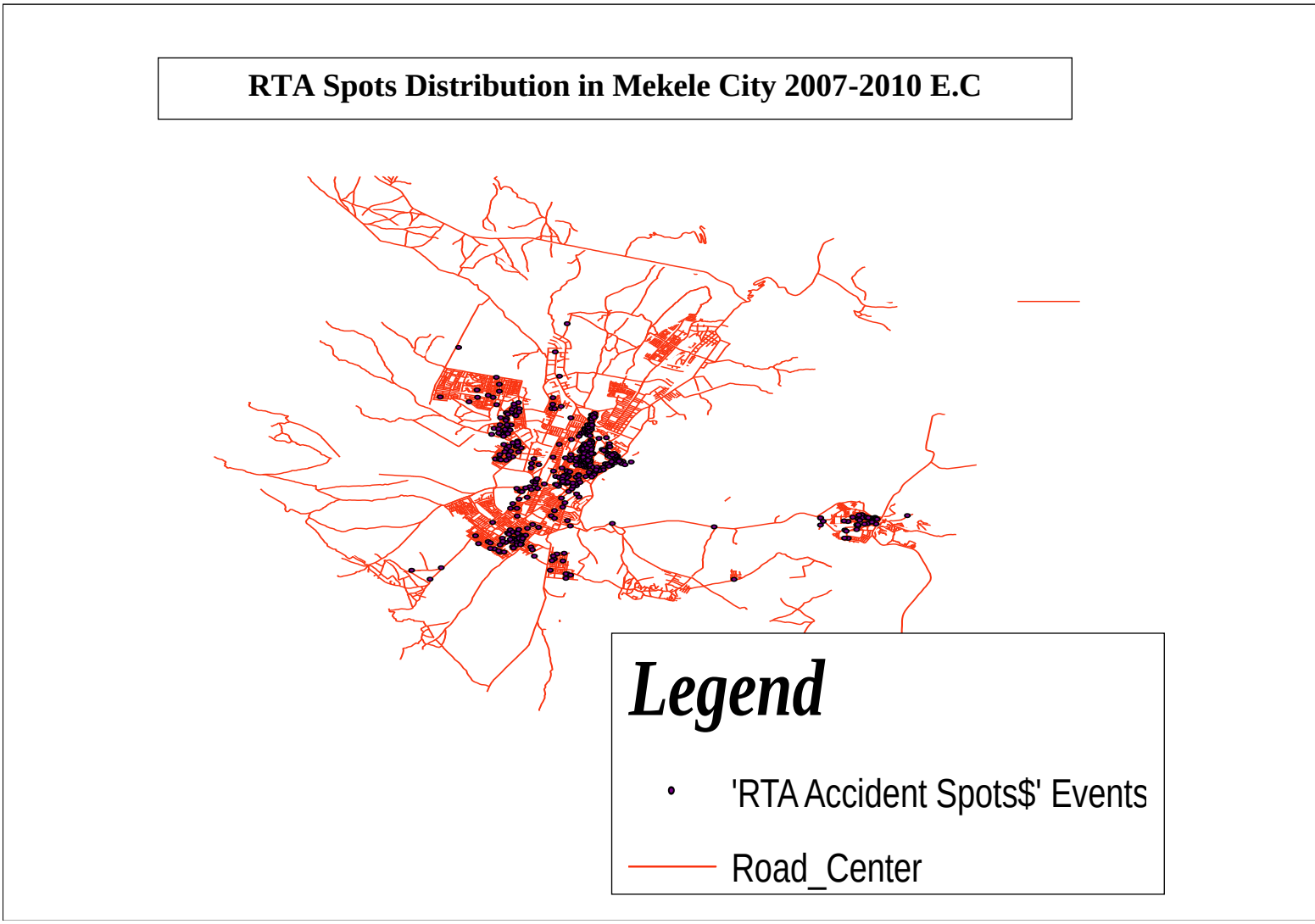


Figure 4.5 RTA Spots distribution in Mekele City (Satellite image: Mekele City Municipal)

4.4 Examine the Trend of Road Traffic Accident in Mekele City

The existence and occurrence of road traffic accidents differ with time as accredited by the variation in the type of transporting vehicles, road divide type, characteristics of roads, weather condition, experience of drivers, level of awareness of road users. The frequencies of occurrence of RTAs in Mekele city also reveal such variations in the previous years due to either of these enumerated reasons. According to Mekele Zone Police Traffic Office (2007) reported, the first five years from 1995/1996 to 1999/2000 E.C shows that only 516 road traffic accidents in the city, these are 92, 72, 119, 111 and 116 in the 1995/1996, 1996/1997, 1997/1998, 1998/1999 and 1999/2000 E.C respectively.

Also, previous study in traffic accident in the city (Kindaya, 2014) revealed that, there have been 288, 342, 322 and 323 road traffic accidents in 2000/2001, 2001/2002, 2002/2003 and 2003/2004 respectively which are a total of 1275 road traffic accidents.

However, according to my findings, there have been 298, 318, 354 and 326 road traffic accidents recoded in 2007, 2008, 2009 and 2010 E.C respectively in the study years from 2007 to 2010 E.C revealed that a total of 1296 road traffic incidences.

As we observed from these data, almost 3087 road traffic accident occurrences have been recorded on the roads of the city from 1995/1996 to 2010 E.C. This means the occurrence of road traffic accidents in the city in the study periods of the last four years from 2007 to 2010 E.C is more than 2.5 times than the reported traffic accidents from 1995/1996 to 1999/2000 E.C and 1.05 times much higher than the RTAs occurred in the previous study from 2000/2001 to 2003/2004 E.C.

Table 4.44 Trend of road traffic accidents in Mekele city (2007-2010 E.C)

Accident Year	**Accident Severity**				**Total RTAs/Year**	**Average/Year**	**%**
	Fatal	Serious	Slight	PDO			
2007	33	106	37	122	298	324	22.99
2008	45	137	28	108	318	324	24.54
2009	43	138	16	157	354	324	27.31
2010	43	118	10	155	326	324	25.15
Total	**164**	**499**	**91**	**542**	**1296**	**1296**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

Accordingly, the road traffic accident incidences of the city , in the study period have shown an increasing trend except in 2010 as total RTAs, but it is still have higher fatal accidents than the its previous years. In the previous studies, the accidents were occurred at an average of 103.2 RTAs have occurred every year in the city between the years 1995/1996 to 1999/2000 E.C, and also an average of 318.75 incidences per year from 2000/2001 to 2003/2004 E.C. Apparently, this average occurrence of RTAs increases to 324 incidences in the study period from 2007 to 2010 E.C. The gradual growth in vehicle and human population movement in the city contributed much to the increasing trend of RTA frequency in Mekele City especially from the year 2007 to 2010 E.C.

4.5 Socio-Economic Impacts of Road Traffic Accidents in Mekele City

4.5.1 Social Impacts of Road Traffic Accidents in Mekele City

4.5.1.1 Drivers, Passengers and Pedestrians Victims of Road Traffic Accident in the City

It is understandable that, the victims are all the road users as being driver, pedestrian or passengers have all implications to the suffering of occurrence to RTA incidents.

Table 4.45 Road Users victims of RTA in Mekele City (2007-2010 E.C).

People Injured	**Accident Year**				**Total**	**%**
	2007	2008	2009	2010		
Drivers	21	26	27	19	93	12.33
Pedestrian	111	101	97	98	407	53.98
Passengers	44	83	73	54	254	33.69
Sum	**176**	**210**	**197**	**171**	**754**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

As Table 4.45 indicates among the road users pedestrians contributes the largest proportion to the total causalities in the society. Therefore, pedestrian produced 407(53.98%) RTAs, which is above half of the total causalities of the road users. In addition to this, passengers and drivers contributes to 254 (33.69%) and 93 (12.33%) RTA causalities in the study period.

Table 4.46 Drivers, Passengers and Pedestrians * RTA severity Cross tabulation

			RTA severity			Total
			fatal	serious	slight	
Road Users	Driver	Count	19	62	12	93
		% within RTA severity	11.6%	12.4%	13.2%	12.33%
		% of Total	2.5%	8.2%	1.6%	12.33%
	Passenger	Count	23	170	61	254
		% within RTA severity	14.0%	34.1%	67.0%	33.69%
		% of Total	3.1%	22.5%	8.1%	33.69%
	Pedestrians	Count	122	267	18	407
		% within RTA severity	74.4%	53.5%	19.8%	53.98%
		% of Total	16.2%	35.4%	2.4%	53.98%
Total		Count	164	499	91	754
		% within RTA severity	100.0%	100.0%	100.0%	100.0%
		% of Total	21.8%	66.2%	12.1%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	81.408[a]	4	.000
Likelihood Ratio	85.022	4	.000
Linear-by-Linear Association	36.484	1	.000
N of Valid Cases	754		

Therefore, from the statistical analysis table above there is significantly high relationship between road users and road traffic accident since p-value =0.000<0.05.

4.5.1.2 Drivers, Passengers and Pedestrians Sex of RTA Victims in Mekele City

It is clear that, the sex of victims as being male or female by itself does not have any effect to the result of incidence to road traffic accidents. However, other human made factors built blocks of differences among sexes incidence to RTAs. The following Table 4.46 portrays the distinction among sexes prevalence to RTA in Mekele City.

Table 4.47 Road Users Sex of RTA Victims in the City (2007-2010 E.C)

	Accident Severity Class	**Accident Year**								**Total**			**%**
		2007		2008		2009		2010					
		M	F	M	F	M	F	M	F	M	F	Total	
Driver	Fatal Injury	4	0	3	0	6	0	6	0	19	0	19	20.43
	Serious Injury	11	1	20	0	18	0	12	0	61	1	62	66.67
	Slight Injury	5	0	3	0	3	0	1	0	12	0	12	12.90
	Total Sum	**20**	**1**	**26**	**0**	**27**	**0**	**19**	**0**	**92**	**1**	**93**	100
Passenger	Fatal Injury	2	0	8	4	4	1	2	2	16	7	23	9.06
	Serious Injury	12	6	34	14	39	19	29	17	114	56	170	66.93
	Slight Injury	19	5	16	7	6	4	2	2	43	18	61	24.02
	Total Sum	**33**	**11**	**58**	**25**	**49**	**24**	**33**	**21**	**173**	**81**	**254**	100
Pedestrian	Fatal Injury	19	8	19	11	22	10	18	15	78	44	122	29.98
	Serious Injury	45	30	45	24	42	20	43	18	175	92	267	65.60
	Slight Injury	7	2	2	0	1	2	3	1	13	5	18	4.42
	Total Sum	**71**	**40**	**66**	**35**	**65**	**32**	**64**	**34**	**266**	**141**	**407**	100
Grand Total		**124**	**52**	**150**	**60**	**141**	**56**	**116**	**55**	**531**	**223**	**754**	

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

Table 4.46 Illustrates that, the number of road users who lost their lives (Fatal Injury), lost either of parts of their body (Serious Injury) and those suffered to slight injury due to RTAs were 164 (drivers fatal (19), passengers fatal (23) and pedestrians fatal (122)), 499 (drivers serious injury (62), passengers serious injury (170) and pedestrians serious injury (267)) and 91(drivers slight injury (12), passengers slight injury (61) and pedestrians slight injury (18)) respectively. The data in the table also indicates that, males are more frequently vulnerable to road traffic accidents than females in the city. Consequently, 531 (70.42%) males and 223 (29.58 %) females were victims of RTAs in the city in the

specified study period. This data indicates that, males are almost 2.38 times more prevalent to RTAs than females in the city.

Table 4.48 Road Users * Sex of RTA victims Cross tabulation

			Sex of RTA victims		Total
			Male	Female	
Road User	Driver	Count	92	1	93
		% within Sex of RTA victims	17.3%	0.4%	12.3%
		% of Total	12.2%	0.1%	12.3%
	Passenger	Count	173	81	254
		% within Sex of RTA victims	32.6%	36.3%	33.7%
		% of Total	22.9%	10.7%	33.7%
	Pedestrians	Count	266	141	407
		% within Sex of RTA victims	50.1%	63.2%	54.0%
		% of Total	35.3%	18.7%	54.0%
Total		Count	531	223	754
		% within Sex of RTA victims	100.0%	100.0%	100.0%
		% of Total	70.42%	29.58%	100.0%

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	41.940[a]	2	.000
Likelihood Ratio	61.412	2	.000
Linear-by-Linear Association	28.847	1	.000
N of Valid Cases	754		

Therefore, from the statistical analysis table above there is significantly high relationship between sex of road users and road traffic accident since p-value =0.000<0.05. Moreover, among the fatal records 113(68.90%) are males and 51(31.10%) females; among the serious injury records 350(70.14 %) are males and 51(29.86 %) females; and among the slight injury records 68(74.73 %) are males and 23(25.27 %) females: which means males are 2.215 times, 2.35 times and 2.96 times much more prevalent than females to fatal accidents, serious injury and slight injury in the city respectively. Therefore, males are more victims of RTAs than females in all accident severity classes and in all years of the study period in Mekele city. Such amount of difference among sexes in their prevalence to RTA

in the city is a manifestation of various factors. Since majority of the drivers are males and are the main sources of economies, they are found to be the most victims of RTAs. This gender based difference in RTAs of Mekele City is similar to the findings of (WHO 2004).

4.5.1.3 Drivers, Passengers and Pedestrians Age of RTA Victims in Mekele City

As clearly shown from the collected data, all age groups may not be equally intricate to road traffic accidents. The duty and profitable role of the age groups in the community could contribute to the causalities of the various age groups. This distribution of road traffic accidents among different age groups has a serious social impact.

Table 4.49 Road users age of RTA victims between the years (2007-2010 E.C)

People Injured	**Age group**	**Accident Year**				**Total**	**%**
		2007	2008	2009	2010		
Drivers	below 18	0	0	0	2	2	2.15
	18-30	9	15	8	11	43	46.24
	31-50	6	9	13	4	32	34.41
	above 51	6	2	6	2	16	17.20
	Sum	**21**	**26**	**27**	**19**	**93**	100
Pedestrian	below 7	10	4	9	6	29	7.13
	7-13	10	11	6	5	32	7.86
	14-17	7	3	10	3	23	5.65
	18-30	28	33	25	35	121	29.73
	31-50	29	22	20	24	95	23.34
	above 51	27	28	27	25	107	26.29
	Sum	**111**	**101**	**97**	**98**	**407**	100
Passengers	below 7	0	2	1	0	3	1.18
	7-13	1	3	1	1	6	2.36
	14-17	0	6	1	1	8	3.15
	18-30	19	36	41	25	121	47.64
	31-50	18	24	24	21	87	34.25
	above 51	6	12	5	6	29	11.42
	Sum	**44**	**83**	**73**	**54**	**254**	100
Total sum		**176**	**210**	**197**	**171**	**754**	

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

Table 4.49 indicates that, road users (drivers, passengers and pedestrians) which are adults found between the age groups of 18-30 and age groups of 31 to 50 for both drivers and passengers are the most prone age groups to RTAs in Mekele City.

Adults between 18-30 years of age group contribute for 285 (43 for drivers, 121 for passenger and 121 for pedestrians crash) which is 37.80% of the total road crashes of road users occurred in the city.

Moreover, the severity rate of RTA in all severity classes is much higher in the age groups of 18 to 30 than the others in the study period in the city (see table 4.50). Children whose age is below 18 years (which means including the under age groups) are also the victims of road traffic accident in the city.

Therefore, the numbers of children who become victims of RTAs in the city in the study years are 103 (13.66%). In addition to this, 152 (20.16%) people whose age is above 50 also suffered from road accidents in the city.

Accordingly, this condition which indicates in the agonies of children under the age of 18 and the productive population between the ages of 18 to 50 drastically affects the wellbeing of the society in the city. This is because; the RTA is concealing the future of children and complicating the life of the adult in the city.

In general from the data obtained, in Mekele city pedestrians are at the top of the traffic accident causality list. Both passengers and pedestrians children with in age group of 18-50 account for 16.05% each, and separately pedestrians causalities covers 53.98% of all casualties.

Table 4.50 RTA victims based on the severity classes in the city (2007-2010 E.C)

	Age Group	Severity Class			Total	% with in Age of Causalities	% by Casualty Group
		Fatal	Serious	Slight			
Drivers	below 18	1	1	1	2	2.15	
	18-30	7	32	4	43	46.24	
	31-50	7	22	3	32	34.41	
	above 51	4	7	5	16	17.20	
Sub-Total		19	62	12	93	100	**12.33**
% Severity with in drivers		**20.43**	**66.67**	**12.90**			
Passengers	below 7	0	1	2	3	1.18	
	7-13	0	4	2	6	2.36	
	14-17	0	7	1	8	3.15	
	18-30	9	79	33	121	47.64	
	31-50	12	60	15	87	34.25	
	above 51	2	19	8	29	11.42	
Sub-Total		23	170	61	254	100	**33.69**
% Severity with in Passengers		**9.06**	**66.93**	**24.02**			
Pedestrians	below 7	8	20	1	29	7.13	
	7-13	9	22	1	32	7.86	
	14-17	3	20	0	23	5.65	
	18-30	32	80	9	121	29.73	
	31-50	33	58	4	95	23.34	
	above 51	37	67	3	107	26.29	
Sub-Total		122	267	18	407	100	**53.98**
% Severity with in Pedestrians		**29.98**	**65.60**	**4.42**			
Grand Total		164	499	91	**754**		
% Severity of All Casualties		**21.75**	**66.18**	**12.07**			

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

The situation of children and adults as being the frequent victims of RTA in Mekele City is found to be similar with the case studied by WHO across the globe. WHO (2004) stated that, over 50% of the global mortality due to road traffic injury occurs among young adults aged between 15 and 44 years, and the rates for this age group are higher in low-income and middle-income countries.

According to the reports of RTAs, in terms of their occupation 35.51%, 29.23% and 27.29% of the victims are workers/employed students and farmer/trade. And the fit and healthy people which are victims of RTA are registered probably up to 93% of the total casualties, as most of the causalities are workers and students.

Table 4.51 Occupation of RTA victims in Mekele city (2007-2010 E.C)

Work	**Accident Year**				**Total**	**%**
	2007	2008	2009	2010		
Student	31	34	27	29	121	29.23
Worker	42	33	31	41	147	35.51
Farmer/Trade	28	29	28	28	113	27.29
Jobless	1	1	1	1	4	0.97
Idler/Insane/Kid	6	4	10	7	27	6.52
Unknown	2	0	0	0	2	0.48
Sum	**110**	**101**	**97**	**106**	**414**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

4.5.2 Economic Impacts of Road Traffic Accident in Mekele City

Road Traffic Accidents have multidimensional influences over the economy of a nation. In addition to the social impacts of RTAs shown above, the city is also suffering huge economic loss from road traffic accidents. Some of the impacts of RTAs have direct economic impacts when it is revealed over a property and have indirect influence when it is exhibited on pedestrians, drivers and/or passengers.

Table 4.52 Estimated cost of RTAs in Mekele City (2007-2010 E.C)

Accident Year	Number of accidents Resulting property damage only	Estimated RTA cost (ETB)	Average cost (ETB	%
2007	122	3,933,225.45	15,012.31	14.86
2008	108	5,790,560.60	20,036.54	21.88
2009	157	7,489,165.85	24,880.95	28.30
2010	155	9,251,683.30	32,123.90	34.96
Total	**542**	**26,464,635.20**	**23,214.59**	**100**

Source: Compiled from Mekele City Traffic Office and Inspection (2010 E.C)

As indicated in table 4.52, the total estimated total cost of RTA in Mekele City from 2007 to 2010 E.C reaches 26,464,635.20 ETB. In the study period, the highest estimated road traffic accident cost has been recorded as 9,251,683.30 (34.96%) ETB in 2010 E.C. While the lowest road traffic accident cost were recorded as 3,933,225.45 (14.86%) ETB in 2007 E.C in the city.

In the years, which is 2008 and 2009 E.C revealed 5,790,560.60 (21.88%) ETB and 7,489,165.85 (28.30%) ETB road traffic accidents cost respectively. This means, the city has lost 26,464,635.20 ETB in the study period of the four years only due to road traffic accidents. Out of 542 road traffic accident to property damages only occurrences in the city in the four years, 1,140 (87.96%) of the accidents have been accompanied with property damages.

Accordingly, every single accident complemented with property damage has led to an average economic loss of 23,214.59 ETB in Mekele City in the study period. The highest frequency of road traffic accidents resulting property damages i.e. 301, have been recorded in 2009 E.C while the lowest which is 262 incidences in 2007 E.C. Mekele city which is yet struggling to fulfill the needs of its inhabitants due to economic constraints is revealing a loss of an average of 6,616,158.80 ETB every year only due to road traffic accidents.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

The above analysis and interpretation showed the RTAs in the city routes or road traffic accidents cannot mitigate at once and for all times. Thus, it needs a continues assessment from time to time by any other researchers as the transportation infrastructure system and the cities master plans improved from time to time. Therefore study has to be made from time to time as the system of urbanization changes and the solution for the problems should be found by applying new systems that can solve it accordingly.

The road traffic accidents are getting worst in the Mekele City. The traffic accident on the city varies according to different factors such as time, driver's condition, the environmental conditions and the vehicles situation and road users. The temporal condition of road traffic accidents indicates us that, there is a significance variation of hourly and daily variations. However, monthly variations are not that much significant.

Moreover, most road traffic accidents occur along dry, good asphalt, two-way lane undivided, roundabouts, Straight and plain. In addition to this, roads with no junctions and +-type (cross-shaped) junctions are the most dangerous, because most of the accidents occurred at these places. Even though there is incidence of taxi traffic accidents in all weather conditions and throughout the day, the intensity of traffic accidents is higher during good weather conditions and day time periods.

The most accidents types were vehicle to pedestrian's collision and most of them were caused by driver's problems. The driver's problem like refusing priority to pedestrians and to other vehicles, over speed, driving too close and failure to respect the right hand drive contributes to 93.68% of the total accidents. Pedestrians also have a big problem while crossing roads and they didn't respect and follow accurate traffic regulations. Thus, 79.85% of the traffic accidents occur while moving pedestrians at roads with no zebra crossings. Similarly the spatial distribution and variation of most of the RTAs are observed along the main roads of the city. Semen sub city is the mostly affected area than the other sub cities. In addition to this, the accidents are spatially varied in different land uses types, such as residential, government offices, commercial areas, around schools and factory areas.

The accidents on the city are causing for almost more than 12.65% deaths, 38.50% serious injuries, 7.02% slight injuries and 41.82% property damages out of the total traffic accidents recorded from 479 RTA spots and it was estimated that the economic loss of 26,464,635.20 ETB. In addition to this, 12.33% injury is on drivers, 53.98% on pedestrians, and 33.69% on passengers that the percentage of the pedestrian and the passengers rated on these roads was 87.67% that indicating the death of the human is mostly put its arm over the passengers and pedestrians.

Generally, road traffic accidents in Mekele city, costs to the country an average estimate about 6,616,158.80 ETB every year annually in study period from 2007-2010 E.C(2014/15-2017/18). Moreover, in social aspect about 58.18 % of the costs were damage to life (fatal, serious and slight injuries), 41.82 % were damage to property only. Therefore, this indicates that there is economically a huge wastage of money and socially harmful in the society. Therefore, it needs serious attention from the city government and its organs and also the society as whole.

In general, this study shows that the frequency and occurrence of RTAs in Mekele City exhibits variations because of the impact of various variables like age and driving experience of drivers, vehicle service year, vehicle category, road divide, road pavement, road moisture condition and weather conditions. Road Traffic Accidents are randomly distributed in the city in terms of time and space. The frequencies of RTAs as well as the socio-economic impacts of RTAs have shown an increasing trend in the study period.

5.2 Recommendations

Based on the basis of the findings of the research study, the following recommendations were drawn.

- Most of the RTAs in city are occurring in the between mid-day to mid-night time especially between 12 AM to 12 pm. Hence, Traffic polices should be assigned in these times and should be given high attention to it. In addition to this, accurate recording and reporting of all types of accidents with in exact severity level, their specific location and their causes should be complete.
- Due to the lack of appropriate land use policy in the city the composition of residential areas, government offices, commercial activities, factories, and other services such as schools has encouraged more traffic accidents. Hence, appropriate implementation of land use policy in the city should be given priority as well as controlling the improper expansion of the city especially in the context of road expansions.

- Awareness about consequence of traffic accident should be provided for the society like as meetings or short-term trainings or through the radio, television, newspapers, and magazines etc. But for the future, it will better if it includes in the school curriculum. This is because most of the traffic accident victims are younger ages and the productive community
- Driver errors are also the main causes of most of the traffic accidents. The young drivers' training and testing should be standardized; a longer minimum time of driving experience should be imposed before a license is issued to a driver. In addition, there should be additional prerequisite criteria for their qualification with regard to their background behavior, free from any addiction and alcoholic drinks, free from any record of criminal acts as well as offending violation of traffic regulations.
- In appropriate use of the roads and sidewalks by services such as Garages, Wood and Metal works, squash and bring down of different load materials and street traders should be controlled effectively. Also parking cars on both or either sides of the road along two-way streets especially in undivided lane in front of offices, hotels, restaurants and large supermarkets can be controlled by introducing sufficient paid parking's.
- The scarcity of traffic signals such as traffic lights and the frequent technical failures of the few presents create confusion around pedestrian crossing areas and at some junctions leading to the incidence of traffic accidents. Therefore, in addition to the maintenance of the existing ones, the expansion of new traffic lights should receive immediate response. In similar manner, road markings should be maintained at all necessary exact locations.
- To effectively control traffic accident, the traffic police should be as long as with the necessary conveniences, together with reasonable salaries in relation to the prevailing current market conditions and they should be paid for the extra time they are on duty even during night times.

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APPENDIXES

APPENDIX A: Road Traffic Accidents Data of Mekele City

Table A1: Tigray Region Zones RTAs from 2002-2010 E.C (Police Commission Report)

Z0NE	Year									Total	%
	2002	2003	2004	2005	2006	2007	2008	2009	2010		
South	196	193	171	149	151	171	180	172	183	1566	16.05
South East	105	127	112	106	128	185	218	210	217	1408	14.43
Mekele	388	371	272	237	186	298	318	354	326	2750	28.18
East	253	201	143	111	107	107	108	113	142	1285	13.17
Central	177	132	81	65	76	62	87	116	109	905	9.27
North West	175	137	102	88	83	100	112	123	126	1046	10.72
West	95	103	97	75	69	86	69	100	105	799	8.19
Total	1389	1264	978	831	800	1009	1092	1188	1208	9759	100

Table A2: Tigray Region Zones RTAs from 2007-2010 E.C (Police Commission Report)

Z0NE	Year				Total	%
	2007	2008	2009	2010		
South	171	180	172	183	706	15.70
South East	185	218	210	217	830	18.46
Mekele	298	318	354	326	1296	28.82
East	107	108	113	142	470	10.45
Central	62	87	116	109	374	8.32
North West	100	112	123	126	461	10.25
West	86	69	100	105	360	8.01
Total	1009	1092	1188	1208	4497	100

Table A3: Total Road Traffic Accidents Occurred in Mekele City (2007-2010 E.C)

Accident Year	Total RTA	%
2007	298	22.99
2008	318	24.54
2009	354	27.31
2010	326	25.15
Sum	**1296**	**100**

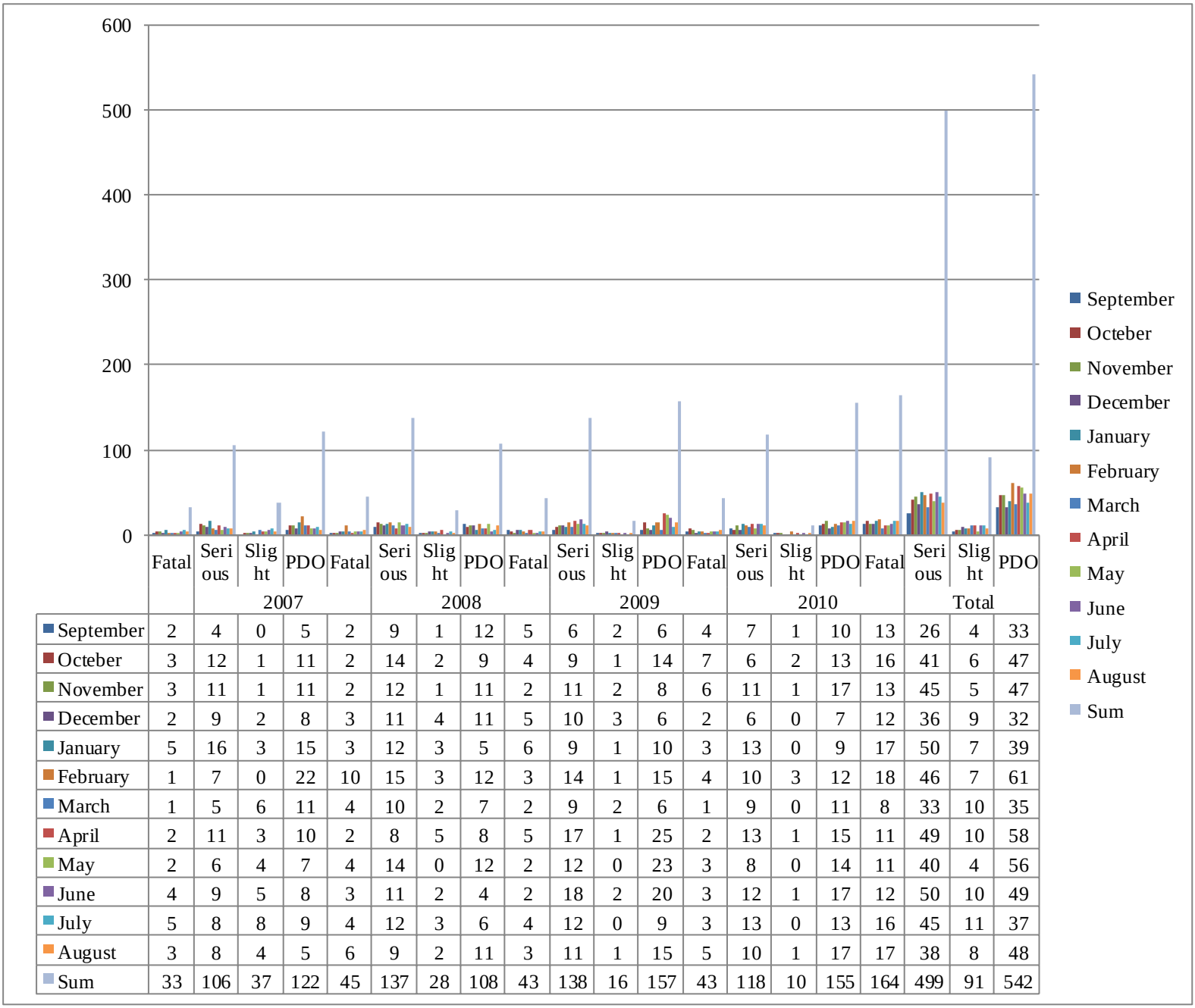
Table A4: Monthly variation of road traffic accidents in the years.

Months	2007				2008				2009				2010				Total			
	Fata	Seri	Sli	PDO	Fat	Seri	Sli	PDO	Fat	Seri	Sli	PDO	Fat	Seri	Sli	PDO	Fat	Seri	Sli	PDO
September	2	4	0	5	2	9	1	12	5	6	2	6	4	7	1	10	13	26	4	33
October	3	12	1	11	2	14	2	9	4	9	1	14	7	6	2	13	16	41	6	47
November	3	11	1	11	2	12	1	11	2	11	2	8	6	11	1	17	13	45	5	47
December	2	9	2	8	3	11	4	11	5	10	3	6	2	6	0	7	12	36	9	32
January	5	16	3	15	3	12	3	5	6	9	1	10	3	13	0	9	17	50	7	39
February	1	7	0	22	10	15	3	12	3	14	1	15	4	10	3	12	18	46	7	61
March	1	5	6	11	4	10	2	7	2	9	2	6	1	9	0	11	8	33	10	35
April	2	11	3	10	2	8	5	8	5	17	1	25	2	13	1	15	11	49	10	58
May	2	6	4	7	4	14	0	12	2	12	0	23	3	8	0	14	11	40	4	56
June	4	9	5	8	3	11	2	4	2	18	2	20	3	12	1	17	12	50	10	49
July	5	8	8	9	4	12	3	6	4	12	0	9	3	13	0	13	16	45	11	37
August	3	8	4	5	6	9	2	11	3	11	1	15	5	10	1	17	17	38	8	48
Sum	33	106	37	122	45	137	28	108	43	138	16	157	43	118	10	155	164	499	91	542

Table A5: Hourly variation of traffic accidents in a day.

Hours of Day	Accident Year				Total	%
	2007	2008	2009	2010		
01:00 - 02:00	0	0	0	0	0	0
02:00 - 03:00	0	0	0	0	0	0
03:00 - 04:00	1	0	0	0	1	0.08
04:00 - 05:00	0	0	0	0	0	0
05:00 - 06:00	1	0	0	1	2	0.15
06:00 - 07:00	8	5	7	9	29	2.24
07:00 - 08:00	26	18	20	21	85	6.56
08:00 - 09:00	40	38	32	33	143	11.03
09:00 - 10:00	19	21	27	30	97	7.48
10:00 - 11:00	12	22	21	20	75	5.79
11:00 - 12:00	16	20	22	24	82	6.33
12:00 - 13:00	28	26	28	21	103	7.95
13:00 - 14:00	32	35	35	36	138	10.65
14:00 - 15:00	20	25	28	17	90	6.94
15:00 - 16:00	26	28	27	28	109	8.41
16:00 - 17:00	27	22	28	28	105	8.10
17:00 - 18:00	11	12	11	13	47	3.63
18:00 - 19:00	1	2	0	4	7	0.54
19:00 - 20:00	6	13	14	7	40	3.09
20:00 - 21:00	13	12	19	13	57	4.40
21:00 - 22:00	6	16	19	12	53	4.09
22:00 - 23:00	5	3	12	8	28	2.16
23:00 - 24:00	0	0	4	1	5	0.39
24:00 -01: 00	0	0	0	0	0	0
Sum	298	318	354	326	1296	100.00

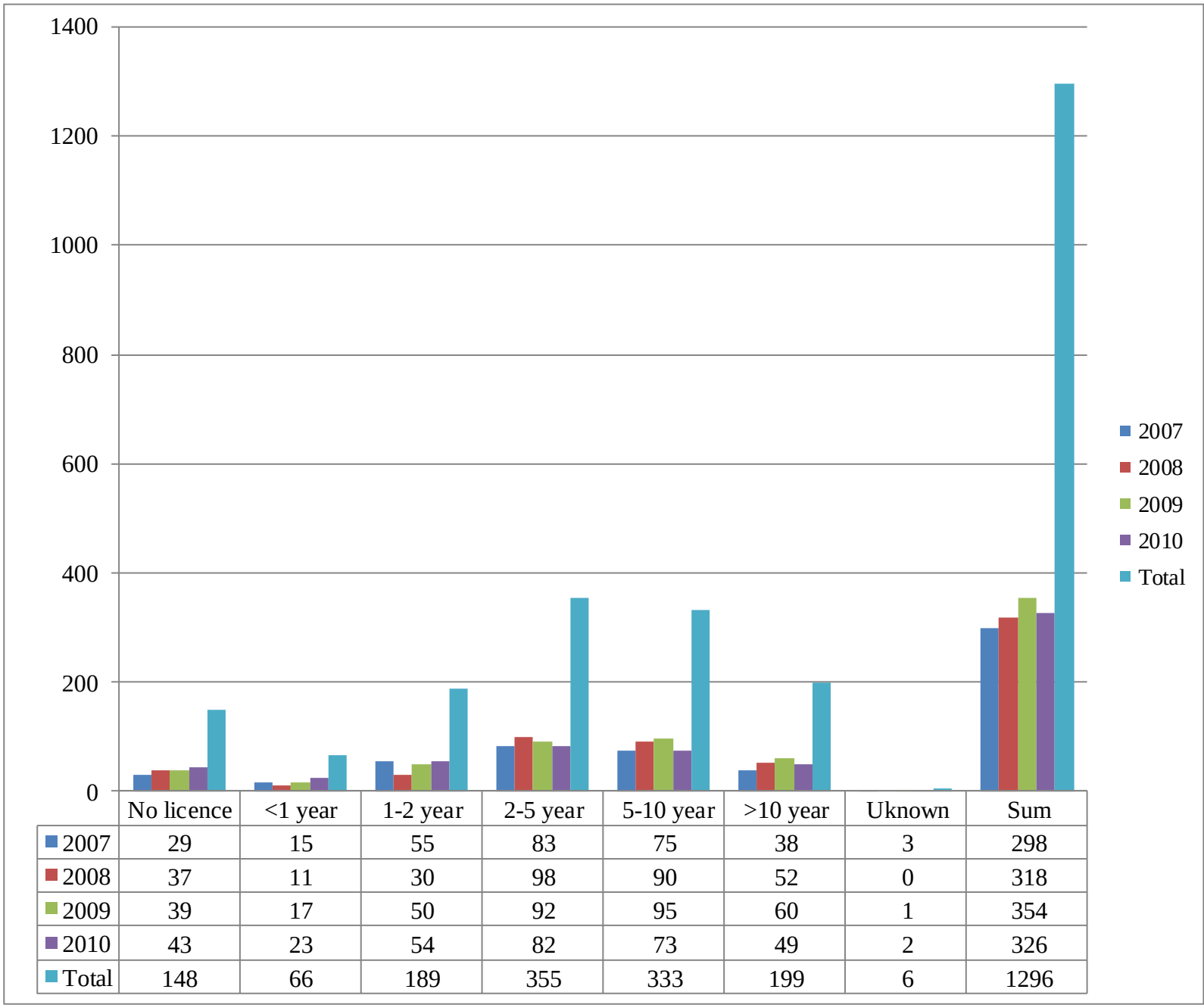
Table A6: Monthly variation of road traffic accidents in the years from 2007-2010 E.C (2014/15-2017/2018)



	2007					2008				2009				2010				Total		
	Fatal	Serious	Slight	PDO	Fatal	Serious	Slight	PDO	Fatal	Serious	Slight	PDO	Fatal	Serious	Slight	PDO	Fatal	Serious	Slight	PDO
September	2	4	0	5	2	9	1	12	5	6	2	6	4	7	1	10	13	26	4	33
Octeber	3	12	1	11	2	14	2	9	4	9	1	14	7	6	2	13	16	41	6	47
November	3	11	1	11	2	12	1	11	2	11	2	8	6	11	1	17	13	45	5	47
December	2	9	2	8	3	11	4	11	5	10	3	6	2	6	0	7	12	36	9	32
January	5	16	3	15	3	12	3	5	6	9	1	10	3	13	0	9	17	50	7	39
February	1	7	0	22	10	15	3	12	3	14	1	15	4	10	3	12	18	46	7	61
March	1	5	6	11	4	10	2	7	2	9	2	6	1	9	0	11	8	33	10	35
April	2	11	3	10	2	8	5	8	5	17	1	25	2	13	1	15	11	49	10	58
May	2	6	4	7	4	14	0	12	2	12	0	23	3	8	0	14	11	40	4	56
June	4	9	5	8	3	11	2	4	2	18	2	20	3	12	1	17	12	50	10	49
July	5	8	8	9	4	12	3	6	4	12	0	9	3	13	0	13	16	45	11	37
August	3	8	4	5	6	9	2	11	3	11	1	15	5	10	1	17	17	38	8	48
Sum	33	106	37	122	45	137	28	108	43	138	16	157	43	118	10	155	164	499	91	542

APPENDIX B: RTA Variations based on drivers & vehicles situation in Mekele City (2007-2010 E.C)

Table B1: Variation of Road Traffic Accident in the city based Drivers' Driving Experience from 2007-2010 E.C



	No licence	<1 year	1-2 year	2-5 year	5-10 year	>10 year	Uknown	Sum
2007	29	15	55	83	75	38	3	298
2008	37	11	30	98	90	52	0	318
2009	39	17	50	92	95	60	1	354
2010	43	23	54	82	73	49	2	326
Total	148	66	189	355	333	199	6	1296

Table B2: RTAs % severity variations (2007-2010 E.C)

Accident Year	Accident Severity				Total	%
	Fatal	Serious	Slight	PDO		
2007	33	106	37	122	298	22.99
2008	45	137	28	108	318	24.54
2009	43	138	16	157	354	27.31
2010	43	118	10	155	326	25.15
Sum	164	499	91	542	1296	100
%	**12.65**	**38.50**	**7.02**	**41.82**	**100**	

Table B3: RTA severity variations and %share based on drivers experience (2007-2010 E.C)

Experience in years	RTA Severity								Total	%
	Fatal	%Share	Serious	%Share	Slight	%Share	PDO	%Share		
No license	29	17.68	70	14.03	6	6.59	42	7.74908	147	11.34
<1 year	8	4.88	23	4.61	5	5.49	30	5.53506	66	5.09
1-2 year	25	15.24	69	13.83	17	18.68	78	14.3911	189	14.58
2-5 year	46	28.05	146	29.26	32	35.16	131	24.1697	355	27.39
5-10 year	46	28.05	114	22.85	20	21.98	155	28.5978	335	25.85
>10 year	5	3.05	76	15.23	11	12.09	106	19.5572	198	15.28
Unknown	5	3.05	1	0.20	0	0	0	0	6	0.46
Sum	**164**	**100**	**499**	**100**	**91**	**100**	**542**	**100**	**1296**	**100**

Table B4: RTA severity variations and %share based on drivers age (2007-2010 E.C)

Age of Drivers	RTA Severity								Total	%
	Fatal	%Share	Serious	%Share	Slight	%Share	PDO	%Share		
< 18	1	0.61	2	0.40	0	0	1	0.18	4	0.31
18-30	82	50	235	47.09	48	52.7473	277	51.11	642	49.54
31-50	69	42.07	177	35.47	31	34.0659	167	30.81	444	34.26
> 51	7	4.27	84	16.83	12	13.1868	97	17.90	200	15.43
Unknown	5	3.05	1	0.20	0	0	0	0	6	0.46
Sum	**164**	**100**	**499**	**100**	**91**	**100**	**542**	**100**	**1296**	**100**

Table B5: Variation of RTAs Severities based on driver's sex in Mekele City (2007-2010)

Sex	**RTA Severity**								**Total**	**%**
	Fatal	%Share	Serious	%Share	Slight	%Share	PDO	%Share		
Male	159	96.95	490	98.20	80	87.91	532	98.15	1261	97.30
Female	4	2.44	8	1.60	9	9.89	8	1.48	29	2.24
Unknown	1	0.61	1	0.20	2	2.20	2	0.37	6	0.46
Sum	**164**	**100**	**499**	**100**	**91**	**100**	**542**	**100**	**1296**	**100**

Table B6: Variation of RTA severities based on driver's driving experience in Mekele City (2007-2010)

Experience in years	**RTA Severity**								**Total**	**%**
	Fatal	%Share	Serious	%Share	Slight	%Share	PDO	%Share		
No license	29	17.68	70	14.03	6	6.59	42	7.75	147	11.34
<1 year	8	4.88	23	4.61	5	5.49	30	5.54	66	5.09
1-2 year	25	15.24	69	13.83	17	18.68	78	14.39	189	14.58
2-5 year	46	28.05	146	29.26	32	35.16	131	24.17	355	27.39
5-10 year	46	28.05	114	22.85	20	21.98	155	28.60	335	25.85
>10 year	5	3.05	76	15.23	11	12.09	106	19.56	198	15.28
Unknown	5	3.05	1	0.20	0	0	0	0	6	0.46
Sum	**164**	**100**	**499**	**100**	**91**	**100**	**542**	**100**	**1296**	**100**

Table B7: Variation of RTAs Severity class based on drivers and vehicles relationship (2007-2010 E.C)

Relation Ship	**RTA Severity**								**Total**	**%**
	Fatal	%Share	Serious	%Share	Slight	%Share	PDO	%Share		
Owner	25	15.24	87	17.43	20	21.98	58	10.70	190	14.66
Hired	130	79.27	406	81.36	69	75.82	481	88.75	1086	83.80
Other	5	3.05	5	1.00	2	2.20	3	0.55	15	1.16
Unknown	4	2.44	1	0.20	0	0.00	0	0	5	0.39
Sum	**164**	**100**	**499**	**100**	**91**	**100**	**542**	**100**	**1296**	**100**

Table B8: Variation of RTAs Severity class based on vehicle types (2007-2010 E.C)

Vehicle Types	RTA Severity								Total	%
	Fatal	%Share	Serious	%Share	Slight	%Share	PDO	%Share		
Bicycle	5	3.05	14	2.81	1	1.10	1	0.18	21	1.62
Motor cycle	7	4.27	20	4.01	2	2.20	2	0.37	31	2.39
Bajaj	8	4.88	28	5.61	14	15.38	18	3.32	68	5.25
Automobile	4	2.44	29	5.81	8	8.79	44	8.12	85	6.56
Land cruiser/ Station Wagon	15	9.15	54	10.82	12	13.19	71	13.10	152	11.73
Pick up	18	10.98	61	12.22	10	10.99	59	10.89	148	11.42
Isuzu(npr)	9	5.49	27	5.41	5	5.49	28	5.17	69	5.32
Isuzu(fsr)	31	18.90	67	13.43	15	16.48	102	18.82	215	16.59
Lorry	2	1.22	4	0.80	2	2.20	23	4.24	31	2.39
Taxi	17	10.37	60	12.02	6	6.59	30	5.54	113	8.72
Minibus(Upto12 Seat)	18	10.98	36	7.21	5	5.49	48	8.86	107	8.26
Bus	7	4.27	21	4.21	4	4.40	48	8.86	80	6.17
Cart	2	1.22	9	1.80	2	2.20	16	2.95	29	2.24
Other	16	9.76	68	13.63	5	5.49	52	9.59	141	10.88
Unknown	5	3.05	1	0.20	0	0	0	0	6	0.46
Sum	164	100	499	100	91	100	542	100	1296	100

APPENDIX C: Crash types and their in Mekele City (2007-2010 E.C)

Table C1: Level of severity of crash types and %share among them (2007-2010 E.C)

Crash Type	RTA Severity								Total	%
	Fatal	%Share	Serious	%Share	Slight	%Share	PDO	%Share		
Head to head	4	2.44	39	7.82	13	14.29	77	14.21	133	10.26
Rear-End	9	5.49	57	11.42	26	28.57	145	26.75	237	18.29
T-Bone	13	7.93	79	15.83	25	27.47	131	24.17	248	19.14
Side-Swipe	0	0	1	0.20	2	2.20	18	3.32	21	1.62
Rollover	10	6.10	26	5.21	9	9.89	49	9.04	94	7.25
Collision with Pedestrians	123	75	275	55.11	11	12.09	0	0	409	31.56
Collision with Animals	0	0	0	0	0	0	10	1.85	10	0.77
Fall from Vehicles	1	0.61	9	1.80	0	0	1	0.18	11	0.85
Collision with road side parked vehicles	3	1.83	1	0.20	0	0	4	0.74	8	0.62
Collision with fixed objects	1	0.61	12	2.40	5	5.49	107	19.74	125	9.65
Others	0	0	0	0	0	0	0	0	0	0
Sum	**164**	**100**	**499**	**100**	**91**	**100**	**542**	**100**	**1296**	**100**

APPENDIX D: Spatial Distribution of RTA spots in Mekele City (2007-2010 E.C)

Table D1: Spatial distribution of Road Traffic Accident Spots in Mekele Sub-Cities (2007-2010 E.C)

Year	**Sub City**	No. RTA Spots	No. RTAs Occurred	% RTA Spots	% No. RTAs Occurred
2007 E.C	Adihaki	4	11	3.74	3.69
	Ayder	3	8	2.80	2.68
	Hadinet	10	40	9.35	13.42
	Hawelti	14	44	13.08	14.77
	Kedamay Weyane	19	49	17.76	16.44
	Quiha	11	35	10.28	11.74
	Semen	46	111	42.99	37.25
Total		**107**	**298**	**100**	**100**
2008 E.C	Adihaki	5	16	4.24	5.03
	Ayder	4	10	3.39	3.14
	Hadinet	12	44	10.17	13.84
	Hawelti	21	46	17.80	14.47
	Kedamay Weyane	17	41	14.41	12.89
	Quiha	9	37	7.63	11.64
	Semen	50	124	42.37	38.99
Total		**118**	**318**	**100**	**100**
2009 E.C	Adihaki	6	19	4.84	5.37
	Ayder	3	9	2.42	2.54
	Hadinet	21	51	16.94	14.41
	Hawelti	20	57	16.13	16.10
	Kedamay Weyane	17	55	13.71	15.54
	Quiha	8	36	6.45	10.17
	Semen	49	127	39.52	35.88
Total		**124**	**354**	**100**	**100**
2010 E.C	Adihaki	5	17	3.85	5.21
	Ayder	2	5	1.54	1.53
	Hadinet	23	49	17.69	15.03
	Hawelti	19	48	14.62	14.72
	Kedamay Weyane	20	53	15.38	16.26
	Quiha	10	34	7.69	10.43
	Semen	51	120	39.23	36.81
Total		**130**	**326**	**100**	**100**
Grand Total		**479**	**1296**		

Table D2: Summary of Spatial distribution of RTA Spots in Mekele Sub-Cities (2007-2010 E.C)

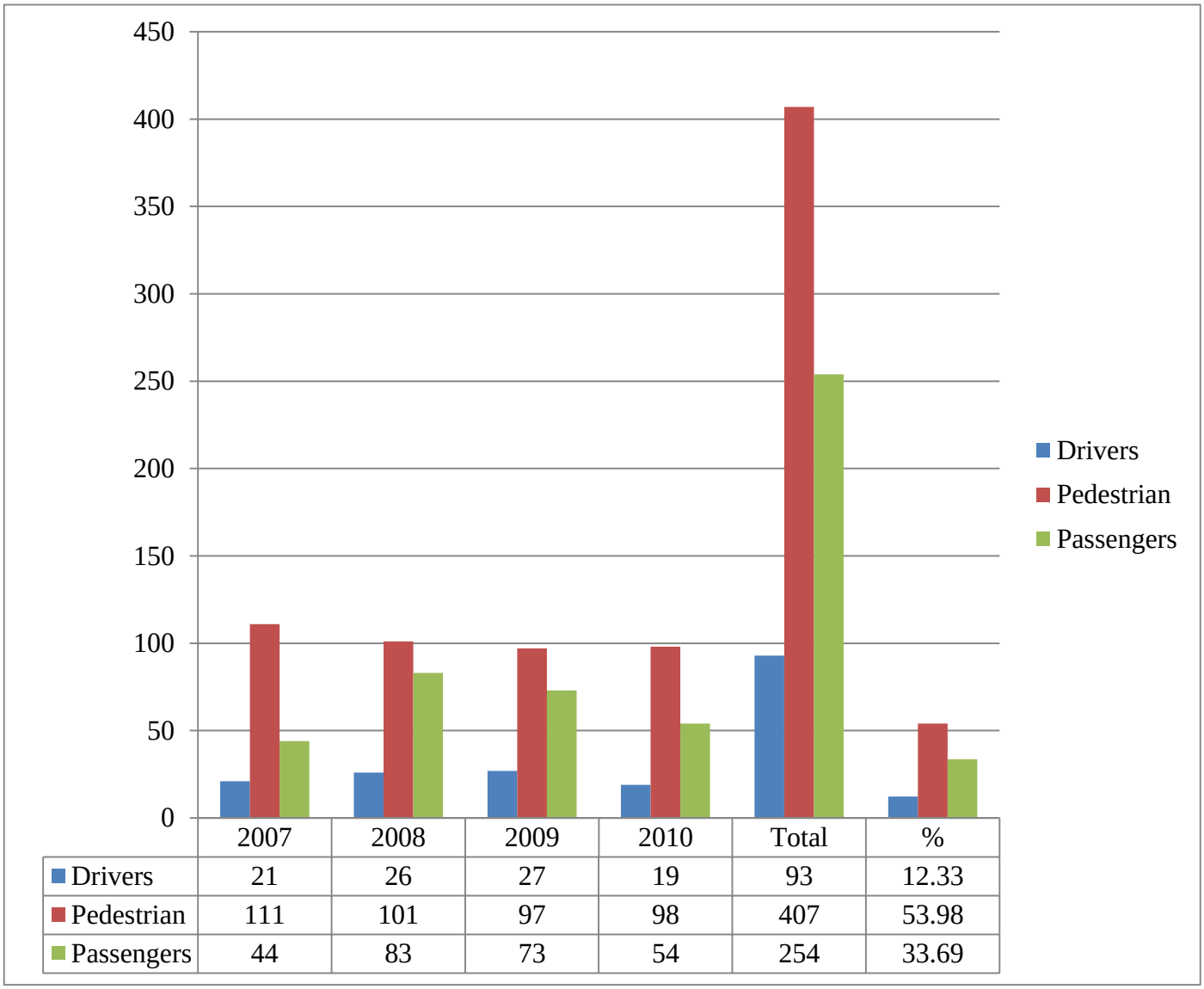
Sub City	No. RTA Spots	% RTA Spots
Adihaki	20	4.18
Ayder	12	2.51
Hadinet	66	13.78
Hawelti	74	15.45
Kedamay Weyane	73	15.24
Quiha	38	7.93
Semen	**196**	**40.92**
Total	**479**	**100**

Table D3: RTA Spots and their consequences to RTA severities in Mekele City (2007-2010 E.C)

Year	RTA Spots	Victims of fatal	Serious Injury	Slight Injury	POD	Total
2007	29	33	106	37	122	298
2008	37	45	137	28	108	318
2009	40	43	138	16	157	354
2010	41	43	118	10	155	326
Total	**147**	**164**	**499**	**91**	**542**	**1296**

APPENDIX E: Road Users RTA victims in Mekele City

Table E1: Drivers, Passengers and Pedestrians of RTA victims in Mekele City (2007-2010 E.C)



	2007	2008	2009	2010	Total	%
Drivers	21	26	27	19	93	12.33
Pedestrian	111	101	97	98	407	53.98
Passengers	44	83	73	54	254	33.69

APPENDIX F: RTA Spot Locations (X, Y Coordinates)

Table F1: Approximate Spot Locations (X, Y Coordinates) of RTA Spots in the City

ADI-HAQI Spots				
X	Y		X	Y
549,877.764	1,490,995.575		549,596.114	1,490,547.315
550,083.052	1,490,940.038		549,440.413	1,490,388.143
549,922.392	1,490,895.906		549,546.032	1,490,221.037
549,774.625	1,490,958.385		549,376.446	1,490,218.557
549,630.824	1,490,841.857		549,552.974	1,489,932.444
549,538.098	1,490,936.567		548,914.302	1,489,711.785
549,679.915	1,490,824.502		548,467.529	1,489,223.360
549,815.285	1,490,616.735		548,547.859	1,488,941.710
547,282.910	1,487,652.960		548,797.278	1,489,012.122
546,807.875	1,487,975.768		547,577.455	1,488,064.032

QUIHA Spots				
X	Y		X	Y
557,455.554	1,489,861.410		558,121.780	1,489,394.695
558,166.095	1,489,743.717		558,392.824	1,489,453.230
558,434.875	1,489,832.945		558,423.364	1,489,626.291
558,425.569	1,489,577.851		558,787.301	1,489,721.093
558,390.534	1,489,618.907		558,720.495	1,489,848.344
558,684.494	1,489,670.363		558,063.881	1,489,759.905
558,666.977	1,489,859.221		558,471.720	1,489,784.719
558,895.795	1,489,651.204		558,289.751	1,489,897.335
558,562.533	1,489,948.458		558,528.346	1,489,989.592
558,780.755	1,489,825.080		558,559.523	1,489,885.883
558,832.236	1,489,838.272		558,898.414	1,489,858.925
558,872.559	1,489,891.406		558,922.899	1,489,824.163
558,591.667	1,489,653.976		558,744.857	1,489,875.852
554,680.985	1,489,544.851		558,653.570	1,489,901.546
557,446.715	1,489,873.158		558,700.423	1,489,875.248
557,519.248	1,489,745.900		558,454.671	1,489,977.115
557,446.715	1,489,612.294		559,710.935	1,489,955.049
558,086.150	1,489,432.234		558,173.554	1,489,134.669
558,079.562	1,489,138.012		555,200.741	1,487,644.729

AYDER Spots	
X	Y
550,648.83	1,492,536.22
550,966.68	1,492,708.78
550,947.84	1,493,493.73
550,452.97	1,493,828.94
548,027.76	1,496,038.46
550,479.25	1,493,981.17
550,531.31	1,493,820.51
550,700.90	1,493,907.78
550,482.72	1,494,220.67
550,655.28	1,494,998.18
550,543.71	1,495,875.86
550,854.40	1,496,896.92

HADNET Spots				
X	Y		X	Y
550,625.496	1,491,013.271		549,912.350	1,488,816.580
550,894.627	1,490,828.557		549,438.440	1,489,134.170
550,706.569	1,490,588.679		549,656.400	1,489,240.400
551,163.710	1,490,626.883		549,163.230	1,489,134.170
550,797.351	1,490,417.996		549,303.030	1,489,324.070
550,740.284	1,490,262.407		549,343.770	1,489,284.990
550,521.168	1,490,132.930		549,374.030	1,489,435.970
550,440.681	1,489,949.346		549,447.140	1,489,362.860
550,525.205	1,489,857.823		549,539.410	1,489,335.440
550,861.147	1,489,775.722		549,592.770	1,489,452.470
550,938.134	1,489,581.909		549,605.440	1,489,269.110
550,855.972	1,487,844.840		549,604.850	1,489,190.690
550,519.623	1,488,383.831		549,775.250	1,489,240.810
549,524.300	1,489,126.800		549,698.890	1,489,159.740
549,433.990	1,488,820.570		549,597.780	1,489,120.830
549,656.410	1,488,911.100		549,669.710	1,489,049.190
550,743.060	1,488,310.740		549,493.420	1,489,051.550
550,461.390	1,488,323.220		549,569.180	1,488,988.170
550,414.440	1,487,976.170		549,542.060	1,488,963.990
550,823.290	1,487,847.810		549,418.840	1,489,025.020
550,942.730	1,487,803.240		549,556.510	1,488,892.650
550,821.940	1,487,683.520		549,636.400	1,488,906.510
550,588.270	1,488,567.790		549,459.220	1,488,782.400
550,490.290	1,488,496.780		549,100.750	1,488,632.930
550,774.310	1,488,592.000		548,956.380	1,488,755.350
549,254.450	1,488,985.820		549,065.900	1,488,681.280
549,182.120	1,489,023.720		549,209.510	1,488,635.830
549,411.680	1,489,125.720		549,945.740	1,488,721.720
549,371.400	1,489,097.350		549,998.920	1,488,487.220
549,565.230	1,489,311.540		548,858.210	1,488,964.410
549,821.220	1,489,493.670		548,855.530	1,488,767.730
549,953.320	1,489,634.440		549,106.750	1,488,893.560
550,110.550	1,489,528.970		549,695.170	1,489,128.320

HAWELTI Spots				
X	Y		X	Y
549,036.402	1,492,007.513		549,332.053	1,492,021.308
549,276.145	1,492,375.029		549,124.365	1,491,972.081
549,984.093	1,492,012.126		549,269.172	1,491,962.020
549,585.185	1,492,257.787		549,101.728	1,492,162.162
549,528.066	1,492,456.080		549,332.053	1,492,141.321
549,212.283	1,492,951.580		549,539.741	1,492,462.914
549,369.245	1,493,053.745		549,572.080	1,492,501.721
549,389.678	1,493,233.462		549,563.097	1,492,606.642
549,106.403	1,493,240.428		549,171.077	1,492,923.205
549,612.584	1,493,819.982		549,310.494	1,492,914.222
549,583.328	1,494,041.030		549,137.301	1,492,901.645
549,088.292	1,494,457.121		549,071.186	1,492,942.608
547,551.199	1,494,247.220		549,235.036	1,493,079.509
550,026.262	1,491,088.869		549,069.030	1,493,092.086
549,959.428	1,491,183.730		549,293.965	1,493,194.492
548,888.940	1,492,896.390		549,288.934	1,493,248.390
549,438.359	1,492,085.065		549,118.975	1,493,497.759
549,202.008	1,492,528.659		549,277.077	1,493,462.546
549,558.591	1,492,652.687		549,254.799	1,493,401.461
549,107.162	1,492,907.447		549,267.016	1,493,673.108
548,955.701	1,493,111.555		549,396.371	1,493,690.715
550,259.461	1,491,098.930		549,493.029	1,493,604.478
550,032.730	1,491,185.526		549,524.649	1,493,569.983
550,053.570	1,491,257.031		549,599.747	1,493,703.651
550,069.380	1,491,284.340		549,422.243	1,493,801.745
549,913.435	1,491,681.031		549,475.781	1,493,907.745
549,929.604	1,491,840.929		549,472.907	1,493,988.233
550,113.577	1,491,796.373		548,520.346	1,494,238.680
549,659.754	1,492,404.344		548,302.597	1,494,074.111
549,569.564	1,492,567.836		549,009.382	1,494,959.120
549,573.876	1,492,596.941		549,086.636	1,494,710.828
549,447.036	1,492,589.395		548,508.488	1,494,501.703
549,339.239	1,492,466.507		548,798.101	1,494,304.077
549,232.521	1,492,264.209		548,926.020	1,494,235.806
549,386.670	1,492,284.331		549,019.084	1,493,970.267
548,984.589	1,492,002.982		549,305.104	1,493,627.115
549,088.792	1,492,008.732		549,201.619	1,492,826.547

KEDAMAY WEYANE Spots				
X	Y		X	Y
551,011.040	1,491,031.654		550,576.224	1,491,074.429
550,723.651	1,491,150.930		550,646.534	1,491,339.400
550,556.947	1,491,369.758		550,785.604	1,491,414.940
551,944.582	1,491,741.672		550,844.680	1,491,569.118
551,749.233	1,491,605.492		550,720.137	1,491,674.487
551,136.823	1,491,963.988		550,495.454	1,491,562.726
551,068.874	1,491,941.514		550,751.515	1,491,374.845
551,216.670	1,491,886.521		550,737.763	1,491,208.658
551,198.691	1,491,771.245		550,727.497	1,491,268.702
551,300.482	1,491,721.010		550,740.862	1,491,188.707
551,281.446	1,491,788.166		550,874.122	1,491,161.978
551,354.683	1,491,776.269		551,004.476	1,491,133.699
551,368.431	1,491,697.744		550,923.707	1,491,538.709
551,410.999	1,491,731.057		551,425.950	1,491,526.893
551,449.071	1,491,728.678		551,559.984	1,491,437.020
551,461.498	1,491,775.475		551,494.710	1,491,359.931
551,532.620	1,491,701.445		551,611.506	1,491,607.663
551,629.123	1,491,700.917		550,483.842	1,492,066.463
551,760.262	1,491,678.972		550,811.479	1,492,040.716
551,773.217	1,491,630.324		550,934.423	1,491,955.105
551,790.667	1,491,693.249		551,099.850	1,492,022.692
551,798.599	1,491,610.494		551,093.413	1,491,776.161
551,689.933	1,491,582.733		551,159.069	1,491,404.110
551,586.027	1,491,517.957		551,193.184	1,491,155.647
551,551.127	1,491,532.498		552,028.00	1,489,669.43
551,561.703	1,491,497.070		551,100.72	1,490,736.79
551,454.888	1,491,456.353		550,978.12	1,490,927.65
551,452.508	1,491,480.413		551,090.44	1,491,035.19
551,339.877	1,491,373.598		550,840.11	1,491,120.71
551,148.985	1,491,433.615		551,083.10	1,491,113.01
551,084.209	1,491,354.297		551,152.47	1,491,258.36
550,893.053	1,491,380.208		550,550.15	1,491,088.78
550,849.428	1,491,333.410		550,659.16	1,491,334.70
550,796.814	1,491,163.406		550,850.76	1,491,572.55
550,813.999	1,491,147.278		550,997.21	1,492,028.41
550,727.715	1,491,266.337		550,953.16	1,492,161.28
551,145.49	1,492,020.71			

SEMEN Spots					
	Y	X	Y	X	Y
551254.060	1491911.721	551,276.025	1,492,060.763	551347.648	1492510.494
551320.345	1491901.035	551,352.454	1,491,969.414	551428.068	1492535.542
551394.599	1491899.768	551,396.427	1,491,955.803	551449.601	1492503.023
551396.048	1491949.029	551,401.139	1,492,142.689	551429.606	1492541.914
551349.141	1491969.132	551,484.374	1,492,197.917	551464.542	1492499.727
551324.329	1492015.857	551,320.783	1,492,331.146	551351.062	1492405.834
551238.484	1492031.432	551,478.615	1,492,346.065	551269.346	1492445.229
551174.373	1492082.142	551,274.454	1,492,376.166	551360.967	1492456.934
551258.768	1492101.340	551,375.226	1,492,397.367	551416.794	1492487.325
551289.557	1492061.858	551,432.287	1,492,577.971	551490.856	1492440.051
551283.580	1492120.899	552,011.791	1,491,908.689	551485.228	1492546.979
551315.636	1492121.624	551,967.818	1,492,083.535	551297.485	1492553.057
551366.889	1492116.553	552,085.341	1,492,197.394	551467.670	1492671.241
551301.147	1492002.636	552,207.053	1,491,921.252	551488.830	1492631.621
551256.233	1491979.998	552,031.160	1,492,147.924	551499.861	1492588.850
551318.715	1491906.469	551,807.106	1,492,318.320	551162.643	1492822.966
551393.512	1491901.579	552089.075	1491885.662	551220.722	1492939.575
551393.331	1491944.682	552113.500	1491874.590	551286.680	1492968.389
551393.512	1491964.423	552239.855	1491892.826	551349.486	1492982.346
551346.062	1491973.840	552134.668	1491944.280	551381.902	1492877.669
551369.063	1492032.881	552104.707	1491996.711	551405.989	1492962.311
551386.992	1492107.497	552199.473	1491959.261	551451.011	1492843.902
551288.108	1492116.553	552257.115	1491924.741	551679.410	1492745.528
551326.865	1492123.797	552260.697	1491852.770	551307.975	1493106.608
551326.865	1492123.797	552300.102	1491894.780	551325.984	1493072.165
551372.685	1492060.772	552308.670	1491905.853	551383.613	1493074.191
551257.320	1492088.843	552132.457	1492020.682	551424.358	1493012.061
551324.329	1492124.159	552165.794	1492102.439	551432.912	1493012.286
551376.850	1492115.104	552128.753	1491978.878	551490.316	1493080.720
551352.763	1492187.547	552066.046	1492084.447	551480.411	1493151.405
551298.431	1492204.209	552141.982	1492121.224	551264.876	1492023.725
551274.163	1492304.904	552184.580	1491975.174	551235.825	1491947.085
551361.275	1492318.668	552233.528	1491961.680	551319.658	1492007.401
551334.290	1492312.692	552274.538	1491841.823	551294.480	1491914.437
551892.984	1491767.899	552359.205	1491800.548	551439.306	1491918.241
551849.298	1491833.011	552525.099	1491897.915	551457.540	1491953.359
551914.618	1491824.690	552115.523	1492137.364	551239.181	1491940.753

551970.536	1491770.053		552084.038	1492197.424		551308.966	1491925.670
551980.631	1491846.583		551962.329	1492197.424		551390.681	1491907.436
551906.707	1491805.876		551952.275	1492184.989		551396.534	1491971.368
551292.544	1491913.607		551906.238	1492124.664		551284.654	1492022.468
551324.915	1491895.346		551858.877	1492270.449		551316.845	1492020.442
551392.701	1491916.927		551829.773	1492317.810		551361.417	1492038.901
551440.013	1491919.141		551768.389	1492347.443		551312.793	1492126.020
551352.306	1491969.773		551930.315	1492438.195		551298.385	1492205.709
551396.298	1491989.140		551955.186	1492556.994		551460.691	1492204.584
551371.673	1492056.649		551875.281	1492772.100		551188.531	1492279.996
551340.431	1491982.195		551421.520	1492984.561		551256.064	1492300.707
551283.201	1491989.216		551345.584	1492952.546		551297.035	1492337.175
551257.560	1492066.867		551216.203	1492928.205		551347.685	1492274.143
551322.819	1492075.436		551335.001	1492939.582		551286.004	1492335.149
551374.015	1492063.791		551424.166	1492990.647		551390.006	1492319.166
551388.297	1492099.606		551309.601	1493027.953		551227.475	1492379.496
551379.288	1492114.328		551364.370	1493086.426		551502.697	1493231.545
551433.341	1492074.777		551426.547	1493197.816		551421.432	1493184.046
551301.286	1492214.083		551485.814	1493353.656		551410.851	1493156.132
551284.586	1492240.450		551,968.079	1,492,444.220		551384.063	1493236.947
551298.429	1492205.074		551,399.830	1,492,429.562		551450.246	1493241.675
551485.416	1492204.635		551,499.032	1,492,629.274		551500.896	1493228.168
551534.635	1492199.142		551,468.669	1,492,636.341		551463.077	1493456.657
551262.394	1492441.939		551,426.266	1,492,510.703		551494.593	1493450.129
551291.398	1492419.527		551,452.703	1,491,903.977		551489.190	1493595.101
551358.414	1492449.629		551314.143	1491873.444		551549.295	1493538.823
551559.425	1493514.060		551518.680	1493583.620		551576.084	1493531.394
551570.681	1493646.651		552061.548	1492180.491		551261.017	1491977.671
552008.964	1491779.172						