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SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

Evaluation of rural road traffic safety

(A Case study: Bichena to Debre work, East Gojjam, Ethiopia)

A Thesis Submitted to the School of Graduate Studies of Addis Ababa University in the partial fulfillment of the Degree of Master of Science in Civil Engineering (Road and Transport Engineering)

By

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Evaluation of rural road traffic safety

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Declaration

I, the undersigned, declare that this thesis is my original work performed under the supervision of my research advisor Dr. Bikila Teklu and has not been presen ted as a thesis for a degree in any other university. All sources of materials used for this thesis have been greatly acknowledged.

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Abstract

Road user safety has economic consequences in terms of property damage and loss of earnings or production resulting from physical injury, in addition to the motional consequences of pain, suffering and death. The endeavor of road traffic safety evaluation is to identify hazards or safety deficiencies in road transport system from Bichena to Debre work, East Gojjam, Ethiopia from the perspective of all road users. The intension is to identify road safety issues and risks that lead to road crashes or harm to people. The road safety evaluation process consists of road traffic crash data, field observation data, and comprehensive questionnaires data collection and analysis.

Based on ordinal logistic regression analysis of road traffic accidents data from Bichena to Debre work for five year (2005 - 2009 E.C) of study period indicates that crash severity is associated with driver age, driver experience, day of the week, and type of road surface.

The traffic police recorded data showed that the types of collision in the zone were vehicle to pedestrian type of collision prevailing dominantly. Overturning is the second prevailing type of crashes occurred. Vehicle to vehicle which is the third common experienced type crashes in East Gojjam zone based on the traffic crashes data of 2005 - 2009 E.C. The analysis on secondary data showed that from crash contributing factors medium vehicles (minibus, Isuzu 24 seats, and automobiles) are the types of vehicles involved in crashes commonly on the study area. Drivers in the age of between 18-30 years were identified as the most affected groups. On Saturday (public market day) and public holydays were crashes happened frequently.

Based on crash rate methods of black spot analysis Mahiber birhan, Yetemb yerez, Around Bichena control terminal, Yeduha junction at Bichena town, Woynam del golma, Gotera, and Agulachi has identified as the black spot road segments which needs treatment according to these respective orders of ranks.

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Acronym

ERA	Ethiopian road authority
ARNS	Amhara national regional state
AADT	Annual average daily traffic
ETB	Ethiopian birr
SPSS	Statistical package software for social science
RTC/A	Road traffic crash/accident
AASHTO	American Association of state highway transportation official
DV	Dependant variable
IV	Independent variable
WHO	World health organizations
OR	Odds ratio
Exp	Exponential (e^x)

1. Introduction

Now a day in Ethiopia, transport has distributed in urban and rural areas for motorized and non motorized transport systems. However, rural communities did not get well transport infrastructures those are populated far from the existing road network system, and these of the proximity rural community who has tried to decrease poverty has faced with transport problems. So, solutions to the transport problems can have a major influence upon people live.

In most of rural Ethiopia, travel and transport has been take place along footpath on rural road networks. Additionally, Back loading ,shoulder loading , head loading , donkey (Kidanmariam G., 1990) and horse loading are the Major means of travel and transport. Animal drawn carts and another transport mode are not involved or very limited in the rural area due to absence of accessible roads.

As Abeje Teffera mentioned about rural communities who are often left isolated and without access, particularly during periods of rains. This excludes them from exposure to new ideas and influences. Remoteness, isolation and lack of services increases vulnerability and severely constrain their ability to contribute to the economy and development of Ethiopia. Investment in road transport, improves the wellbeing of the poor: access to social services and facilities, access to market, access for employment opportunities; and reduces the negative impacts of natural disasters and shocks and provides the links needed to manage it.

As Legesse T., (2016) reported about roads to rural areas in Amhara national regional state as most of the areas are inaccessible and it takes a long distance to get the main roads.

Road user safety has economic consequences in terms of property damage and loss of earnings or production resulting from physical injury, in addition to the motional consequences of pain, suffering and death. Safety and economy are the foundations on which Competent design rests. Inadequate consideration of either will automatically result in inadequate design(Ethiopian road Authority, 2013).

The study has conducted to evaluate the rural road traffic safety based on questionnaires, observations/field inspections, and crashes data analysis.

Traffic crashes (accident) represents obsession for all members of society, and has become one of the most important problems that drain material resources, human potentials and targeting communities in the most important elements of life which is the human element. In addition, the incurred social, psychological problems and material losses are huge, which have become imperative work to find solutions and suggestions and put them into practice to reduce these crashes or at least handling the causes and mitigate the negative effects.

1.1 General background of the study

The study area comprises Bichena town administration, Enarg Enawga and Enemay woreda road segments. Accordingly, the traffic safety of this section has evaluated from 2005 - 2009 E.C for the general rural road traffic safety assessment based on traffic police crashes recorded data, field inspection, interview, and questionnaires. Therefore, Bichena to Debre Work Woreda road segment is taken as the background of the study area which has been explained below. It is tried to see the causes which leads to road traffic crashes in the rural area.

Based on Www.rta.nsw.gov.au, (2011) road safety evaluation is a formal examination of the potential and actual road safety risks for an existing road from the perspective of all road users. The intension is to identify road safety issues and risks that lead to road crashes or harm to people. It includes a crash investigation, questionnaires and field observation.

According to the latest World Health Organization, (2016) report, around 1.25 million people died from road traffic injuries in 2013, with another 20-50 million people sustaining non-fatal injuries as a result of traffic collisions or crashes. Road traffic injuries are the ninth leading cause of death globally, and the leading cause among people age 15–29 years. Almost 60% of road traffic deaths occur among people aged 15–44 years.

Fanueal Samson, (2006) on his study defined Accessibility and mobility as the key functions of transportation systems. Accessibility is the ability to reach desired goods, services, activities and destinations. Mobility is the movement of people and goods.

According to WHO, (2015) Road traffic injuries disproportionately affect a young working population and the cost to individuals, families and governments is enormous. Injuries and their associated healthcare costs are a common cause of poverty and bankruptcy, and the overall cost is as high as 5% of GDP in some low- and middle-income countries. Road safety laws improve road user behavior and reduce road traffic crashes, injuries and deaths – especially laws relating to the five key risk factors for road safety – speed, drink–driving, the use of motorcycle helmets, seat-belts and child restraints.

Traffic accident trend in Amhara national regional state (ANRS) reported as Fesseha Hailu and Teshager Sileshi, (2008) in urban areas pedestrians are more vulnerable groups of the populations whilst in the rest of the region areas the most risk takers are passengers.

Haile Mekonnen Fenta1∗, (2017)on his study in the year 2013/14, a total of 2775 accidents was registered in Amhara Regional state, Ethiopia. However, in 2014/15 the total number is increased to 3028 (9% increment). Among these accidents in 2014/15, 542 cases were deaths.

According to the report among 3028, 1112 (36.7%) were caused by drivers who deny priorities to pedestrians and 584 accidents were because of rollovers.

World Health Organization, (2011) reported as Driver distraction is an important risk factor for road traffic injuries. There are different types of driver distraction, usually divided into those where the source of distraction is internal to the vehicle such as tuning a radio, or using a mobile phone, and those external to the vehicle such as looking at billboards or watching people on the side of the road. Driver distraction can be one of four types: visual (e.g. looking away from the road for a non driving-related task);cognitive (e.g. reflecting on a subject of conversation as a result of talking on the phone – rather than analyzing the road situation); physical (e.g. when the driver holds or operates a device rather than steering with both hands, or dialing on a mobile phone or leaning over to tune a radio that may lead to rotating the steering wheel); auditory (e.g. responding to a ringing mobile phone, or if a device is turned up so loud that it masks other sounds, such as ambulance sirens).

As World Health Organization, (2016a) has reported In 2013, illicit drug use was estimated to be responsible for just over 39,600 road traffic deaths worldwide. thus, Raising awareness of drug-driving and its impact on road safety – including deaths, injuries, property damage and harm to other road users – among the general public and policy-makers can reduce drug-driving and create a climate in which legislation and enforcement will be supported.

Regression model has been described by cafiso and montella, (2004) as the base model of the crash prediction model for predicting the value of the accident frequency of the road segments. The accident frequency is a dependent variable predicted as function of a set of independent variables explanatory's of the traffic volumes, geometric design and traffic control features of the roadway segment.

Safety is an important factor in all roadway improvements. However, it may not be practical to provide an obstacle-free roadside on local roads and streets. Every effort should be made to provide as much clear roadside as is practical. This becomes more important as speeds increase. Flatter slopes, guardrail, and warning signs all help to achieve roadside safety(AASHTO, 2001).

Safety reviews of existing roads are becoming an accepted practice in many agencies around the World and an inspection methodology for safety evaluation the roads using those deriving from the judgments collected on inspected sites during the safety review processes at daytime and nighttime site inspections are very important. Daytime site inspections elements were road name, pavement width, other measures, visibility obstructions, presence of accesses,

markings, delineation and signs conditions, pavement conditions, roadside obstacles, description of dangerous road users' behaviors, description of the potential accident scenario, and schematic plan of the site. However, night time site inspections differ from daytime site inspections since they are focused only at understanding how the road is perceived in the night. these elements are markings, delineation , legibility of the road alignment, roadside(unshielded or unshielded embankment, ditch, trees, rigid utility poles, rigid obstacles, not breakaway barrier terminals, and inadequate bridge rails) , cross section and accesses(cafiso and montella, 2004). But, for this study night time inspections has not taken since the amount of traffic at night is not much enough.

According to yu, (2013)rural roads are the lines connecting the adjacent townships and villages, they are collector highways for short distance transport.

The transport service between Bichena town administration and Debre work woreda has provided all modes of transport categories of Ethiopian road authority vehicular classifications. Additionally, during field observation Bajaj, Handcart, and carts are serving as a short distance transport delivery mode in Bichena town and Debre work town. On the other hand, the remote communities have used donkey, mule, and horse as transport means from their locality to the market and other service areas in the study areas. It is clearly observed that on the study area most of the peoples are transported with the modes of foot this implies that a distribution of transport system in the rural area has not satisfied. Even though, not enough vehicular motorized transport and non motorized transport modes are exist that able to be serve the community, crashes were happened. So, the road traffic safety has to be inspected using the past five year's traffic crashes.

1.2 Statement of the problem

Of the total traffic accident happened in the country for the five year (2005-2009 E.C), Amhara has accounted for 22.43% next to Oromiya 29.48% (Federal traffic police commission, 2017). This shows that Amhara has taken a disproportionately high share of the total accident relative to its low number of vehicles(G/Yesus B., 2015). This entails the need to examine the causes of accidents in the region.

According to Fesseha Hailu and Teshager Sileshi, (2014) traffic accident extent in each zones of Amhara National Regional State has a considerable variation in absolute number of road traffic accident deaths and mortality rates. As a result, these studies showed that In East Gojjam zone high number of deaths was recorded and the main victims of East Gojjam road traffic accidents were found to be passengers.

Legesse, (2016) also suggested that the construction of more road networks is imperative in Amhara region taking into account the socio-economic importance of the areas to be connected to the main road system of the country. The author after his detailed analyses of the road transportation network in Amhara region, he explained the Level of Accessibility in the Amhara Region on each zones and from the result he showed that Motta is least accessible and Bichena is more accessible in East Gojjam.

For that reason, considerate East Gojjam road traffic safety of each Woreda road and identifying major causes of the traffic accident has vital significance to implement remedial solution for these severer problems. In light of these, in this research it is attempt to in-depth assess and gain information on part of East Gojjam Zone roads segment particularly considering Bichena town to Debre work woreda.

1.3 Research questions

In order to have reasonable, accurate and realistic response to the problem, the author needs to pose the following questions to enable him examine the identified problem.

- What are the major contributing factors of road traffic crash on study sections?
- What are the significant factors that related with the road traffic crash severity?
- Which road segment highly susceptible to traffic crashes on the study area?

1.4 Objectives of the study

1.4.1 General objective

The general objective of the study is to evaluate the rural road traffic safety in the perspective of all road users. Evaluating road safety of the study area helps to identify the major causes of the road traffic crashes and to take mitigation measurements on these identified causes.

1.4.2 Specific objective

- To perform descriptive analysis of the road traffic crashes data.
- To develop regression model for road traffic crash severity.
- To identify the black spot areas on the selected segments.

1.5 Significance of the research

This research mainly concerned with the assessments of current status of road traffic safety from Bichena to Debre work.

The research is believed to;

- Provide inputs for decision-making on road traffic crashes mitigation measure.
- Motivate further investigation on the road traffic safety.
- Be an important reference material for similar research and it can be used for academic purpose as well, and
- Contribute to review the effectiveness of current traffic crashes control mechanisms.

1.6 Scope of the research

This study represents an attempt to evaluate the rural road traffic safety (Bichena to Debre work), finding the contributing factors in crashes from 2005 -2009 E.C and suggesting mitigation measures for minimizing the road accidents in the study area.

1.7 Limitations of the study

This study comprises the evaluation of all the causes of road traffic crash in the study sections. The causes of the traffic crashes in the study section were identified as drivers defect, pedestrian and passenger defects, and roadway defects. However, due to inaccessibility of geometric design elements data about evaluation regarding to it is excluded. On ordinal regression model development the property damage is neglected because the human being fatal, serious and slight physical injuries are not able to compare with property damaged.

1.8 Organization of the study

Chapter one deals with the back ground of the study, objectives to be achieved during the study, the significance, scope and the limitations of the study.

Chapter two also deals with the review of the related literatures. It describes the characteristics, causes and effects of road traffic crashes regarding to global, national and specific to the study section.

Chapter three describes background of the study area, data sources, populations and methods used for the thesis.

Chapter four presents analysis and discussions. In this chapter both primary and secondary data has been analyzed.

Chapter five provided conclusion and recommendation of the thesis.

2. LITERATURE REVIEW

2.1 Global crash statistics

Now a day road traffic injuries are killing all the groups of population worldwide. According to (World Health Organization, 2016b) reviewed and reported on the impact of road traffic injuries from World Health Organization, (2015) Road traffic injuries has killed more than 1.25 million people every year and it is the number one cause of death among 15–29 year olds. Based on the report the road traffic injuries are the first among top ten causes of death among people aged 15–29 years.

Road traffic injuries are affecting all users of the road World Health Organization, (2015) report showed that low and middle-income countries are hardest hit, with double the fatality rates of high-income countries and 90% of global road traffic deaths. On the report Vulnerable road users are pedestrians, cyclists and motorcyclists that make up half of these fatalities.

Road traffic injuries place a heavy burden on national economies as well as on households. In low- and middle income countries they particularly affect the economically active age group, or those set to contribute to family, society and the workforce in general. Many families are driven deeper into poverty by the loss of a breadwinner, or by the expenses of prolonged medical care, or the added burden of caring for a family member who is disabled from a road traffic injury. The economic costs also strike hard at a national level, imposing a significant burden on health, insurance and legal systems. This is particularly true in countries struggling with other development needs, where investment in road safety is not commensurate with the scale of the problem. Data suggest that road traffic deaths and injuries in low- and middle-income countries are estimated to cause economic losses of up 5% of GDP. Globally an estimated 3% of GDP is lost to road traffic deaths and injuries(WHO, 2015).

Ninety-percent of road traffic deaths occur in low- and middle-income countries, and while these countries also account for 82% of the world's population, they nevertheless bear a disproportionate number of deaths relative to their level of motorization, as they account for only 54% of the world's registered vehicles. many high-income countries have managed to break the link between rising motorization and road traffic deaths, with making infrastructure safer, improving the safety of vehicles, and implementing a number of other interventions known to be effective at reducing road traffic injuries to dramatically reduce such deaths (World Health Organization, 2015).

Road transport systems have contributed enormously to the development of most countries in the world World Health Organization, (2017a)By improving people's ability to access education, employment and health care and enhancing the efficiency of businesses to provide goods and services, such systems have resulted in a number of positive economic and social benefits. However, there are also adverse consequences resulting from ever expanding road transport systems and the services they facilitate. Rapid motorization has frequently been accompanied by corresponding increases in road traffic deaths and injuries, while many urban areas now face the additional challenges of increasing levels of air pollution - and associated rises in respiratory diseases - and increasing congestion, which in turn are linked to reduced levels of physical activity and other health consequences. The report also describes about Speed which has a positive effect on mobility in terms of reducing transport times, but it impacts negatively on road safety, affecting both the likelihood of a road traffic crash and the severity of its consequences. Speed also has adverse effects on levels of environmental and noise pollution, and the "liveability" of urban areas.

2.2 Africa crash statistics

According to the African Development Bank, (2014) report Deaths due to road traffic accidents are highest among the most economically active population (15-59 years),Men are three times more likely to be involved in road traffic accidents than females in the 15-59 age group, and Strategies that can be adopted by governments to reduce the number of fatalities and injuries due to road traffic accidents include improved road infrastructure, speed limits, compulsory seat belts and child restraints, drunk-driving laws, bans on the use of cell phones while driving, and legal requirements for motorcyclists to wear helmets. Generally, which showed on the report Enforcement of road safety measures is generally weak across the continent.

The African Region has the highest road fatality rates of all the world's regions. Young men are the most vulnerable road users. Pedestrians, cyclists, and persons travelling on motorized 2- and 3-wheelers are at great risk of death and injury on the roads. Most countries still lack policies for protecting vulnerable road users and promoting investment in public transportation. Most countries are yet to enact comprehensive laws concerning the major risk factors of speed control, drink-driving, helmet use, seat-belt use, and child restraint. Even where comprehensive laws are in place, poor law enforcement renders the laws ineffective. Post-crash care is inadequate or lacking in many countries(Amoi-Séminet, 2013).

The African Region remains the least motorized of the six world regions, but suffers the highest rates of road traffic fatalities, By comparison, the global average for middle-income countries is 20.1 deaths per 100 000 population. While the African region possesses only 2% of the world's vehicles it contributes 16% to the global deaths(Amoi-Séminet, 2013).

Nigeria and South Africa have the highest fatality rates (33.7 and 31.9 deaths per 100 000 population per year, respectively) in the region. More than one in four deaths in the African Region occur on Nigeria's roads, and with six other countries; Democratic Republic of Congo, Ethiopia, Kenya, South Africa, Tanzania, and Uganda are responsible for 64% of all road deaths in the region. While Ethiopia, Kenya, and Tanzania have relatively low (for the region) road fatality rates, Nigeria, South Africa, and Uganda combine big populations with very high fatality rates, resulting in large numbers of deaths. These seven countries must reduce their road deaths considerably if the region is to realize a significant reduction in deaths(Amoi-Séminet, 2013).

Africa needs strong, high level encouragement and leadership to promote regional integration for infrastructure development. Vehicle overloading is not a new issue, but since2000 there have been additional efforts to tackle the problem to ensure that heavy vehicle axle loads are not exceeded. The damage caused by over loading rises exponentially with each additional ton of axle load, and this reduces the life of a road substantially(the African Development Bank, 2014).the report includes the steps needed to tackle vehicle overloading largely depend on successful enforcement of the legislation and overcoming corruption in the enforcement agencies, which remains an obstacle in some cases. The road accident death rate per capita in Africa is the highest of any region in the world, at 28.3deaths per 100,000 people, with an estimated cost of around $3.7 billion.

Road crash is a growing problem in Africa resulting in close to 1000 deaths, tens of thousands of injuries and enormous amount of economic losses every day. the specific characteristics of victims in the region signifies that road crash is the fourth leading cause of deaths of people aged 5-44 years; over 75% of the casualties are of productive age between 16-65 years; and the vulnerable road users constitute over 65% of the deaths(African development bank, 2013)

2.3 Ethiopian crash statistics

The road accident statistics in Ethiopia, in common with many other countries, show that death rates from road accidents are 30 to 50 times higher than in the countries of Western Europe. The numbers of serious injuries resulting from road accidents are equally alarming. Economic analysis has shown conclusively that this high level of road accidents has economic consequences for the country that is equivalent to a reduction of 2-3% of GDP. This is a very significant drain on the economy. Furthermore, the consequences of the road accidents impose a great deal of grief and anguish on a considerable proportion of the population. Every effort should therefore be made to reduce the number of serious accidents(Ethiopian road Authority, 2013).

The reports showed on road safety management and policies evaluated by the African Development Bank, (2014)in Ethiopia is; national policies to separate road users as a way of protecting vulnerable road users , support investment in public transport, motorcycle helmet law that covers all riders, all roads and all engine types, and requires an international or national helmet standard are comprehensive laws.

In Ethiopia the traffic crash trend shows in the increasing situation due to the factors of all driver, pedestrians, and roadway and environmental conditions. As the study of AtsebahaGebremeskel, (2014)result showed that there exists of large difference in road traffic accident victims among drivers, passengers, and pedestrian in their sex and age levels. on his findings the Male drivers, passengers, and pedestrians were the most affected one as compared to their female counterparts and road traffic accident (death, serious injuries and light injuries) mostly affected age categories of between 18-30 regardless of their sex, and starts declining after age 31. Consequently, the road traffic accidents were extremely affecting the economically active citizens i.e., youths and young adult groups.

According to Negesa, G/Selassie and Mohammed, (2017)investigation based on three year the Ethiopian Federal Police report, each year more than two thousand people die and ten thousand people injured in road traffic crashes. On their investigation all records' of 402 road traffic accident patients' were retrieved and included. from the total of crash data they identified that two hundred ninety three (72.9%) were males and one hundred and nine (27.1%) females. based on their findings the age of RTA patients ranged from 1 to 75 years old and the maximum number of patients (43%) found in 15-24 years.

After detailed analysis of the Characteristics of Police-reported Road Traffic Crashes in Ethiopia over a Six Year Period by Getu, Washington and King , (2013) showed that the clear trend that emerges more than half of the fatalities in Ethiopia involve pedestrians. According

to their findings the majority of the crashes occur during daytime hours, involve males and persons in the 18-50 age group Ethiopia's active workforce. The authors also described the predominant collision between motor vehicles and pedestrians, a rollover on a road tangent section, and Failing to observe the priority of pedestrians, and speeding were the major causes of crashes in the country.

In Ethiopia, the rate of road traffic accidents (RTAs) is very high; because of road transport is the major transportation mechanism along with poor road infrastructure, poor enforcement of traffic laws and other factors(Yideg Munana, 2015).

the magnitude of road traffic accident in Ethiopia specifically Addis Ababa has been investigated by Bekele, (2015). After in detail discussed, he concludes that there is small gap in involvement of road traffic accident among urban (2.8%) and rural (2.6 %) dwellers.

Ethiopia promotes road safety as a national issue with a road safety lead agency accountable to the ministry of transport. However, there is no self-standing road safety policy**.** Legal instruments to enhance road safety have been revised and some are yet to be updated. There is a road safety national strategic plan in which the country targets to reduce fatalities by 50% in the decade. however, the plan is not translated into achievable targets for each stakeholder with sufficient resource allocations required for the implementation to attain the national target(African development bank, 2013).

Road safety education is provided for school children, but trained teachers and training materials are significantly lacking. public campaigns are regularly made but does not target specific road users' group or road safety issues based on relevant information from the road crash data(African development bank, 2013).

On this study periods from 2005 -2009 E.C, the Ethiopian crash statistics of Oromiya, Amhara and Addis Ababa has recorded the highest crash statistics rate from first to third orders respectively as shown appendix 2 below.

2.4 Amhara region crash statistics

After an in-depth analysis on the road transportation networks of the Amhara region, result showed that most of the areas in Amhara region are inaccessible and need a long distance travel to access the nearest main road (Legesse, 2016). However, the traffic accidents are increasing from time to time.

Traffic crash is increased from time to time in alarming rate and it is a serious problem throughout the country, particularly in Amhara region. According to (Mekonnen and Lakew, 2014)findings drivers giving priority stated by the law, pedestrian's manner while crossing

the road, drivers usage of seat belt have statistically significant impact for the occurrence of traffic accidents in the Bahir Dar city. Additionally, after they recommended giving traffic crash awareness for the people from concerned body they showed that Pedestrian's manner while crossing the road is one cause of traffic crashes in the city.

As shown table **2- 1** below, the types of severity per the analysis period of time is depicted. As it is clearly shown below on death 3607 crashes, serious injury 3494 crashes, slight injuries 5836 crashes , and damaged vehicle 6043 crashes were recorded from traffic police station of each woreda from 2005 - 2009 E.C. Generally, a total of 12937 crashes were recorded in Amhara Regions, Ethiopia from 2005-2009 E.C.

Table 2- 1 Amhara region types of crash severity per each zone

zone	types of severity (2005-2009E.C)				Types of severity in % (2005-2009E.C)			
	Death	Serious	Slight	Damaged vehicles	Death	Serious	Slight	Damaged vehicles
South Gonder	373	234	326	284	10.34	6.70	5.59	4.70
North Gonder	379	249	276	236	10.51	7.13	4.73	3.91
Gonder town	136	183	568	536	3.77	5.24	9.73	8.87
Bahirdar town	202	178	355	811	5.60	5.09	6.08	13.42
Awi	312	193	175	223	8.65	5.52	3.00	3.69
w/gojjam	475	354	388	654	13.17	10.13	6.65	10.82
E/Gojjam	334	307	373	338	9.26	8.79	6.39	5.59
North Shewa	410	617	889	733	11.37	17.66	15.23	12.13
Oromiya	196	223	659	381	5.43	6.38	11.29	6.30
South wolo	327	277	592	298	9.07	7.93	10.14	4.93
Dessie town	94	205	390	711	2.61	5.87	6.68	11.77
North wolo	330	390	669	747	9.15	11.16	11.46	12.36
Wagihemra	39	84	176	91	1.08	2.40	3.02	1.51
sum	3607	3494	5836	6043	100	100	100	100

Source: ANRS police commission traffic police

Based on ANRS police commission traffic police recorded data in Amhara region, the type of crash severity that is human injuries and property damaged was described below **Figure 2- 1**. As shown below each type of human injuries and property damage with respect to all zones

per each analysis year has been provided from the secondary data of Amhara national regional state road traffic safety police commission. As shown figure 2- 1 the traffic crashes trends has shown as increasing.

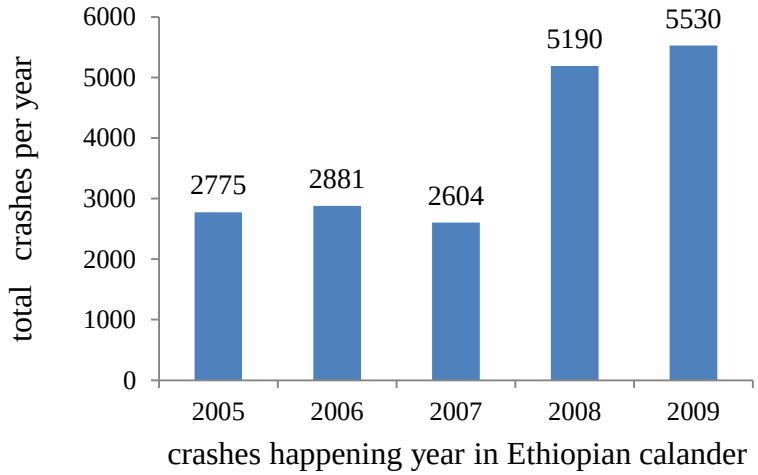

Figure 2- 1 Road traffic injuries in Amhara region for five years

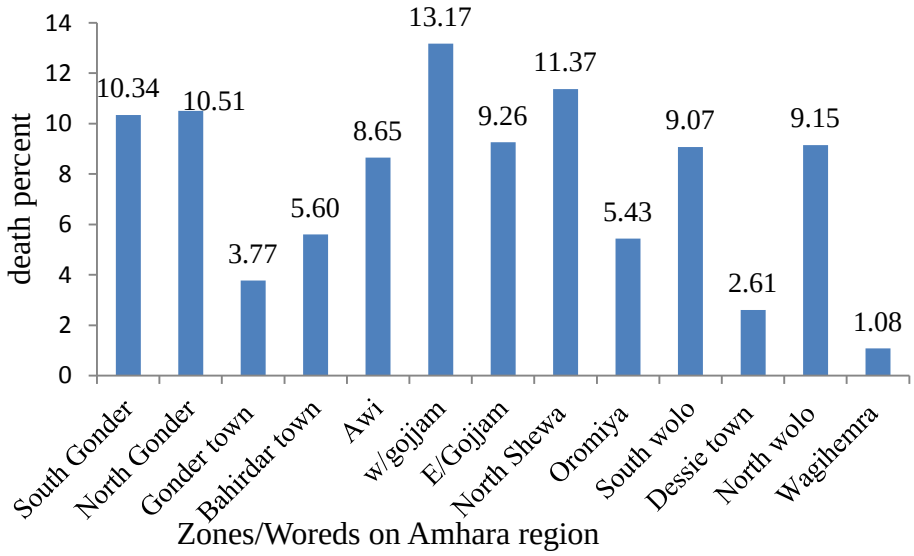

Figure 2-2 fatal injuries in Amhara regions for five years

Based on ANRS police commission traffic police recorded data on table 2- 1above; Figure 2-2 above organized and which shows the fatal injury occurred in Amhara region for the study period of five years. West Gojjam has recorded the highest fatal rate among the described zones or woreda. North shewa, North Gonder, South Gonder, East Gojjam, North wollo, South Wollo, Awi, Bahir dar town, Oromiya, Gonder town, Dessie town, and Wagihemra follows in descending order of fatal rate occurrence respectively.

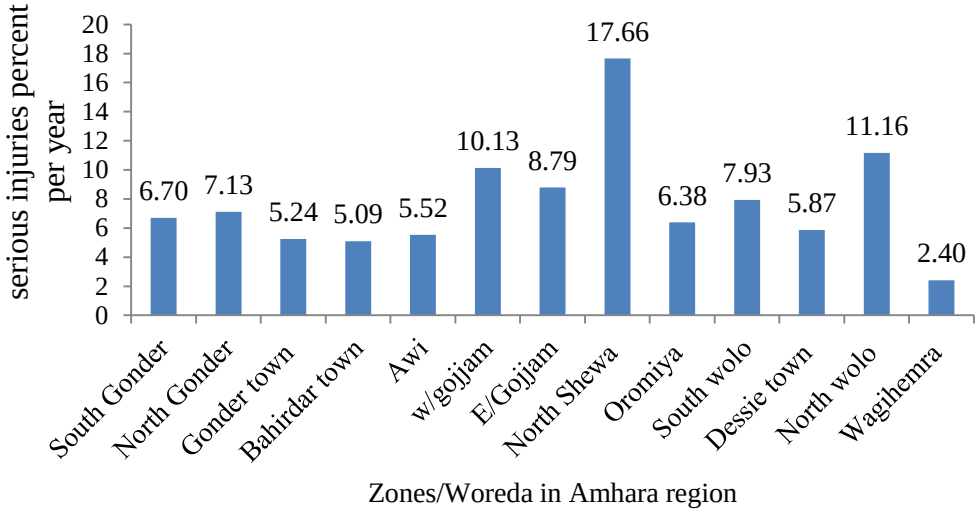

Figure 2- 3 serious injuries in Amhara regions for five years

Based on ANRS police commission traffic police recorded data on table 2- 1 above; Serious physical injuries occurrence has been shown on figure 2- 3 above in each zones/woreda of Amhara regions. From the analysis, North Shewa, North Wollo, West Gojjam, East Gojjam, South Wollo showed the maximum injuries in descending orders respectively.

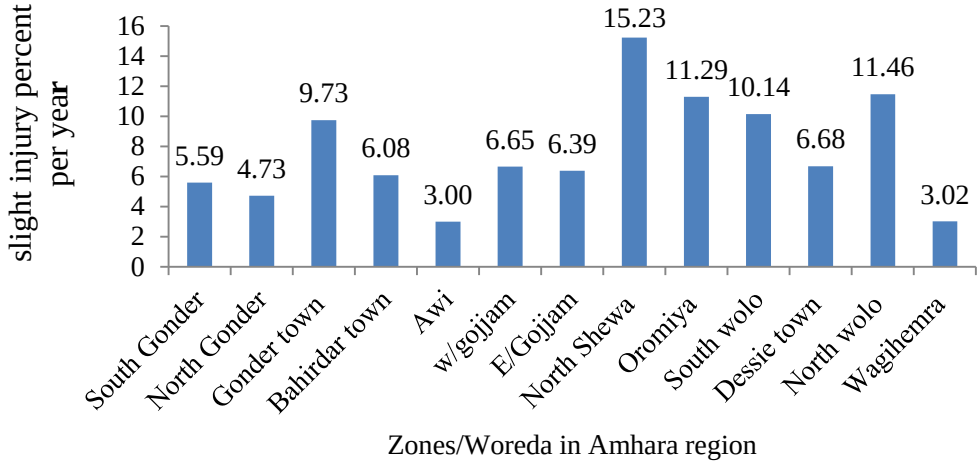

Figure 2- 4 Slight injury in Amhara regions for five years

Based on ANRS police commission traffic police recorded data; Figure 2- 4 arranged and which showed the slight injuries in Amhara region of each zones/woreda. As a result, from the analysis North Shewa has recorded the first highest zones in slight injuries from Amhara region for the analysis periods of five years.

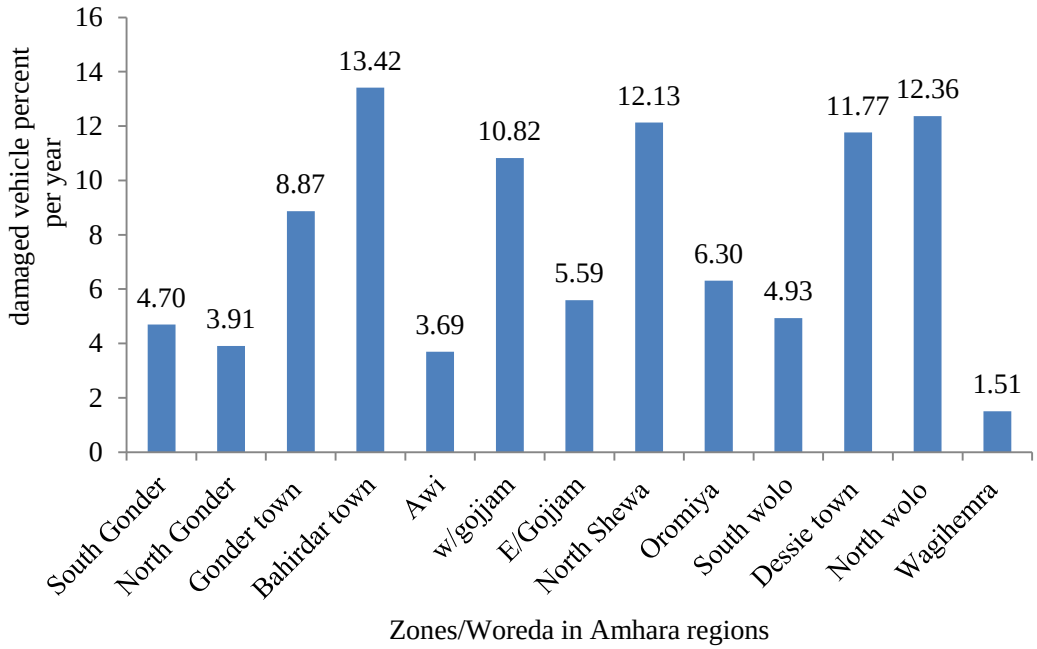

Figure 2- 5 property damage in Amhara region for five years

Based on ANRS police commission traffic police recorded data from table 2- 1 above; Figure 2- 5 has organized and which showed that the property damage analysis on the Amhara regions, Bahir dar town has the highest records.

Table 2- 2 Amhara region damaged property estimated cost for each zone/year in ETB

zone	2005 E.C	2006 E.C	2007 E.C	2008 E.C	2009 E.C	Total
South Gonder	4984008	5473485	5038354	4572000	3047700	23115547
North Gonder	6232686	6348562	5079653	11998098.16	6577300	36236299.16
Gonder town	1886183	3707185.4	2015846.19	1415700	1394539	10419453.56
Bahirdar town	3393300	2293157	3021828	1719376	4398076	14825737
Awi	8353850	30461110	6331431	5035550	6418655	56600596
w/gojjam	3883658	5256700	5316103	9003700	7699950	31160111
E/Gojjam	335651	3909969	3899782	6410200	5052178	19607780
North Shewa	10133533	9036787	11781244	18215015	26150189.7	75316768.7
Oromiya	5462960	3622302	6287090	6918450	268253991	290544793
South wolo	8537574	6258986	3743900.13	19226770	6352400	44119630.13
Dessie town	3099150	3527413	2827371	6252854	6683290	22390078
North wolo	22986208	20550206	29299926	2687140.65	20731182	96254662.65
Wagihemra	2034496	3334439.8	1899300	2716000	3431000	13415235.8
Sum	81323257	103780302	86541828	96170853.81	366190450.7	734006692

Source: ANRS police commission traffic office

As ANRS police commission traffic police accident reported data showed on Table 2- 2 above, traffic police estimated cost on the property damage of Amhara region road traffic crashes is 366,190,450.7(ETB) per year.

2.4.1 Road traffic crash trends of East Gojjam

East Gojjam is one zonal part of Amhara regions, in Ethiopia. The population of this zonal area in the region has got road networks which connect the capital city of Ethiopia and its zonal town Debre Markos with 299 km in distance which crosses through Lumamie, Amber, Amanual, Gozamen, and Dejen woredas. This creates a good opportunities for the economic

growth of each woreda because the road connected both the rural and town part of a populations. Additionally, the most rural area peoples come close to these woreda center towns. However, a great care should be exercised regarding on traffic rule awareness on each woreda.

Table 2- 3 East Gojjam types of crash severity for five years

Type of severity	Road traffic crashes per year (E.C)					Total	Percent
	2005	2006	2007	2008	2009		
Fatal	49	46	56	74	88	313	31.71
Serious injuries	27	41	28	37	60	193	19.55
Slight injuries	34	32	32	32	34	164	16.62
Property damage	94	74	53	48	48	317	32.12
Subtotal	204	193	169	191	230	987	100.00

Source: East Gojjam zone road and transport core process

For the purpose of evaluating the crashes trends on East Gojjam zone the road traffic crash data has been collected from East Gojjam zone road and transport core process as shown on Table 2- 3. The type of crash severity has been depicted relative with the year in which crashes happening on five year. From the table it is clearly shown that 32.12% of the crashes belong to Property damage, 31.71% were Fatal, 19.55% were serious injuries, and 16.62% were slight injuries.

Table 2- 4 East Gojjam types of crashes in day of the week for five years

No.	day	Crashes per each year(E.C) in East Gojjam zones					Total	Percent
		2005	2006	2007	2008	2009		
1	Monday	28	34	21	32	39	154	15.6
2	Tuesday	36	35	23	29	22	145	14.69
3	Wednesday	25	26	20	28	26	125	12.66
4	Thursday	38	26	30	15	36	145	14.69
5	Friday	25	23	24	19	39	130	13.17
6	Saturday	23	31	31	30	43	158	16.01
7	Sunday	29	18	20	38	25	130	13.17
Subtotal		204	193	169	191	230	987	100

Source: East Gojjam zone road and transport core process

Table 2- 4 shows East Gojjam road traffic crashes trend based on the crash happening days. As shown above 16.01% of crash were happen on Saturday, 16.6 % on Monday, 16.69% both Tuesday and Thursday, 13.17% both Sunday and Friday, and 12.66% were happen on Wednesday.

Table 2- 5 Pedestrian crashes depending on occupation in East Gojjam

Year	Pedestrian Occupations							Total	percent
	Student	Government Officer	Farmer	Merchant	Job seeker	Private worker	Other		
2005	20	15	25	0	9	0	12	81	16.56
2006	25	20	31	0	1	0	15	92	18.81
2007	15	18	44	0	5	0	6	88	18.00
2008	17	16	58	0	4	0	13	108	22.09
2009	21	29	44	1	5	1	19	120	24.54
total	98	98	202	1	24	1	65	489	100
percent	20.04	20.04	41.31	0.20	4.91	0.20	13.29	100	

Source: East Gojjam zone road and transport core process

On table 2- 5 above, the type of crashes within the study period regarding with occupation of victimized pedestrian is shown. From the table we can realize that students and government officers are highly faced with a crash next to farmers.

Table 2- 6 East Gojjam traffic crashes depending on age of driver for five years

Age categories Of drivers	Road traffic crashes in E.C					Total	Percent
	2005	2006	2007	2008	2009		
< 18 years	5	7	9	4	2	27	2.74
18 - 30 years	76	80	56	100	127	439	44.48
31- 50 years	76	74	66	62	60	338	34.25
> 51 years	31	30	32	13	7	113	11.45
Unknown	16	2	6	12	34	70	7.09
Sum	204	193	169	191	230	987	100

Source: East Gojjam zone road and transport core process

Based on table 2- 6 above the effect of age on the traffic crashes have been investigated. From the table 18 - 30 years age categories of drivers highly susceptible for crashes (44.48%), 31- 50 years age categories also the second highly vulnerable groups on road traffic crashes (34.25%), age older than 51 years also at risk (11.45%).

Table 2- 7 East Gojjam traffic crashes related with driver experience for five years

Driving experience	Road traffic crashes per year (E.C)					Total	Percent
	2005	2006	2007	2008	2009		
No driving license	5	4	7	10	4	30	3.04
< 1 year	17	10	14	20	27	88	8.92
1-2 year	46	41	14	40	41	182	18.44
2-5 year	55	72	74	57	68	326	33.03
5-10 year	31	37	34	28	31	161	16.31
>10 year	28	16	4	22	19	89	9.02
Unknown	22	13	22	14	40	111	11.25
Subtotal	204	193	169	191	230	987	100.00

Source: East Gojjam zone road and transport core process

In East Gojjam the road traffic crashes for five year analysis period of 2005 - 2009 E.C indicated that 33.03% of crashes were committed by a driver experienced within 2-5 year, 18.44% of the crashes were involved by driver these experienced within 1 -2 years, 16.31% of crashes were 5-10 year experience holder drivers, and drivers holding above 10 years experience the crashes decreases.

Based on the traffic police recorded data the types of collision in the zone shows vehicle to pedestrian type of collision were prevailing dominantly in East Gojjam zone with 42.25% of the total collision types occurring. Overturning is the second dominant type of crashes occurred in East Gojjam based on the traffic police record data of road traffic crashes 2005 - 2009 E.C. vehicle to vehicle accounts 19.76% on five year analysis periods and which is the third common experienced type crashes in East Gojjam zone.

2.4.2 Causes of rural road traffic crashes

The causes of road traffic crashes are described by different authors as the effect of Road users, road way, and vehicles. Even thought the contribution percent is different, it is possible to say a crash in the study area is the grouping defects of the road transport systems. From the

traffic police recorded data retrieved that speeding the major causes of crashes in the study area.

To evaluate the rural road of the selected section it is vital to have a data from different concerning bodies like road traffic crashes data, geometric data, and traffic volume data. Since it is not possible to get the geometric data of the road it is only limited to inspect the operating speed of drivers on the selected road segments.

Geometric design could be defined as "the process of applying some engineering principles to the design of transportation facilities to ensure safety and efficiency for all users" (AASHTO, 2001). Geometric design elements include a wide range of roadway features such as horizontal and vertical alignment, cross section, roadside development, intersections, pavement, lighting, and design speed.

Sustainable rural development is a function of a number of factors in which transportation is of importance. efficient and effective rural transportation serves as one of the channels for the collection and exchange of goods and services, movement of people, dissemination of information and the promotion of rural economy (adedeji, o.a; olafiaji, e.m; omole, f.k*; olanibi, 2014). However, the road traffic crashes now a day becomes the most serious victimized disease in the world killing all age categories of the people.

The importance of transport facilities in rural areas can be justified from both social and economic perspectives. Socially, a significant proportion of Ethiopian population lives in the rural areas and demands various forms of transport to facilitate socio-political interactions. Secondly, the rural areas are very important in the supply of food, raw materials to urban centers and the country's economic growth as a whole. In light of the above, it becomes expedient to examine rural transportation problems, so that the extent of the problems can be known, and possible solution proffered to achieving sustainable rural development.

According to kevin hamilton and janet kennedy, (2011) investigation the causes of rural road accident are human factors (driver behavior); environment factors (the road); and vehicle factors (defects). As the authors' investigation the main driver behavior factors associated with rural road accidents are identified as speeding, alcohol and drug use, Driver fatigue and sleepiness, Driver distraction, not wearing Seat belt usage, darkness, and animals.

according to kay fitzpatrick and mark wooldridge, (2001)the candidate design consistency measures, the speed reduction on a horizontal curve relative to the preceding curve or tangent clearly has the strongest and most sensitive relationship to accident frequency.

In Ethiopia road traffic crash information are obtained from traffic police records and may be from hospital records. shenker *et al.*, (2015) mentioned on his finding the road accident is a

random phenomenon and it is very difficult to do the exact prediction of future trends of accidents by using any model or theory, but developed model is helpful for the design of safe highways. Additionally, it will contribute to identifying the potentially hazardous locations on highways and to the treatment of safety improvements.

According to Anusha and Kumar, (2016) the Analysis of the data on accidents, the drivers of the motor vehicle are the single major factor responsible for the accidents as they fail to perceive the situation ahead because of poor reflexes, fatigue, inexperience or being under the influence of toxicants. They also replay other factors, which contribute directly or indirectly to the road accidents such as the road, the vehicle, the road user, and environmental factors.

Rural roads face many unique safety challenges that result in higher crash rates. First, roadway design and the presence of roadside hazards (such as utility poles, sharp-edged pavement drops off, and trees located close to roadways) create additional safety risks. Second, compared to urban crashes, rural crashes are more likely to be at higher speeds, a contributing factor to higher severity. Third, it often takes longer time for emergency vehicle response to the scene of a rural crash which affects the survival rate of those injured(Sisiopiku, 2011).

Based on the data from East Gojjam Zone traffic police records the major causes of road traffic crashes were identified as Over speeding, not giving priorities for pedestrians, not giving priorities for vehicles, not keeping the right distance, wrong way driving, incidental starting of drivers, illegal driving, inappropriate turning, and overloading.

3. METHODOLOGY OF THE STUDY

3.1 Introduction

The road safety evaluation process consists of a comprehensive site description, a complete crash data analysis, a road survey conducted with the aid of suggested checklists, and speed data collection and analysis. Finally, a concise and brief report should be prepared with clear identifications of problems and recommendations. Road safety evaluations are applicable to all types of existing roadways and at every stage of their development.

Generally, here it is tried to show how the study could be done regarding to achieve the objectives of the study. As a result, to accomplish the objectives of the study the following points will be discussed such as the study area information described, target population of the study, source of data, data collection methods, sample size of the representative populations, and study analysis techniques.

3.2 Study Area

The study area of the research covers approximately 43 km from Bichena to Debre work in East Gojjam, Amhara region, Ethiopia. Enarj Enawga is one of the woredas in the Amhara Region of Ethiopia. Part of the Misraq Gojjam Zone, Enarj Enawga is bordered on the South by Enemay, on the SouthWest by Debay Telatgen, on the West by Hulet Ej Enese, on the North by Goncha Siso Enese, on the NorthEast by Enbise Sar Midir, on the East by the Abbay River which separates it from the Debub Wollo Zone, and on the South East by Shebel Berenta. Towns in Enarj Enawga include Debre Werq and Felege Berhan.Enemay is one of the woredas in the Amhara Region of Ethiopia. Part of the Misraq Gojjam Zone, Enemay is bordered on the south by Dejen, on the west by Debay Telatgen, on the north by Enarj Enawga, and on the east by Shebel Berenta. The administrative center of this woreda is Bichena; other towns in Enemay include Dima and Yetmen**.**

Figure 3- 1 Bichena to Debre work town road locations (source Google earth)

As per 2009 E.C the population survey data of Bichena town, Enarg Enawga woreda, and Enemay woreda were reported as 295608, 305406, and 601014 respectively as shown below table **3- 1**.

Table 3- 1 population statistics of study area

Woreda	Sex	Rural	Town	Rural and Town
Bichena town administration	Male	181361	114247	295608
Enarg Enawga	Female	187498	117908	305406
Enemay	Total	368859	232155	601014

Source: Bichena town administration, Enarg Enawga woreda, and Enemay woreda congress office yearly unpublished magazine, 2009 E.C.

The study area is classified in to subsections:

For this study purpose based on the police recorded traffic crash data some of road segments have been selected for black spot identifications analysis after ranking in decreasing order. Among these seven sections of the road, a section has been selected based on crash frequencies that is having four or higher number of crash frequencies on the study periods.

Section I: Kuy junctions (Mahibere Birhan)

Section II: Yeduha junction at Bichena town

Section III: around Bichena town control terminal

Section IV: Woynam Del golma

Section V: Yerez Yetemb

Section VI: Gotera

Section VII: Agulachi

3.3 Research Design

In the direction of determining risk factors affecting the fatal versus non-fatal accidents in a rural region of Turkey, considering variables associated with the individual, the environment, and the motor vehicle (Çelik and Senger, 2014) analysis has been conducted and a successful results have gained by obtaining the data during 2008-2012 traffic police road accident reports.

Road accident and safety study in Sylhet region of Bangladesh by (Banik *et al.*, 2011b)showed that the analysis has utilized three(3) year traffic police crashes recorded data and (Gebremeskel, 2014) also on his study Addis Ababa road traffic accident study and possible engineering solutions: case study of Akaki-kaliti sub city roads uses a five year traffic crashes recorded data for analysis and they finalized with a successful results.

Road Accident Analysis on a case study of Federal route FT024 Yong Peng- Parit Sulong has studied by (Yong *et al.*, 2016) and he showed that a successful result has been achieved with a four year traffic police crashes recorded data. Therefore, for this study to perform a descriptive and inferential analysis the five year traffic Police accident register's data on a selected road section has been utilized between 2013 to 2017**.** Variables related to crash events such as crash location, crash type, time of day, day of week, weather conditions, the crash types, environmental, roadway conditions, etc explained in terms of crashes. A regression model would be developed on the traffic police recorded data.

The intention of this study is to evaluate the rural road traffic safety for one lane two-way roadway segments regarding with identify location with high number of road traffic crashes on the selected sections and to identify the causes of the crashes on and then recommend engineering corrective measures.

3.4 Data Source

road traffic safety would be achieved with good driving practices, good roadway and environment conditions, and well informed or awarded pedestrians about traffic crash are exists. Consequently, in this study both primary and secondary data are needed to achieve the objective. So, average annual daily traffic volume, and crash data will be collected from secondary sources. Additionally, field inspections, and questionnaires will be collected from primary data sources. Generally, the study needs both of the primary and secondary data sources.

3.5 Target population of the study

The study has a great input to the assessment of rural road traffic safety. The major crash contributing factors are the road users, drivers, and roadway and environmental conditions. So, in order to identify the most accident vulnerable factors along the study area; the resident of Bichena town administration, Enemay and Enargi Enawga Woreda communities, and drivers are included as a target population. Generally, the target populations are drivers, woreda road and transport officers, traffic polices, and road users (pedestrian). The community data will be gathered from respective administration centers of Bichena town administration, Enemay woreda and Debre work woreda.

3.6 Sampling method

In the study section of road segments it is known that Enemay and Enargi Enawga woreda residents and Bichena town administrative communities are included. Since, the study area covers Bichena town administration, Enemay and Enargi Enawga Woreda town residents it is difficult to field survey, time consuming, and costliness. Generally, it is not possible to take all the whole populations as a sample. Therefore, the representative sample from each target population should be selected. Even though, the rural communities distributed in large areas; some of the villages around the road section is better to cluster them on the same geographical locations. Therefore, in the rural community cluster sampling method has done in high proximity to the roads and those whom are living very far from the road sections , and lastly for sampling purpose from six clustered section areas has taken for sampling investigation. For the town sections the stratified sampling methods has been used. Therefore, in this research, probability sampling (simple random, stratified and clustered sampling) techniques applied.

3.6.1 Sample size and data collection method

In this thesis the primary and secondary data has been used. Several techniques were employed to collect primary data. Some of these include: questionnaires, and field inspections.

In this study, three prepared attitudinal type of questionnaires has been prepared. The first was completed by the traffic police and woreda transport officers, the second by road users (pedestrians), and the third by drivers. The questionnaires has designed to identify the most reflective difficulties and traffic safety problems that road users face while moving along, traveling as a passengers, and crossing the roads. It will also helpful to serve the researcher to

identify the level of faithfulness and understanding of traffic regulations of the individual person being questioned.

the questionnaires of traffic police and drivers collected by the writer of this thesis while that of pedestrians were collected by the four daily employee whom were trained before they went to the field how they carry out the task.

On the other hand, the secondary data such as road crashes has been collected from the police crash record files of Bichena town administration, Enemay and Enargi Enawga Woreda.

To collect the primary data the number of sample size would be estimated based on (Israel, 1992) developed equations which yield a representative sample for proportions.

$$n_o = \frac{Z^2 pq}{e^2} \quad \text{.....Equation 1}$$

Where, n_0 is the sample size, Z^2 is the abscissa of the normal curve that cuts off an area a at the tails (1 - a equals the desired confidence level, e.g., 95%), e is the desired level of precision, p is the estimated proportion of an attribute that is present in the population, and q is 1-p. The value for Z is found in statistical tables which contain the area under the normal curve. Assume there is a large population but that we do not know the variability in the proportion that will adopt the practice; p=.5 (maximum variability).

For the known number of populations Israel, (1992) also supports for a simplified formula for proportions of Yamane (1967:886) which provides a simplified formula to calculate sample sizes with a 95% confidence level and population proportion (P) = 0.5.

$$n = \frac{N}{1+N(e)^2} \quad \text{..... Equation 2}$$

Where; n is the sample size, N is the population size, and e is the level of precision.

According to Israel, (1992) investigation if the population is small then the sample size can be reduced slightly (Correction For Proportions needed). This is because a given sample size provides proportionately more information for a small population than for a large population. The sample size (n_0) can be adjusted using Equation:

$$n = \frac{n_0}{1+\frac{(n_0-1)}{N}} \quad \text{.....Equation 3}$$

Where: n the sample size, n_o is calculated sample size in equation 1 and N is the population size.

3.7 Primary data collection methods

3.7.1 Questionnaires

Questionnaires for driver*:* the questionnaires for drivers were distributed at the destination of Bichena and Debre work towns. It is known that Bichena road and transport process has 99 vehicles and Debre work road and transport process has 86 vehicles (source: woreda road and transport process). Therefore, the number of sample size was determined using the methods employed on estimating sample size based on the proportion methods with an approximate confidence level of **95**% and margin of error/level of certainty of **5** %. So, the number of sample size would be determined and reduced to 80 using equation 3.

Questionnaires for traffic police: the Questionnaires for traffic police and woreda level road and transport officers were collected at the locations where they might be seat to control the traffic movements and on their offices. The number of sample size was taken all the number of traffic police available in Bichena town administration (two in numbers), Enemay woreda (two in numbers) and Enargi Enawga woreda (two in numbers) because they are actually small in number. lastly, two road and transport officers from both Bichena(two in numbers) and Debre work(four in numbers) has been collected.

Questionnaires for pedestrians: Here the questionnaires distributed to the target pedestrian of Bichena town administration, Enemay and Enargi Enawga woreda populations were 384 that is based on the number of sample sizes estimated depending on the confidence level (level of certainty), that the characteristics of the data collected will represent the characteristics of the total populations (95%) and margin of error that is the accuracy required for any estimates made from the sample (5%). However, for the factor of safety 10% of the questionnaires has been added and totally 422 questionnaires has been distributed.

The pedestrian questionnaires estimated above were collected from Bichena town administration, Enemay woreda, and Debre work woreda residents. As a result, the questionnaires were distributed after the sampling techniques have been decided. For sampling purpose time and cost are the factors that affect the sampling procedures. Bearing in mind this idea first the rural communities is clustered based on their geographical location (villages) then six clustered village communities have been selected. Lastly, simple random sampling methods would be used to take the samples.

Among the selected clustered villages some has been selected based on those are living very close or near to the road sections and others are far from the road but those may have the

probability of moving along the road section for marketing , worshiping , health service and other purposes. Therefore, the sample size for the rural communities would be 142 out of 422.

Questionnaires for Bichena town administration and Debre Work town community has been firstly stratified type of sampling technique applied based on age and occupations later on simple random sampling has been used. Therefore, the sample size for Bichena town administration and Debre Work town community were 140 and 140 respectively out of 422.

3.7.2 Field inspection Data

Field inspection/observation is part of primary data collection methods which helps in the study area to evaluate the traffic safety by providing current gaps on the safety of the rural road section from Bichena to Debre work. the study area would be inspected according to (Brigada, Beograd and Tel, 2012) about the Function of the road, Cross sections, Alignment, Intersections, Junctions, Traffic Signals, Railway crossings, Service and rest areas (petrol stations, restaurants, shopping facilities, parking places etc.), Parking, Loading and Deliveries, Traffic signing, Markings, Lighting, Road side features (slopes, plantings, civil engineering structures, drainage ditches and other obstacles), Public Transport stops, Needs of pedestrians and cyclists (extra sidewalks and crossings).

3.8 Secondary data collection

Firstly, traffic volume data such as the average annual traffic volume has been collected on the study period of 2013 – 2017 from Ethiopia road authority. Secondly, crash data has been collected and an in-depth crashes study would be carried out in order to discover more about the factors that precipitate accidents and the opportunities for controlling or removing these factors. As a result, the five year road traffic crash data has been collected from the Bichena town administration, Enemay woreda, and Debre work woreda traffic police records from 2013 – 2017 years i.e (2005-2009 E.C). Therefore, after an in-depth analysis of traffic crashes it is clear that to identify the major influencing factors of road traffic crashes. Based on these factors it is better to relate the crashes with the influencing factors with a mathematical relationship. The relationship will be done by using regression modeling which helps to identify and assess the importance of various factors that contribute to accidents and injuries.

3.9 Data analysis techniques

The methodologies employed to analyze the data were both descriptive and inferential statistics. The data obtained will be checked and edited manually, then coded and entered into the computer using the Statistical Package for the Social Sciences (SPSS) software.

3.9.1 Primary data analysis

To evaluate the rural road traffic safety from Bichena to Debre work it is vital to collect a data and analysis has to be made to identify the major contributing factors, and to give possible engineering solutions for road traffic crashes. Thus, the primary data which is collected by the author were structured questionnaires (for pedestrian, traffic police, and drivers), and field observational data.

A. Questionnaire analysis

The questionnaire prepared for the target groups has both close ended and open ended types. the closed ended questionnaires for pedestrians are prepared for the purpose of knowing the demographic data of the respondent, his/her awareness about the traffic crashes level, to identify whether the respondents know about the traffic rule or not.

Closed ended questionnaires for driver prepared for the purpose of collecting the demographic data of the respondents, to know the attitude or perception of drivers about traffic crashes level, to know whether they are responsible to the live of the passenger, stray animal and pedestrians, to understand the driver commitment to the traffic rule.

closed ended questionnaires for transport and road officers, and traffic police men are also arranged likewise others to have a general understanding about demographic status, level of understanding about the cause of road traffic crashes, to know about the commitment of drivers and pedestrian about obeying the road traffic rules.

It is clearly known that open ended questionnaires are descriptive type by its nature because all the respondents have the right to clarify about the situation on his/her understandings. Therefore, these questions have been arranged for all respondents to understand the causes of road traffic crashes, mitigation methods and to know the hot spot areas susceptible to crashes in the study areas. Since it is described above for the open ended questionnaires nature, for the given questions included in the questionnaires form of all respondents the descriptive type of analysis has been utilized accordingly.

Generally, the organized data will be interpreted using Descriptive analysis methods in the form of tables, charts, and graphs. Regression models will be developed to interpret the effect of the independent variables (crash hour, driver age, types of crash, road way conditions,

driver experience, day of the week, ...,etc) on the dependent variables (the types of crash severity that occurred in the past five years along the study section).

B. Field inspection data analysis

Here it is to put clear methods how the field road observational data could be analyzed. the study section has been observed in details and the road has been unpaved before upgrading to asphalt surface road right now. Unfortunately, the author did not have the chance to see the unpaved road. So, the field conditions that lead to crash has been inspected based on the check list provided on the appendix 1 and described briefly.

3.9.2 Secondary data analysis

Secondary data such as five year road traffic crash data and AADT data has been collected. After the road traffic crashes data from all the three Woreda's has been collected then the author goes to enter in to SPSS software to analysis the parameters of road traffic crash data. Traffic crash data record format has the demographic parameters of driver and injured persons, detailed information's of vehicles involved and detailed information about roadway.

On the result parts it is tried to show how the five year traffic crashes severity will be related with another parameters like driver demography, roadway conditions, type of vehicle involved, day of the crash happening, etc. As a result, to have such result ordinal logistic regression modeling has used. Ordinal logistic regression or (ordinal regression) is used to predict an ordinal dependent variable given one or more independent variables.

Statistical Model

A statistical model has a great advantage in different fields of study to express the relationship between a response variable and explanatory variables. Regression models are used to develop a better understanding of the relationship between a dependent variable and a set of independent or explanatory variables. Regression modeling is often exploratory in nature. A number of different models may be developed to explain the behavior of a dependent variable of interest. The explanatory variables used in the model are restricted to those that are available on the survey data file; as a result the variables selected to explain the variation in a dependent variable may only be strong correlates of the actual causative factor. Model variables may be categorical, counts or continuous measurement variables.

Linear regression models are used when the dependent variables are counts or continuous measurements; logarithmic transformations are advocated for count data. Logistic regression is used when the dependent variable is a categorical variable defined at two levels; multinomial regression models may also be applied to categorical dependent variables with

more than two levels. Generally, Logistic regression may be useful when we are trying to model a categorical dependent variable as a function of one or more independent variables being the dependent variable has two outcomes.

Response variables

The response variable of the model has been chosen as the road traffic crashes severity from the traffic police daily recorded data. This is expressed as fatal injury, serious injury, and slight injury of human beings risk regarding with traffic crashes. It is clear to suggest that the peoples risk by traffic crashes has identified as slight physical injuries, serious physical injuries, and lastly death as a sequence of natural ordering.

Table 3- 2 dependant variable and coding

dependent Variable	dependent variable coding		
Y : types of road traffic crash severity	0: Fatal	1:serious injury	2: slight injury

Explanatory variables

The explanatory variables used in the model has been taken from traffic police daily recorded crashes data which is types of crashes, crash hours, day of the week, driver gender, driver education level, Driver relation with Vehicle, Experience of the Drivers (years), Vehicle type, Vehicle ownership, age of drivers, Road Geometry, Type of Road Pavement, Road surface condition, Lighting conditions, and Weather condition.

Table 3- 3 explanatory variable and coding

Independent Variable	Independent variable coding
X1 : types of crashes	0: vehicle to vehicle, 1:vehicle to pedestrian, 3: overturn, 4: others
X2: crash hours	
X3:day of the week	0:Monday, 1:Tuesday, 2:Wednesday, 3:Thursday, 4:Friday, 5: Saturday, 6: Sunday
X4:driver gender	0:male , 1:female
X5:driver education level	0:illiterate, 1:read & write informally, 2:primary education (grade 1-8), 3:secondary education(grade 9-12), 4: above preparatory
X6:Driver relation with Vehicle	0: private, 1:employeed, 2:rent
X7: Experience of the Drivers (years)	
X8:Vehicle type	0: light vehicle(two wheel, three wheel), 1: medium vehicles

	(minibus, Isuzu 24 seats, automobiles), 2: heavy vehicles (trucks, buses)
X9:Vehicle ownership	0: private, 1: governmental, 2: nongovernmental organization
X10:age of drivers	
X11:Road Geometry	0: straight , 1:steep gradient , 2:upward gradient, 3: curves
X12:Type of Road Pavement	0: dust, 1: gravel, 2: asphalt
X13:Road surface condition	0: dry, 1:wet
X14:Lighting conditions	0: day, 1: night
X15:Weather condition	0: good, 1: hot, 2:cool, 3:cloud

On types of crashes coding table 3- 7 above includes fall from vehicle, Collide with stop vehicle, Vehicle to static object, vehicle to animals ...etc.

Categorical response data

A categorical variable has a measurement scale consisting of a set of categories. They occur in highly quantitative fields such as engineering sciences and industrial quality control, when items are classified according to whether or not they conform to certain standards. The categorical variables are response variables. In some studies, they might also serve as explanatory variables. Statistical models for categorical response variables analyze how such responses are influenced by explanatory variables. The explanatory variables can be categorical or continuous (Agresti, 2007).

We can modify the binary logistic regression model to incorporate the ordinal nature of a dependent variable by defining the probabilities differently. Instead of considering the probability of an individual event, you consider the probability of that event and all events that are ordered before it.

Logistic regression analysis studies the association between a categorical dependent variable and a set of independent (explanatory) variables. The name logistic regression is used when the dependent variable has only two values, such as 0 and 1 or Yes and No. The name multinomial logistic regression is usually reserved for the case when the dependent variable has three or more unique values, such as Married, Single, Divorced, or Widowed.

In multiple regressions, a mathematical model of a set of explanatory variables is used to predict the mean of a continuous dependent variable. In logistic regression, a mathematical

model of a set of explanatory variables is used to predict a logit transformation of the dependent variable.

Odds ratio (OR) in logistic regression

Ordinal regression is used to predict the "odds" of having a lower or a higher value for your dependant variable(y), based on the independent variables(x). For interpretation of ordinal regression results is commonly used odds ratio. Odds ratio could be calculated by exponent of coefficients that is **exp** (β).

Generally, the odds ratio for variables in logistic regression represents how the odds change with a one unit increase in that variable holding all other variables constant. Or for every one unit increase/decrease in x, y increase/decrease respectively by OR. Where, here x and y represents expletory and response variables respectively.

Odds of an event are the ratio of the probability that an event will occur to the probability that it will not occur. If the probability of an event occurring is *p*, the probability of the event not occurring is (1-p). Then the corresponding odds is a value given by

Odds of {Event}= p / (1-p)

Since logistic regression calculates the probability of an event occurring over the probability of an event not occurring, the impact of independent variables is usually explained in terms of odds.

In statistics, the ordered logit model (also ordered logistic regression or proportional odds model), is a regression model for ordinal dependent variable. It is natural to consider methods for more categorical responses having more than two possible values. The most well-known of these ordinal logistic regression methods is called the proportional odds model. The basic idea underlying the proportional odds model is re-expressing the categorical variable in terms of a number of tertiary variables based on internal cut points in the ordinal scale (Reddy and Endale, 2015). The cut points may vary depending on the category types of the response variables.

We define the cumulative probability as the probability of being in category *j* or lower: $P(y \leq j) = P_1 + ... P_j$. It is called cumulative because it is the sum of the probabilities of being in the categories 1, 2, and so on, up to *j*. For example, let us say a response variable has four categories of cut points. (Strongly agree = 4, agree = 3, disagree = 2, and strongly disagree = 1).

The odds and its respective probabilities are:

θ_1 = P (score of 1) / P (score greater than 1); for *j* = 1 (strongly disagree): $P(y \leq 1) = P_1$

θ_2 = P (score of 1 or 2) / P (score greater than 2); for *j* = 2 (disagree): $P(y \leq 2) = P_1 + P_2$

θ_3 = P (score of 1, 2, or 3) / P (score greater than 3); for *j* = 3 (agree): P(y ≤j) = P_1+P_2+P_3

The last category doesn't have an odds associated with it since the probability of scoring up to and including the last score is 1.

All of the odds are of the form:

θ_j = prob(score ≤ j) / prob(score > j) or, θ_j = prob(score ≤ j) / (1 - prob(score ≤ j)) Since the probability of a score greater than *j* is 1 – probability of a score less than or equal to *j*.

Ordinal logistic regression

Ordinal logistic regression (OLR) is a type of logistic regression analysis when the response variable has more than two categorizes with having natural order or rank.

It is natural to consider methods for more categorical responses having more than two possible values. A categorical variable is considered ordinal if there is a natural ordering of the possible values, for example Low, moderate, and High. A number of proposed models for this type of data are extensions of the logistic regression model. The most well known of these ordinal logistic regression methods is called the proportional odds model. The basic idea underlying the proportional odds model is re-expressing the categorical variable in terms of a number of binary variables based on internal cut-points in the ordinal scale.

Ordinal regression will be enabling us to determine which of our independent variables have a statistically significant effect on our dependent variable.

Testing the Assumption of Proportional Odds

A commonly-used model for analyzing data with categorical ordinal outcomes is logistic regression with the assumption of proportional odds. This assumption, sometimes called the assumption of parallel lines, and it assumes that the effect of an IV on the ordinal DV is uniform over all of the categories or levels of the DV. That is, a one-unit increase in an IV has the same effect on the probability of a response being in a higher category regardless of category.

Ordinal Logistic regression Model

$$\text{logit}\left(\frac{\theta ij}{1-\theta ij}\right) = \text{logit}\left(\frac{P\ (yi \leq j)}{P\ (yi > j)}\right) = \alpha_j - (\beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_k X_k)$$

Where,

- θ_{ij} denotes the probability that the response of an individual with characteristics X_i falls in the jth category.
- j response categories.

- i observations
- $X_{1,} X_{2,}...,X_k$ are k^{th} explanatory variables.
- α_j = intercept for outcome ≤ j
- β= a vector of regression coefficient

The ordinal logistic model for the cumulative probability (θ_j**)** and k^{th} independent variable is then

$$\ln(\theta_j) = \alpha_j - (\beta_1 X_1 + \beta_2 X_2 + ... + \beta_k X_k) \quad , \quad \text{or}$$

$$\theta_j = P(y \leq j) = \frac{\exp(\alpha j - \beta 1X1 + \beta 2X2 + \cdots + \beta kXk)}{1 + \exp(\alpha j - \beta 1X1 + \beta 2X2 + \cdots + \beta kXk)} = \frac{P(yi \leq j)}{P(yi > j)}$$

Where;

j goes from 1 to the number of categories minus 1.

θ_j = the cumulative response probabilities

K =the number of explanatory variables

$X_{1,} X_{2,}...,X_k$ are k^{th} explanatory variables.

α_j = intercept for outcome ≤ j

β= a vector of regression coefficient

j response categories.

i observations

According to YILDIZ, (2014) reviewed from O'Connell, 2006 on the above equation, dependent variable Y consists of J ordinal categories. Like the other models, one category is chosen as the reference category (generally the highest category). J – 1 cut-off points are estimated this way and the estimations give information for every consecutive category about cumulative probabilities. Probability of being in the chosen category or being in a lower category is taken into account together in cumulative probability.

Ordinal regression is a member of the family of regression analyses. As a predictive analysis, ordinal regression describes data and explains the relationship between one dependent variable and two or more independent variables. In ordinal regression analysis, the dependent variable is ordinal (statistically it is polytomous ordinal) and the independent variables are ordinal or continuous-level (ratio or interval)(Statistics Solutions, 2014).

According to Statistics Solutions, (2014) there are three major uses for Ordinal Regression Analysis: causal analysis, forecasting an effect, and trend forecasting. Other than correlation analysis for ordinal variables, which focuses on the strength of the relationship between two or more variables, ordinal regression analysis assumes a dependence or causal relationship

between one or more independent and one dependent variable. Moreover the effect of one or more covariates can be accounted for.

Generally, **ordinal regression** might be used to identify the strength of the effect that the independent variables have on a dependent variable. A typical question is, "What is the strength of relationship between dose (low, medium, high) and effect (mild, moderate, severe)?"

Ordinal regression can be used to forecast effects or impacts of changes. That is, ordinal regression analysis helps us to understand how much will the dependent variable change, when we change the independent variables. A typical question is, "When is the response most likely to jump into the next category?"

Ordinal regression analysis predicts trends and future values. The ordinal regression analysis can be used to get point estimates. A typical question is, "If I invest a medium study effort what grade (A-F) can I expect?"

Categorical variables have two main types of measurement scales. Many categorical scales have a natural ordering. For example (low, medium, high), response to a medical treatment (excellent, good, fair, poor), and frequency of feeling symptoms of anxiety (never, occasionally, often, always). Categorical variables having ordered scales are called ordinal variables.

Categorical variables having unordered scales are called nominal variables. Examples are religious affiliation (categories Catholic, Protestant, Muslim, Orthodox, other), primary mode of transportation to work (automobile, bicycle, bus, subway, walk), and favorite place to shop (local mall, local downtown, Internet, other). For nominal variables, the order of listing the categories is irrelevant. The statistical analysis should not depend on that ordering. Methods designed for ordinal variables utilize the category ordering. Whether we list the categories from low to high or from high to low is irrelevant in terms of substantive conclusions, but results of ordinal analyses would change if the categories were reordered in any other way(Agresti, 2007).

Accident Rate methods has been used to identify the most hazardous locations along the selected road segments. An accident black spot refers to a section of a road regarded as a high-risk location for vehicle crashes. Identification of accident black spots was carried out using the crash rate method. The crash rate formula was used to determine the ranking of accidents for every kilometer. Based on Atsbeha, (2014) reviewed from Layton, 1996; and McMillen, 1999 Accident rate method uses accident numbers divided by vehicle number to provide rates such as accidents per million entering vehicles per spot location and accidents

per million vehicle-Km for sections of highways. Locations with higher than a predetermined crash frequency are classified as high accident locations. Crash rates must account for exposure, which is the opportunity for a crash to occur, and traffic volumes are one of the most used factors to measure exposure. Clearly, comparing locations by crash rate requires traffic volume data and the length of the roadway segment that is being analyzed. For this study a road segments of 1 km length has been chosen.

The number of reported crashes to calculate crash rates corresponds to the validated data; only the reports obtained and confirmed as valid should be counted. This practice might underestimate the actual crash rate but ensures a more rigorous comparison between the different roadways analyzed. The accident data or the secondary data was collected from reports maintained by the police departments of respective woreda along study segments. It comprised of five years of accident records. The data provided by the police department consisted of time, location, type of accident and other details such as vehicles involved regarding the cause of Accident.

In statistical terms, road crashes at individual sites are rare, random, multifactor events. This means that comparison between the numbers of road crash at particular site must be made with respect to a fixed time period, typically one year. Furthermore, a single year data will be subjected to considerable statistical variation. Ideally, several years data are required, from which a mean, annual road crash rate can be calculated. Three years is generally regarded as a practical minimum period for which a reasonably reliable annual average rate can be calculated. Due to non availability of the data for three years, in this analysis one year data has been considered to discover the road crash prone locations (Dhruvit and Shah Pranay, 2016).

4. DATA ANALYSIS AND DISCUSSION

4.1 Introduction

Evaluation of the rural road traffic safety in East Gojjam specifically a case study Bichena to Debre work with six selected villages: Debre work, Telma, Woyra, Gotera, Woynam, and Bichena has been done. The reason for choosing these villages is that they represent rural villages and town villages serviced by the selected study rural road sections.

The researcher has been utilized two approaches of gathering information. The first approach involved primary data collection: such as structured questionnaire (for pedestrian, driver and traffic police), and Field observation (inspection), while the second approach involved secondary data collections: such as AADT and road traffic crashes data.

This chapter presents the research findings, analysis and interpretations of the results acquired from both the primary data and secondary data. Statistical methods of analysis were used which included a descriptive and inferential analysis.

4.2 Research findings

This study investigated the rural road traffic safety with special focus on rural villages and town villages of Debre work, Telma, Woyra, Gotera, Woynam, and Bichena. Data from these villages were collected from April to June 2018. The data were collected in two ways as mention on above. The researcher adopted these two approaches so that they can complement each other on validating the research results obtained. Each of the two methods used for data collection addressed different themes relevant to the objectives of the study. The structured questionnaire was used to collect data that would be representative of the local community's and therefore four hundred and twenty two (422) questionnaires were distributed to each of the six villages. In total, four hundred and eleven (411) questionnaires were collected from the six villages. The face-to-face interview was conducted with the traffic police men, woreda road and transport officials. Field observation and speed inspection on the study segment also involved in the research. The presentation and analysis of this study is therefore done in two parts. The first part will focus on primary data and the second part will provided secondary data.

4.3 Primary data analysis

4.3.1 Descriptive analysis

Statistical analysis that would use for primary data analysis in this study is descriptive statistics such as a table, bar charts to describe the frequency distribution and percentage.

I. Data collected through questionnaires

Questionnaires: a collection of questions given to different people in the same form. Data collected through questionnaires were obtained from the general population of the study areas. The researcher made sure that the questionnaire distributed to the identified villages will be acceptable to be representative of the rural villages under the jurisdiction of East Gojjam zone road traffic safety and transport core process. Thirty five (35) questionnaires were then randomly distributed to each of identified four rural villages of the study area (Telma, Woyra, Gotera, and Woynam), and one hundred and fourthy (140) for each of Bichena and Debre work towns. In order to ensure that reliable and relevant data that would satisfy the objectives of this study were obtained, the researcher structured the questionnaire into four information seeking categories. The questionnaire sought to establish the following relevant information: Biographical information, respondents' practical road usage information, the perception of respondents about roads traffic safety, and the level of satisfaction (rating) by the respondents' about road traffic safety.

Response rate

The proportions of questionnaires given to the sample are completed and which should be as high as possible in order to minimize possibility of bias (to make sure the sample is representative of the population). After checking the reliability and validity of the questionnaires the researcher distributed 422 questionnaires for pedestrians. Among the total questionnaires distributed 411 questionnaires' for pedestrians were completely filled, valid and returned to the researcher. The other 11 questionnaires were defected on account of different reasons. Additionally, the response rate of drivers has been mentioned as follows in the table 4- 1 below, the response rate of the driver indicated that all the questionnaires distributed to the drivers were completely filled by the respondents.

Table 4- 1 Questionnaires response rates

Target group		Total	Percent
Pedestrian questionnaires response rate	Total questionnaire distributed	422	100
	Questionnaire collected	411	97.39
	Questionnaire defected	11	2.61
Driver questionnaires response rate	Total questionnaire distributed	80	100
	Questionnaire collected	80	100
	Questionnaire defected	0	0

Source: own survey

i. Analysis methods of the pedestrian questionnaires

a) Demographic (Biographical) Profile of Respondents

Biographical information of the respondents is significant in research. It gives a clear picture about the type of participants the researcher is dealing with. This also helps in determining the reasons for a variety of responses which are influenced by biographic factors. In establishing the biographical information of respondents in this regard, the researcher surveys the following biographical information: gender, educational status, and age group. The findings with regard to demographical information demonstrated as follows:

As shown on Table 4- 2 below the questionnaires responded by pedestrian are explained in terms of frequency, such that respondents participated on the survey were 244 (59.4%) males and 167 (40.6%) females. in view of the fact that age has its own effect on individual understanding of situations with different perspective, it has been included in the analysis as shown Table 4- 2. as it is shown respondents frequency versus age groups, it is clear that which age group is more participated on the survey part. 211(51.3%) were becomes in the age group of 18-30 years, 30- 50 year age group follow with a frequency of 100(24.3%), the others 14-17 years, 7-13 years, unknown age of respondents, and >50 year follow respectively. Generally, the active age group of population has been sampled as a major sample because of the working force age group is more of in 18 - 50 years old in Ethiopia.

Education brings behavioral change of the society as a whole. As a result, it is desired to include the educational qualification of respondents to understand very well about the awareness of the community on the study sections relative to his/her qualifications. Table 4- 2 shows the information of respondents' frequency regarding with educational level. these of the respondents whom are grade 1-12 and whom are completed this grades have participated in the survey with a maximum percentage of other with 98(23.8%). another respondents

categorized as above preparatory has recorded 52 (23.4%), illiterate groups 63(15.3%), 52(12.7%) these respondents can read and write who participated on the study survey. four (1%) respondents were participated whom are not volunteer to mention it or they may be forgot it.

Here it is tried to show the respondents frequency with respect to occupations on survey participation. It is necessary to depict because the educational level of qualified person may joined with different occupations. Example; one degree holder individual may join with office work or/and private work. From Table 4- 2 shown below respondents participated depend on occupation: private workers (26.8%), students (26.3%), office workers (18.5%), farmers (16.8%), unemployed (11.2%), and pedestrian didn't mentioned occupation were (0.5%).

Table 4- 2 Demographic Profile of Respondents

		Frequency	Percent
Gender	male	244	59.4
	female	167	40.6
	Total	411	100.0
Age	7-13 year	29	7.1
	14-17 year	52	12.7
	18-30 year	211	51.3
	30-50 year	100	24.3
	> 50 year	9	2.2
	age unknown	10	2.4
educational level	Illiterate	63	15.3
	read and write/informal	52	12.7
	primary education(1-8)	98	23.8
	secondary education(9-12)	98	23.8
	above preparatory	96	23.4
	unknown	4	1.0
Occupation	Private Worker	110	26.8
	Unemployed	46	11.2
	Student	108	26.3
	office worker	76	18.5
	farmer	69	16.8
	unknown	2	.5
	Total	411	100.0

b) Respondents Perception about road traffic crashes

In this subsection of questionnaires analysis some of the information about the road traffic safety related with pedestrian understanding has been discussed. therefore, it is to let pedestrians mention their background knowledge on level of road traffic crashes, pedestrians recognition on proposed accident reduction methods, overloading (participating as a passenger above the capacity of vehicle seat), and most familiar collision experienced on the study sections.

Here the author interested to know the attitude of respondent about level of road traffic crashes in the study area. As a result, the respondents agreed on as it is a big problem with 321(78.1%), a moderate problem 63 (15.3%), not a problem 8 (1.9%), and lastly some respondent not mentioned their idea with 19 (4.6%) out of 411(100%) respondents.

Almost all the surveyed respondents agreed on overloading might be the causes of road accident based on Table 4- 3. the respondents believe on overloading were depicted as 93.4% of agree on it is a cause of traffic crash accident and 6.6 % agreed on as it did not leads to traffic crashes. Even though 93.4% of respondents has blamed overloading as it leads to crashes 79.8 % respondent has witness as they are participating a passenger above the capacity of the vehicles.

Table 4- 3 Respondents Perception about road traffic crashes

		Frequency	Percent
Now How do you perceive the level of road traffic accident problems?	A big problem	321	78.1
	A moderate problem	63	15.3
	Not a problem	8	1.9
	unknown	19	4.6
	Total	411	100.0
Do you believe that overloading lead to traffic accident?	yes	384	93.4
	no	27	6.6
	Total	411	100.0

According to table 4- 4 below, the perceptions of pedestrian on proposed crash reducing methods has been surveyed and the following results has been recorded as; Improving road safety education 400 (97.3%), prohibit walking along the roadway 393 (95.6 %), do not participate as a passenger above the capacity of vehicles seat 365 (88.8%), obey traffic rules and signs 350 (85.2%), share traffic rule awareness to the children & others 348 (84.7%),

Avoid alcohol intoxication while walking 334 (81.3%), use zebra crossing 280 (68.1%), and Avoid illegal crossing 258 (62.8%).

Table 4- 4 Pedestrians' perception on proposed crash reduction methods

		Frequency	Percent
Avoid illegal crossing/ crossing without proper precautions	Not selected	153	37.2
	selected	258	62.8
Obey traffic rules and signs	Not selected	61	14.8
	selected	350	85.2
use zebra crossing	not selected	131	31.9
	selected	280	68.1
Do not participate as a passenger above the capacity of vehicles seat	not selected	46	11.2
	selected	365	88.8
improving road safety education	Not selected	11	2.7
	selected	400	97.3
prohibit walking along the roadway	Not selected	18	4.4
	selected	393	95.6
share traffic rule awareness to the children & others	Not selected	63	15.3
	selected	348	84.7
Avoid alcohol intoxication while walking	Not selected	77	18.7
	selected	334	81.3

c) Respondents rating about traffic police men and drivers

Pedestrians who live along the study area segment have been taken as a source of information for evaluations of rural road traffic safety on traffic police and drivers' commitment to their job. As a result, an attention has given to them because they know very well how drivers and traffic police perform their tasks. So, it is tried to carry out survey on pedestrians for the driver and traffic police commitment to their tasks accordingly. In this section the pedestrian rating system on both driver and traffic police will be discussed. According to the pedestrians response shown on Table 4- 5 below, traffic police commitment to their duties has been evaluated and 50.1% of the response has rated with a good rating range followed by a poor rating results of 36.0%, and lastly they have got very good rating with13.9%.

As Table 4- 5 it is possible to conclude that driver did not give priorities to the pedestrian because the respondents has been rated 45.75% with poor rate and next 26% with very poor rating , lastly 21.9% and 6.3% followed by good and very good response rates respectively.

Table 4- 5 Respondents rating about traffic police men and drivers

		Frequency	Percent
How do you rate the traffic police commitment to their duties?	very good	57	13.9
	good	206	50.1
	poor	148	36.0
How do you rate drivers give priorities to pedestrians as required by law.	very good	26	6.3
	good	90	21.9
	poor	188	45.7
	very poor	107	26.0
	Total	411	100.0

d) Respondents' practical road usage information

On the study area current conditions of what pedestrian has been done while moving along the road and to check in what percent did they know the road traffic rule, here is the respondents response discussed below.

According to Table 4-6 below, more than half of the surveyed respondents 234 (56.9%) has responded as they have sometimes moving on the roadway leaving the walkway, 113(27.5%) always, 54 (13.1%) they never move on the roadway, and lastly 10(2.4%) of respondents did not select their choice. Table 4- 6 shows that 86.4% of the respondent has been moving on the left side, 4.9% moves on the right side, 2.7% they have not utilizing road the nearly, and 6.1% were not mention their idea. in order to know the respondents awareness about traffic signs, road marks and rule the survey has been carried out with different field of respondents such as farmers, office workers, unemployed, students, and private workers has been chosen. The response result has show 44% of respondents did not know traffic rules and 53.3% know very well. From the Table 4- 7, 79.8% of the respondent has involving as a passenger above the capacity of the vehicles. However, 20.2% of them were not participated as a passenger.

Table 4- **6** Respondents' practical road usage information

		Frequency	Percent
How frequent do you have to leave sidewalks and walk along roads?	always	113	27.5
	sometimes	234	56.9
	never do this	54	13.1
	unknown	10	2.4
Which one do you apply while you are walking along roads?	moving on the left side	355	86.4
	moving on the right side	20	4.9
	have not go around the road	11	2.7
	unknown	25	6.1
Do you know traffic signs, road marks and rule very well?	yes	219	53.3
	no	181	44.0
	unknown	11	2.7
Do you become as a passenger above the loading capacity of the vehicle?	yes	328	79.8
	no	83	20.2
	Total	411	100.0

Based on the respondents' response on Table 4- 7 below, 62.5% were sometimes, 30.2% were always, and 7.3% of the respondents have never crossed the road.

Table 4- 7 pedestrians' zebra using practice

		Frequency	Percent
While you are crossing the main road how often do you use zebra crossing?	always	59	14.4
	sometimes	72	17.5
	no zebra crossing	175	42.6
	cross everywhere	105	25.5

ii. Analysis methods of Traffic police questionnaires

a) Demographic profiles of respondents

Demographic information of the respondent has a great impact on the analysis of the questionnaires because the respondent understanding might be depend on age, sex, educational level, and Experience of service.

On Table 4- 8 below, the respondent age it is clearly enabled to have information with questionnaires 30-40 years and 25-29 years aged respondents has been participated with equal level of participations, and that of 41-50 years has been participated with 16.7%.

As it is observed Table 4- 8 below, the number of traffic police men in each woreda is small in number. actually Bichena town administration has three traffic police men, Enemay woreda has three traffic police, Enargi Enawga woreda has two traffic police but for the purpose of more clarifying the causes and remedial solution of the road traffic crashes in the selected section of the study area it is required to add woreda level road and transport process officers' as a respondent that is why the total number of the respondent is become 12. Among the total respondents 25% covers female traffic polices and 75% covers male respondents. Educational level of the respondents has been shown on Table 4- 8 as 66.7% of the total respondent covers degree level, and the rest of 33.3% covers diploma.

Table 4- 8 shows the experience of respondents with 41.7% of both 5-8 year and above 11 year experience, following with 16.7 % less than 3 year experience. Note that almost all traffic police men categorized above 11 years age group.

Table 4- 8 Demographic profiles of traffic police

		Frequency	Percent
age of traffic police	25-29 year	5	41.7
	30-40 year	5	41.7
	41-50 year	2	16.7
sex of traffic police	male	9	75.0
	female	3	25.0
educational level of traffic police	Diploma	4	33.3
	Degree	8	66.7
Experience of service	Less than 3 years	2	16.7
	5-8 years	5	41.7
	above 11 years	5	41.7
	Total	12	100.0

b) Respondents Perception about road traffic safety

According to Table 4- 9 below, the survey interested to get the perceptions of the respondent regarding with which vehicle causing a high number of traffic crash in the study section medium vehicles such as minibus, Isuzu (24 seats), and automobiles has been identified as major vehicles causing crashes. The type collision has been identified based on the

respondent perception as 33.3% covers with vehicle to vehicle, 25% with vehicle to bicycle, and vehicle to pedestrian with 16.7%. On the installation of the road traffic signs, marking and lights on the important areas, there is no sign marking and they have not responded. So, 100% No. Table 4- 9 below shows on the study section 91.7% of the respondent has not agree on as there has been enough number of traffic police men in the study sections. According to Table 4- 9, 50% of the respondent has been agreed on public has been alerted about traffic accidents by traffic police men and that of 50% has not agreed on. According to the traffic control mechanism mentioned below on Table 4- 9, 75% covers public awareness makes a more effective safety control methods.

Table 4- 9 traffic police Perception about road traffic safety

		Frequency	Percent
Which types of road accidents or collision were highly prevailing?	vehicle to vehicle	4	33.3
	vehicle to bicycle	3	25
	vehicle to pedestrian	2	16.7
	vehicle to object	1	8.3
	unknown	2	16.7
Which type of vehicles is causing high number of road accidents?	medium vehicles (minibus, automobiles)	12	100
Do you think that the road has enough road traffic signs, marking and lights in all important areas?	no	12	100
Do you believe that there is enough traffic police?	yes	1	8.3
	no	11	91.7
Do you think that woreda traffic police has created enough awareness about road traffic accidents for the population?	yes	6	50
	no	6	50
Which one is more effective road safety control method to reduce the traffic accident in this woreda?	traffic light, signs and markings	2	16.7
	traffic police control	1	8.3
	creating public awareness	9	75
	Total	12	100

c) Respondents rating about Pedestrians and drivers

Based on Table 4-10 below**,** the respondent rating on the study area; pedestrian has not given priority for vehicle on the required environment. As respondents rating on the driver in giving priorities for pedestrian required by law has rated as poor level of treating the pedestrian.

Table 4- 4 traffic police rating about Pedestrians and drivers

		Frequency	Percent
How do you rate pedestrians expectation for vehicles in giving priorities where they using roads?	good	2	16.7
	poor	7	58.3
	very poor	3	25.0
How do you rate drivers in giving priorities for pedestrian?	good	1	8.3
	poor	7	58.3
	very poor	4	33.3
	Total	12	100.0

iii. Analysis methods of the driver questionnaires

a) Demographic profiles of respondents

From Table 4- 11 below, the survey on the study road sections only male drivers has been observed. As shown on Table 4- 11, 100% of the respondent was males. Based on the survey as shown on Table 4- 11**,** above 33(41.3%) of the respondent included in 18-30 years aged categories following with 31-50 years , <18 years, and >50 years aged drivers respectively. The driver educational level has been tried to gather. As a result, 47.5% of drivers have been Primary education (1-8) levels, 38.8% of them were Secondary education (9-12), 3.8% were read and write/informal, with 10% of drivers did not mentioned their educational level. On drivers driving license level survey 45% of the drivers were first level holders, 22.5% of drivers were second and third level holders, and 10% drivers' fourth level holders.

Table 4- 5 Demographic profiles of respondents (Driver)

		Frequency	Percent
driver gender	male	80	100.0
	Female	0	0
driver age categories	< 18	24	30.0
	18-30	33	41.3
	31-50	20	25.0
	> 50	3	3.8
driver level of education	read and write/informal	3	3.8
	Primary education (1-8)	38	47.5
	Secondary education (9-12)	31	38.8
driver license level	first level	36	45.0
	second level	18	22.5
	third level	18	22.5
	fourth level	8	10.0
	Total	80	100.0

b) Respondents Perception about road traffic crashes

On Table 4- 12**,** the study section of the road traffic crashes were happening based on the respondents perception 49(61.3%) on public holiday, 29(36.3%) on weekend, 2(2.5%) were on working days. Most of the drivers has been perceived as speeding will be the causes of road traffic crashes with 52(65%) and 28(35%) has been not perceived as a causes of traffic crashes.

Table 4- 6 Drivers Perception about road traffic crashes

		Frequency	Percent
In your understanding, which point of time traffic accident is more?	Working day	2	2.5
	Weekend	29	36.3
	On Public Holyday	49	61.3
Do you think that speeding will lead to traffic accident?	yes	52	65.0
	no	28	35.0
	Total	80	100.0

c) Respondents rating or views about traffic police

As shown on Table 4- 13, drivers has rated 33.8% both very good and poor rating levels , and the rest of rating covers 32.5% with good to traffic police men.

Table 4- 7 Drivers rating/views/ about traffic police

		Frequency	Percent
How do you rate the traffic police commitment to their duties?	very good	27	33.8
	good	26	32.5
	poor	27	33.8
	Total	80	100.0

d) Driver practical experience on the road information

According to Table 4- 14 below**,** the practical driving practice of drivers has been evaluated and the following points regarding with these information seat below. The duration of drivers experience on the road segments has the frequency with its percentages of 35(43.8%) with 1 - 2 years, 18(22.5%) 3-5 years, 14(17.5%) 6-7 years, 7(8.8%) one years and below, and 6 (7.5%) 8-10 years. The practice of making overloading by the drivers has the frequency of 45(56.3%) with sometimes, 25(31.3%) never do make overload, and 10(12.5%) of respondents were make always overloading. Drivers approximate driving speed on the rural sections were responded as 68(85%) 80-100km/hr, 8(10%) 60-80km/hr, 3(3.8%) >100km/hr, and 1(1.3%) were 20-40km/hr. Giving priority for pedestrians has been responded by the drivers with the frequency of 56(70%) always, 21(26.3%) sometimes, and 3(3.8%) of the respondents were never give priorities.

Based on Table 4- 14, 23(28.8%) of drivers were used drug and driving and 57(71.3%) were not driving while drugging. 57(71.3%) of drivers use seat belt, 12(15%) sometimes, 11(13.8%) were did not wear seat belt while driving. Those of the respondents' not wearing seat belt were responded the reasons why not wear seat belt as "I always miss it" 17(21.3%), and "it is not comfortable" 6(7.5%).Among the respondents of the study 30(37.5%) were using mobile phone while driving and 50(62.5%) were not used the mobile phones. Respondents also mentioned their alcohol usage condition with driving as 11(13.8%) were using usually, 29(36.3%) sometimes, 40(50%) were never used alcohol at the condition of driving.

Table 4-14 shows also 43(53.8%) were involved in crashes; among these drivers faced with crashes: 13 (16.3%) once, 16 (20%) twice, 5 (6.3%) three times, 9 (11.3%) were four times involved. Moreover, among those drivers face with crashes 42 (52.5%) has reported to traffic

police and 38(47.5%) crashes were not reported to the traffic polices. Additionally, 31(38.8%) of drivers has been driven while they have got tired, 47(58.8%) sometimes, and 2(2.5%) were never. Based on the analysis 43(53.8%) were distracted on the condition of driving, and 37(46.3%) were responded not distracted while driving.

More than half of the respondents that is 49 (61.3%) were have got training about road traffic safety, and 31(38.3%) were not got training. Finally, the respondents' practical driven on town section with an approximate speed of 31(38.8%) with 40-50km/hr, 21(26.3%) both with 20-30 & 30-40km/hr, and 7(8.8%) of them were driving less than 20km/hr.

Table 4- 8 Drivers practical experience on the road information

		Frequency	Percent
How long have you been driving from Bichena to Debre work?	1 year and below	7	8.8
	1-2 year	35	43.8
	3-5 year	18	22.5
	6-7 year	14	17.5
	8-10 year	6	7.5
How often do you make overloading?	always	10	12.5
	sometimes	45	56.3
	never do	25	31.3
what is your normal speed (approximately) between Bichena to Debre work?(except Bichena and Debre work town)	20-40km/hr	1	1.3
	60-80km/hr	8	10.0
	80-100km/hr	68	85.0
	> 100km/hr	3	3.8
Have you give priorities to pedestrians as required by law?	always	56	70.0
	sometimes	21	26.3
	Never	3	3.8
Have you drive while using drug?	yes	23	28.8
	No	57	71.3
Do you wear a seat belt when you drive?	always	57	71.3
	sometimes	12	15.0
	never	11	13.8
If your answer is ‘never wear a seat belt on the above question ’, what is the reason?	not comfortable	6	7.5
	I always miss it	17	21.3

Do you use mobile phone while driving?	yes	30	37.5
	no	50	62.5
Do you drive when you drunk any alcoholic beverages?	usually	11	13.8
	sometimes	29	36.3
	never	40	50.0
Have you faced accidents while driving?	yes	43	53.8
	no	37	46.3
If yes, how often do you involved in accidents?	once	13	16.3
	twice	16	20.0
	three times	5	6.3
	four times	9	11.3
Did you distracted by any means while driving?	yes	43	53.8
	no	37	46.3
If you are involved in accidents have it reported with traffic police?	yes	42	52.5
	no	38	47.5
How often do you drive while you have got tired?	usually	31	38.8
	sometimes	47	58.8
	never	2	2.5
Have you got additional training about road safety by concerned body?	yes	31	38.8
	no	49	61.3
While you have driving in Bichena and Debre work town, what is your speed approximately?	< 20km/hr	7	8.8
	20-30km/hr	21	26.3
	30-40km/hr	21	26.3
	40-50km/hr	31	38.8
	Total	80	100.0

iv. Open ended questionnaires analysis

i. Pedestrian questionnaires

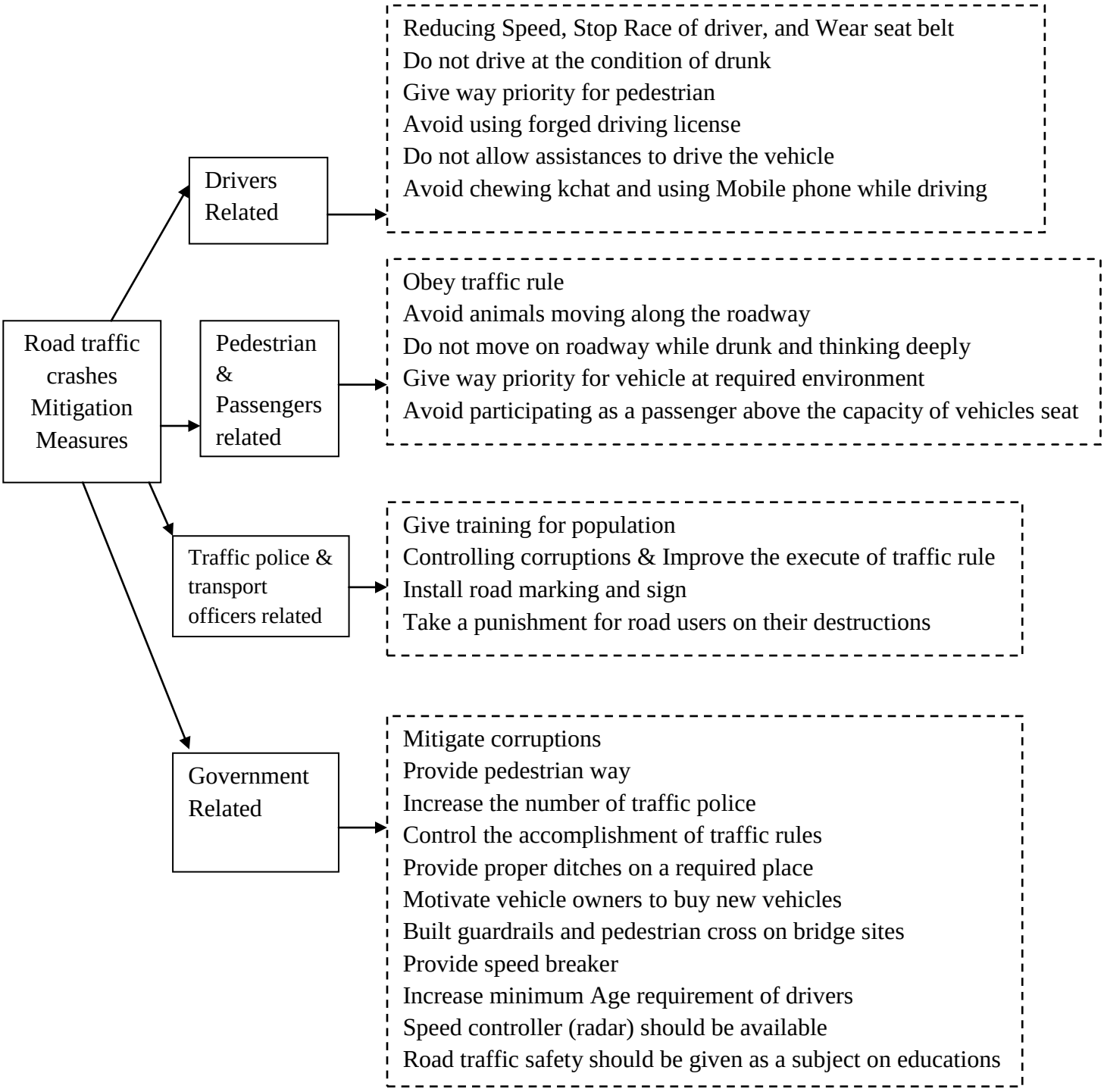

Figure 4- 1 pedestrians open ended questionnaire analysis

Figure 4- 1 above shows the road traffic crashes mitigation methods proposed from the respondent open ended questionnaires. As a result, respondents response indicates that all government, drivers, pedestrians/and passengers, traffic police and transport officers should strive to reduce the crashes.

ii. Driver questionnaires

Drivers point of recommendation on prevent and reduction of road traffic accidents are classified based on the responsibilities of the governments, drivers, Road user (pedestrian & passengers), and Traffic police and transport officers related as described below:

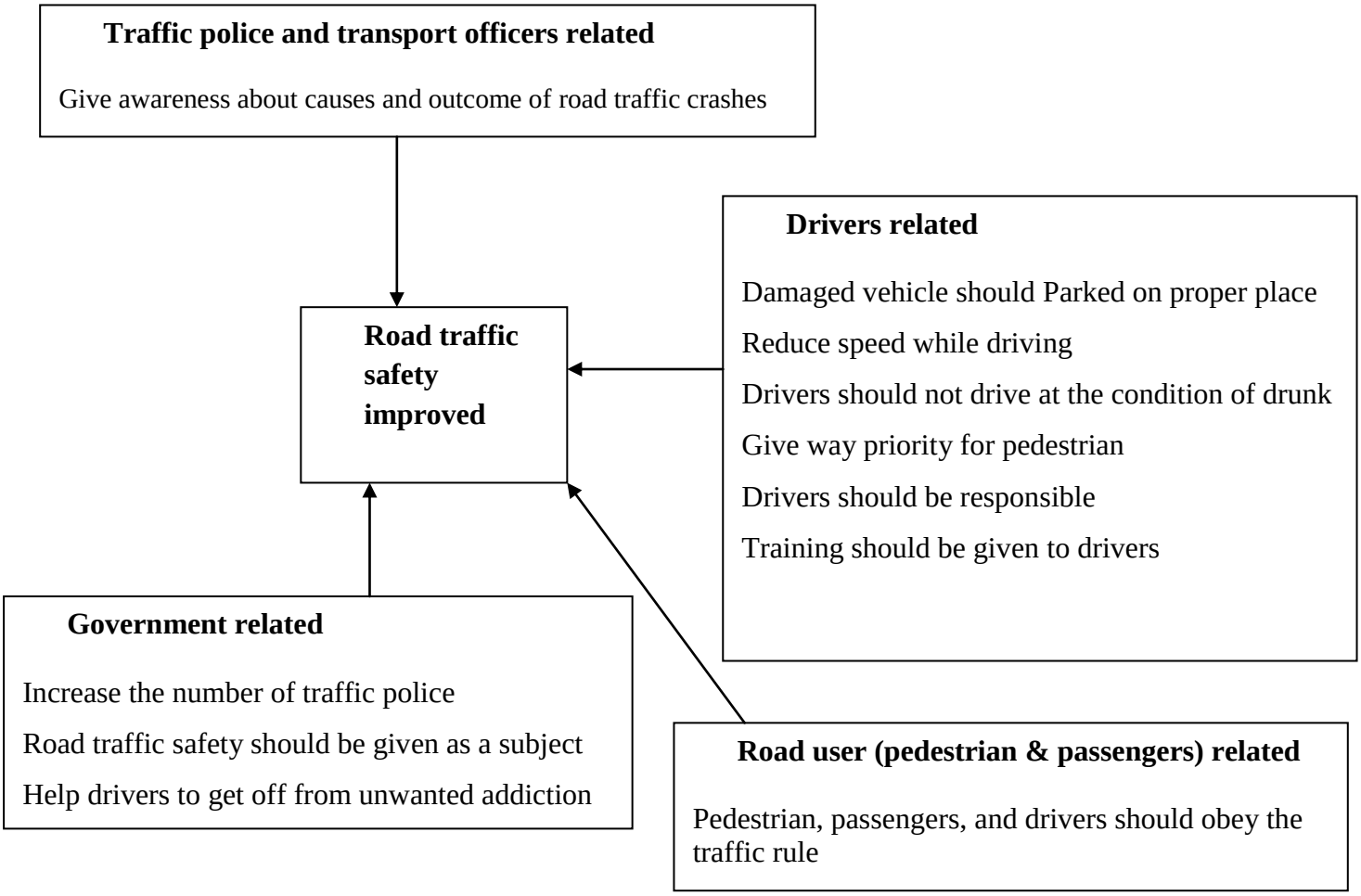

Figure 4- 2 drivers open ended questionnaires' analysis

to prevent and reduce the road traffic crashes on the study area respondents suggested focusing on drivers, government, road users, Traffic police and transport officers related point of recommendation as shown above figure 4 - 2.

As shown on figure 4 – 2 above the drivers respond as to achieve the improved traffic safety in road system all drivers, pedestrian, government, and traffic police should attempt to reduce the traffic crashes.

iii. **Traffic police and transport officials open ended questionnaires analysis:** to prevent and reduce the road traffic crashes on the study area respondents suggested

focusing on drivers, government, road users, Traffic police and transport officers related point of recommendation as shown above figure 4 - 3.

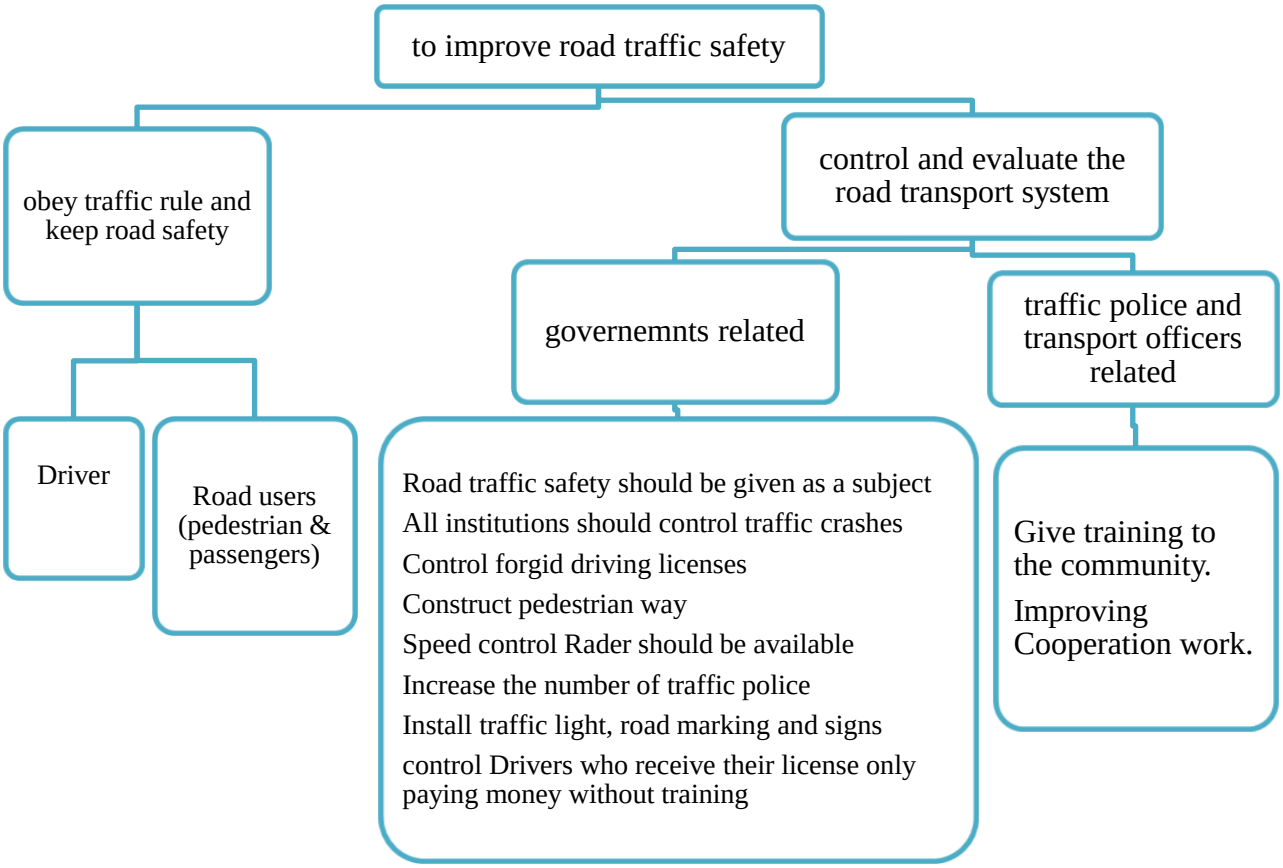

Figure 4- 3 Traffic police and transport officials open ended questionnaires analysis

Traffic police and transport officials rated drivers speed as, Even though no radar there is over speeding and very high.

II. Field inspection of the study segments

road safety inspection is an on-site detailed review of an existing road looking for potential problems. In the road survey, a review and documentation of the characteristics of the roadway need to be conducted. The road survey comprises not only the physical features of the roadway but also traffic operations, roadside development, different users of the roadway, and environmental conditions.

i. Checklists

The purpose of road safety review checklists is to assess in identifying any potential safety issues. Many of the elements considered in the checklists may not be relevant to the roadway

being review or others may seem repetitive. The checklist has been proposed keeping the same four major areas described in the road survey section, which include geometric design elements(Speed, Road alignment, Cross section, Intersections, Auxiliary lanes, Clear zones and crash barriers, Bridges and culverts, Pavement, and Lighting), traffic control devices(Traffic signals , Marking and delineation), roadway activity(Pedestrians, Cyclists, Parking and public transport , and Heavy vehicles, emergency vehicles and slow-moving vehicles), and environmental considerations (Weather, and Animals).

Road safety inspections is to systematically identify and treat defects in design and traffic control on existing roads, ideally speaking before these defects contribute to accidents. in this study inspection of the road has been achieved according to (Brigada, Beograd and Tel, 2012) inspection format(checklist) as shown Appendix 1:

Road: asphalt

Section: Bichena to Debre work town.

The road safety field inspection result

1. Function and surrounding

• upgrading of gravel road to asphalt road is suitable for its today function.

• Some small accesses without appropriate signs (access to private properties and farmland).

• Speed limits sign, traffic signs and pavement marking should be provided.

2. Cross sections

• The study road segment has one traffic lanes per each direction.

• Paved carriageway about 7.0 m: additional gravel shoulder of about 1.5 m in rural areas of flat and rolling terrain and 0.5m in rural areas with mountainous and escarpment terrain are provided. Longitudinal markings or edge of asphalt should be established.

• At some places there are no ditches and connection with the ditches is blocked with soil and stones, leads to inadequate drainage in the case of heavy rain falls.

• It is vital to install the prohibited signs in the appropriate places such as traffic of horse carts and cyclist in town areas.

• Most of drivers are driving with excess speed: Lack of Police speed control and speed breaker.

3. Alignment

• Sight is obstructed by vegetation mostly in Ethiopian summer seasons around 40+050 which is between Telma and Woyra. And also from the drivers point of view it is pointed that

around 50+500 (Agulach that is near to Debre work St. Trinity church) sight distance is not good.

4. Intersections

• There are few small intersection (right of way was not signed - stop signs are missing).

• on the study road segments intersections there has been observed some sloped connection (at station 53+240) in Debre work town and another one has not smooth connection.

• In the most cases no sufficient sight conditions for the drivers (sight was obstructed by vegetation, houses, parked vehicles, etc.)

5. Traffic signals, Railway crossings, Public transport, and Needs of vulnerable Road users

• No facilities, no comments

6. Service and rest areas

• Rest areas (control terminal) exit around the gasoline station where in Bichena town is there and no parking facilities are on the sides of the road.

•The control terminals of Debre work town is not enough good to handle vehicles at Ethiopian summer, as a result drivers forced to park these vehicles on the road sides at the entrance of control terminals that leads to crashes.

• The sight around the control terminals of Bichena town are obstructed by parked vehicles and vehicles that were serve charging on gasoline station.

7. Traffic signing, marking and lighting

• Visibility of the road especially at night should be improved by adding the delineators.

• Some stop signs are missing at access roads, and speed limit signs (signs and markings should be installed for the both direction).

• There are no information signs for gasoline station, parking area, and other utility.

• Vegetation causes the problems to the sign visibility.

• Markings should be renewed through regular maintenance. Edge line should be marked.

8. Road side features; Civil engineering structures Plantings and trees other obstacles

• There are some dangerous features within the safety zone (trees and parked vehicles).

• Vegetation along the road can cause the visibility problems. Sight is obstructed by the planting (vegetation) in curves and at intersection (agriculture) roads.

• At the bridges a barrier should be installed and pedestrian crosses along the bridge should be constructed. No pedestrian road along bridge at Ziya River station 48+460.

• At the Ziya River bridges (49+460) guard rail should be installed.

4.4 Secondary data analysis

4.4.1 Study area road traffic crashes trends

The study area comprises two woreda and one town administration that is Bichena town administration, Enemay woreda, and Enarji Enawga woreda with a stretches of 43 km length in rural sections of Ethiopia, East Gojjam from Bichena to Debre work. The major finding of the study is to identify the major causes of road traffic crashes in the rural section on the selected sections based on the primary and secondary data, and lastly the possible engineering measures will be recommended based on engineering measurements. Generally, it is going to identifying the most contributing or influencing factors of accidents identify the hot spot accident sections, and an ordinal regression applied to assess the road traffic crashes severity relationships with the independent variables. On this study ordinal logistic regression analysis has been provided based on secondary data of road traffic crashes from three Woreda. So, it is clear to present the results both Descriptive and inferential methods of statistics analysis.

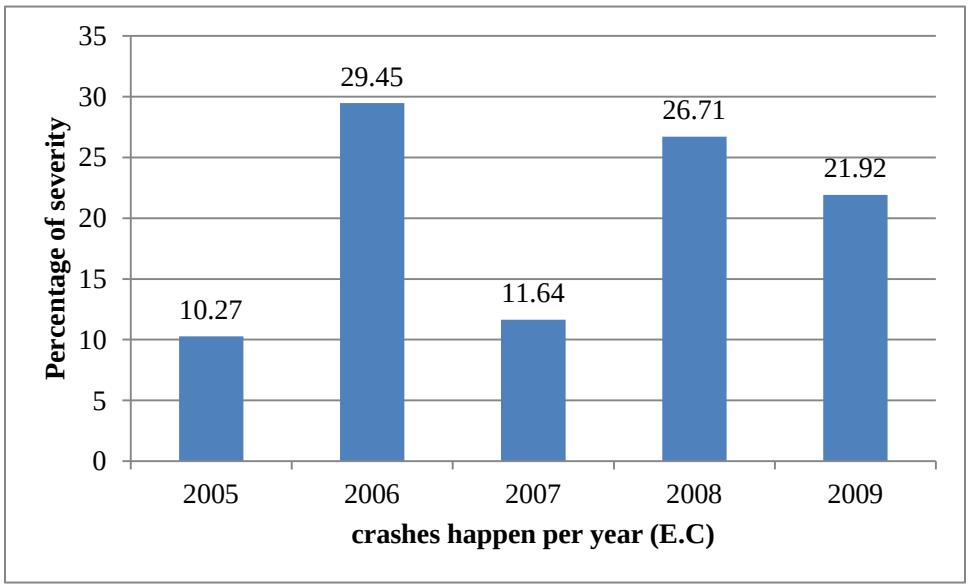

Figure 4- 4 Woreda level road traffic crashes trends for five year

According to Figure 4- 4 above the trend of road traffic crashes on the study area in five year crash data with respect to the type of severity based on the traffic police recorded from the three woreda has been shown. From the graph it can be depicted that among the crashes of the study section within the selected period of time in the year of 2006 E.C has been recorded the highest

crashes of 43(29.45%), in 2008 E.C also recorded as the second highest recorded values of 39(26.71%), and in 2009 E.C the third highest crashes has been recorded.

On the above Figure 4- 15**,** it is shown that the severity trend has been shown relative to the year of crash happen. But for more clarification the type of severity with respect to the crashes happening year has been shown Table 4- 15 below.

Table 4- 15 Woreda level traffic crashes severity for five years

Year (E.C)	type of severity on study sections per year				total
	fatal	serious injuries	slight injuries	property damage	
2005	3	2	3	7	15
2006	5	7	8	23	43
2007	5	7	1	4	17
2008	11	10	10	8	39
2009	8	10	10	4	32
subtotal	32	36	32	46	146

Source: Woreda level traffic crash severity organized by author

Table 4- 16 woreda level traffic crashes per day of the week

Day of the week	Crashes per day per five year	percent
Monday	18	12.3
Tuesday	29	19.9
Wednesday	14	9.6
Thursday	23	15.8
Friday	24	16.4
Saturday	26	17.8
Sunday	12	8.2
sum	146	100

Source: Woreda level traffic crash severity organized by author

Based on Table 4- 16 the traffic police recorded data from the three woreda has been collected and the analysis has done and lastly Tuesday, Saturday, Friday, Thursday, Monday, Wednesday,

and Sunday were recorded as the highest to lowest susceptible day of the week in crashes respectively.

As shown on table 4- 17 drivers age was affected highly on the range of 18-30 years old 52.74%, 31-50 years old drivers also follow with 21.23%.

Table 4- 17 woreda level traffic crashes per drivers' age of categories

Age category of driver	2005 E.C	2006 E.C	2007 E.C	2008 E.C	2009 E.C	TOTAL	Percent
≤18		1		1		2	1.37
18-30	10	14	7	23	23	77	52.74
31-50	3	9	3	10	6	31	21.23
>50	1	4	1		1	7	4.79
unknown	1	15	6	5	2	29	19.86
subtotal	15	43	17	39	32	146	100

4.4.2 Black spot identification on the study sections

In study segments, approximately seven accident locations are currently considered as ‘dangerous’. These ‘dangerous’ accident sites or so-called black spots are selected by means of their historic accident data for the period 2005-2009 E.C. based on these data, each site within the last five years four or more accidents have occurred is selected.

I. Accident rate method

According to Banik *et al.*, (2011) investigation accident/crash rate method combines the accident/crash frequency with vehicle exposure (i.e., traffic volume) and is expressed as “accident per million vehicles for intersection” (and other spot location) or “accident per million vehicle of travel" for highway section. The locations are then ranked in decreasing order by accident rate. After arranging in decreasing orders the top seven accident locations has been taken for analysis.

Accident rate methods of black spot identification on the study sections for a length of 5 km and 10 years accident data has been utilized and come up with a satisfied results (Dehury *et al.*,

2013). Now for this study 1 km length of segments has been used approximately on the areas with highest traffic crashes data that has been registered from police report data.

Crash rates allow comparing crash data of different sections of roadway with different lengths and traffic volumes. Crash rates for sections are expressed in terms of crashes per million vehicle kilometers and computed using the following equation:

$$R_{sec} = \frac{10^6 * C}{365 * T * V * L}$$

Where,

R_{sec} is the accident/crash rate at section (accident/million vehicle-km)

T is the period of study time frame of the analysis/period length (years)

V is the annual average daily traffic (AADT) during study period

L is the length of the section (kilometer)

Ranking of the Top seven Road crash Section

Based on crash rate methods of black spot analysis the top seven road crash sections ranking has been prepared and presented in the Table 4- 9 below. Among the top seven road crash ranking by the analysis it is to be noted that it was based on data compilation over five years starting from 2005 E. C to 2009 E.C. As a result, accident locations depending on frequency of crash data are arranged as follows; Around Bichena control terminal (23), Woynam del golma(14), Mahibere birhan(10), Yetemb yerez(9), Yeduha junction at Bichena town(8), Agulachi(6), Gotera town(4), Dibisa(3), Debre work town(3), Didisu(3), Warkaw(3), Telm(3), Muga river/suoa bridge/(3), Dima kebele(3) , Enegena fentergie kebele(tenguma)(3), Endeshegniti(3), Ansilal mankorkorya(2), Yetmen town(2), Hulut anba debel gumer goti(2), Mereregni goti(2), Wofit kebele(2), Gol wokima & deji agamina(meteya)(2), Quamicherk(2), Debre work control terminal(1), Ziya(1), Teza river(1), Woyra(1), Yekegan(1), and Gotera on yemegera(1).

To apply the crash rate methods crash data, study period, road length, and traffic volume data are required. So, AADT data has been collected from Ethiopian road authority as shown table 4- 18 below.

Table 4- 18 Annual Average Daily Traffic by road section

Year	Dejen to Bichena	Bichena to Motta
2012/13	383	341
2013/14	466	368
2014/15	483	395
2015/16	575	590
2016/17	577	785
TOTAL	2484	2479

Source: ERA

For Road Section I: Kuy junctions (Mahibere Birhan)

C= 10, *T*=5 year, *V*= 2484 veh/day, *L*= 1 km, then

$$R_{sec} = \frac{10^6 * C}{365 * T * V * L} = \frac{10^6 * 10}{365 * 5 * 2484 * 1} = \frac{10000000}{4533300} = 2.206$$

This value indicates that if one million vehicles travel in the road section **I** the number of crashes happening were 2.206. That is 2.206 crashes/ million entering vehicle-km.

For Road Section II: Yeduha junction at Bichena town

C= 8, *T*=5 year, *V*= 2484 veh/day, *L*= 1 km, then

$$R_{sec} = \frac{10^6 * C}{365 * T * V * L} = \frac{10^6 * 8}{365 * 5 * 2484 * 1} = \frac{8000000}{4533300} = 1.765$$

This value indicates that if one million vehicles travel in the road section **II** the number of crashes happening were 1.765. That is 1.765crashes/ million entering vehicle-km.

For Road Section III: Around Bichena control terminal

C= 23, *T*=5 year, *V*= 2484 veh/day, *L*= 1 km, then

$$R_{sec} = \frac{10^6 * C}{365 * T * V * L} = \frac{10^6 * 23}{365 * 5 * 2484 * 1} = \frac{23000000}{4533300} = 5.073$$

This value indicates that if one million vehicles travel in the road section **III** the number of crashes happening were 5.073. That is 5.073 crashes/ million entering vehicle-km.

For Road Section IV: Woynam Del golma

C= 14, *T*=5 year, *V*= 2479 veh/day, *L*= 1 km, then

$$R_{sec} = \frac{10^6 * C}{365 * T * V * L} = \frac{10^6 * 14}{365 * 5 * 2479 * 1} = \frac{14000000}{4524175} = 3.094$$

This value indicates that if one million vehicles travel in the road section **V** the number of crashes happening were 3.094. That is 3.094crashes/ million entering vehicle-km.

For Road Section V: Yerez Yetemb

C= 9, *T*=5 year, *V*= 2479 veh/day, *L*= 1 km, then

$$R_{sec} = \frac{10^6 * C}{365 * T * V * L} = \frac{10^6 * 9}{365 * 5 * 2479 * 1} = \frac{9000000}{4524175} = 1.989$$

This value indicates that if one million vehicles travel in the road section **V** the number of crashes happening were 1.989. That is 1.989 crashes/ million entering vehicle-km.

For Road Section VI: Gotera

C= 4, *T*=5 year, *V*= 2479 veh/day, *L*= 1 km, then

$$R_{sec} = \frac{10^6 * C}{365 * T * V * L} = \frac{10^6 * 4}{365 * 5 * 2479 * 1} = \frac{4000000}{4524175} = 0.884$$

This value indicates that if one million vehicles travel in the road section V**I** the number of crashes happening were 0.884. That is 0.884 crashes/ million entering vehicle-km.

For Road Section VII: Agulachi

C= 6, *T*=5 year, *V*= 2479 veh/day, *L*= 1 km, then

$$R_{sec} = \frac{10^6 * C}{365 * T * V * L} = \frac{10^6 * 6}{365 * 5 * 2479 * 1} = \frac{6000000}{4524175} = 1.326$$

This value indicates that if one million vehicles travel in the road section **VII** the number of crashes happening were 1.326. That is 1.326crashes/ million entering vehicle-km.

Table 4- 19 crash rate methods of hot spot area identification

Road segments (sections)	Section length (km)	# of crashes	Frequency	Crash rate	ranks
Around Bichena control terminal	1	23	29.11	2.206	3
Woynam del golma	1	13	16.46	1.765	5
Mahibere birhan	1	10	12.66	5.073	1
Yetemb yerez	1	6	7.59	3.094	2
Yeduha junction at Bichena town	1	14	17.72	1.989	4
Agulachi	1	9	11.39	0.884	7
Gotera	1	4	5.06	1.326	6

Based on crash rate method and frequency of crashes on the selected sections of road black spot has identified from a total of approximately 43 km, the road section on Mahiber birhan has been identified as a high crash road segments. Next, Yetemb yerez road segment has been identified as the second black spot road segments on the study segments. Lastly, Around Bichena control terminal, Yeduha junction at Bichena town, Woynam del golma, Gotera, and Agulachi are the black spot road segments which needs treatment according to these respective decreasing orders of ranks. As shown table 4- 19 above, the rank order one indicated that the road sections needs immediate treatment rather than others, and rank seven indicates that the section needs a treatments after other sections has treated.

4.4.3 **Inferential statistics**

Inferential statistics is the procedure by which we reach a conclusion about a population based on the information contain in the sample drawn from that population. Therefore among inferential statistics, we would use ordinal logistic regression.

I. Ordinal Logistic Regression Analysis

Ordinal logistic regression is a type of logistic regression analysis that when the response variable is categorized more than two with having natural order or rank. That is, we can rank the values, but the real distance between categories is unknown. Under Ordinal Logistic Regression Analysis we can deal Model Fitting Information, Goodness-of-Fit, Pseudo R-Square, Parameter Estimates and Test of parallel lines.

Logit link function is used in the analysis because it is evenly distributed categories and is reasonable choices when the changes in the cumulative probabilities are gradual and logit involves all levels of the response and dichotomizes the response scale.

Model Fitting Information

Table 4- 10 Model Fitting Information of ordinal regression

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	63.385			
Final	25.435	37.951	22	.019

Link function: Logit.

The Model Fitting Information table, which gives the -2 log likelihood for the intercept only and final models, can be used in comparisons of nested models. The statistically significant chi-square statistic (**p<0.05**) indicates that the Final model gives a significant improvement over the baseline intercept only model. This tells us that the model gives better predictions than if we just guessed based on the marginal probabilities for the outcome categories. Therefore, the final model (with factors that affect road traffic crashes severity as a predictor) is significantly better than the 'road traffic crashes severity model.

Goodness-of-Fit

Table 4- 11 ordinal regression Goodness-of-Fit

	Chi-Square	df	Sig.
Pearson	35.706	36	.482
Deviance	25.435	36	.905

Link function: Logit.

Pearson has the null hypothesis of the model is adequately fit. If **p<0.05** we reject null hypothesis. From the above table 4- 21; the results from the analysis suggest the model does fit very well **(p>0.05)** (i.e. fail to reject the null hypothesis (accept) depending on the observed data). Also the model fits adequately.

Pseudo R-Square

Table 4- 22 Pseudo R-Square for logistic and ordinal regression models, it is not possible to compute the same R^2 statistic as in linear regression so three approximations are computed instead.

Table 4- 12 Pseudo R-Square of ordinal regression

Cox and Snell	.718
Nagelkerke	.816
McFadden	.599

Link function: Logit.

What constitutes a "good" R^2 value depends upon the nature of the outcome and the explanatory variables. Here, the pseudo R^2 values (e.g. Nagelkerke = 81.6% that is 81.6 % of the variance in the dependant variable (out comes) will be explained by the explanatory variables) indicates that

there is relatively high proportion of the variation in the types of road traffic crash severity between victimized. This is just as what would expect because there are numerous factors that affect the road traffic crash severity of victimized.

Parameter estimates

On ordinal logistic regression it is tried to show how the dependant (response) variables are related with the independent (explanatory) variables. The explanatory variables have been chosen from police daily recorded archive. From the analysis we can observe that how the independent variables interrelated with the types of crash severity.

The parameter of the model has been selected from parameters estimate Table 4- 23 shown below from out puts of SPSS soft ware. Table 4- 23 contains the estimated coefficients for the model. The estimates labeled Threshold are the α's, intercept equivalent terms. The estimates labeled Location are the ones we're interested in. They are the coefficients for the predictor variables.

Table 4- 13 Parameter Estimates of ordinal regression

Variables	categories	Fatal injuries			Serious injuries			Slight injury
		estimates	odd ratio	p value	estimates	odd ratio	p value	This is the reference categories of crash severity
	Crash hour	0.00004	1.00003114	0.629	0.00004	1.00003114	0.629	
	driver age	**0.609**	1.60648711	**0.031**	**-0.609**	1.60648711	**0.031**	
	driver experience	**-0.896**	0.49785187	**0.021**	**0.896**	0.49785187	**0.021**	
types of crash	vehicle to vehicle	-25.422	2.5462E-09	0.997	-25.422	2.5462E-09	0.997	
	vehicle to pedestrian	-16.510	2.6222E-06	0.998	-16.510	2.6222E-06	0.998	
	overturn	-26.241	1.3459E-09	0.997	-26.241	1.3459E-09	0.997	
	others	0[a]						
day of the week	Monday	-2.480	0.14508298	0.263	-2.480	0.14508298	0.263	
	Tuesday	1.982	4.67768216	0.417	1.982	4.67768216	0.417	
	Wednesday	-5.063	0.01942732	0.213	-5.063	0.01942732	0.213	
	Thursday	**-12.063**	**8.3562E-05**	**0.022**	**12.063**	**8.3562E-05**	**0.022**	
	Friday	-8.535	0.0013022	0.108	-8.535	0.0013022	0.108	
	Saturday							
	Sunday	0[a]						
Driver relation with Vehicle	private	-4.231	0.03712591		-4.231	0.03712591		
	employed	0a						
	rent	0a						
driver education level	Illiterate							
	read and write/informal							
	Primary education (1-8)	2.124	5.22438204	0.469	2.124	5.22438204	0.469	
	Secondary education (9-12)							
	Above preparatory							
Vehicle type	light vehicles (two wheels, three wheels)	0		0	0		0	

	medium vehicles (minibus, automobiles)	-1.276	2.69998809	0.593	1.276	2.69998809	0.593	
	heavy vehicles (trucks, buses)							
Vehicle ownership	private	24.950	271984398	0.997	24.950	271984398	0.997	
	government	20.349	7570763.98	0.998	20.349	7570763.98	0.998	
	Nongovernmental organization	0			0			
Road Geometry	straight	-7.384	0.00318993	0.266	-7.384	0.00318993	0.266	
	steep gradient	1.837	4.17842217	0.811	1.837	4.17842217	0.811	
	upward gradient	0			0			
	curves							
Type of Road surface	Dust/earthen road							
	gravel	**-5.443**	**0.01445277**	**0.031**	**5.443**	**0.01445277**	**0.031**	
	asphalt	0						
Road surface condition	dry	22.120	30049704.4		22.120	30049704.4		
	wet	0			0			
Lighting conditions	day	-5.945	0.00977791	0.486	-5.945	0.00977791	0.486	
	night	0			0			
Weather condition	good	3.922	21.1769293	0.142	3.922	21.1769293	0.142	
	hot	0			0			
	cool							
	cloud							
driver gender	Male							
	Female							

This parameter is set to zero because it is redundant. a

There is a strong association between factors that affect crash severity, when p-values are less than alpha level.

According to (Tulu,G., 2017) findings on Injury Severity of Pedestrians Involved in Road Traffic Crashes in Addis Ababa, Ethiopia showed that increasing pedestrian age, less educated drivers, less experienced drivers, commercial vehicles (mini buses, buses and trucks), night time, posted speed limit over 60 km/h, pedestrian crashes at intersections, land use (resident, church, hospital and school areas), and type of sub-city Factors that decrease the probability of fatal injury are owner-drivers, non-motorized vehicle type, high school educated drivers and posted speed limit below 60 km/h were significant factors. Likewise, in this study driver age, driver experience, day of the week, and type of road surface.

In the Parameter Estimates table we see the coefficients, their standard errors, the Wald test and associated p-values (Sig.), the 95% confidence interval of the coefficients, and odds ratios. Since p-values less than alpha level they are statistically significant; otherwise not.

The thresholds are shown at the top of the parameter estimates output, and they indicate where the latent variable is cut to make the three groups that we observe in our data. The threshold coefficients are representing the intercepts, specifically the point (in terms of a logit) where crash severity might be predicted into the three categories.

The estimates labeled location are the coefficients for the predictor variables. There appears to be relationship between crash severity and the factors that affect crash severity. From the observed significance levels in above table 4- 23, we can see that all explanatory variables are factors that affect crash severity of road users. Based on the small observed significance level, we can reject the null hypothesis that it is zero. The estimates labeled Location are the ones we are interested in. They are the coefficients for the predictor variables. The Wald statistic is the square of the ratio of the coefficient to its standard error. The significance of the Wald statistic in the column with heading sig (< 0.05) indicates the importance of the predictor variables in the model (we reject the Null hypothesis $H_o = \beta_i$ and high values of the Wald statistic shows that the corresponding predictor variable is significant.

Conclusion, the findings indicate that crash severity is associated with driver experience, age of driver, day of the week, and types of road surface. From these the independent variables that have no significance association with crash severity are types of crashes, crash hours, driver

gender, driver education level, Driver relation with vehicle, Vehicle type, Vehicle ownership, Road Geometry, Road surface condition, Lighting conditions, and Weather condition.

By taking the exponent of the pooled estimate relative to a given predictor, i.e. taking $e^{\beta i}$, we obtain an estimate of the common odds ratio that describes the relative odds for Xj differing by one unit. Values greater than one indicate that the variable in question increases the odds of being slight injury and values between 0 and 1 indicate a decrease in the odds of being slight injury. exp(β), is a factor by which the odds of being slight injury change when with independent variable increases by one unit (i.e. from 0 to 2).https://www.stat.ubc.ca/~rollin/teach/643w04/lec/node62.html

Interpretations of the result

The log odd of severe outcome for day of the week Thursday is decreased by -12.063. The estimated odds ratio (OR = 8.3562E-05) indicates that day of the week Thursday are 8.3562E-05 times less likely to commit fatal crashes than day of the week that is Sunday (reference group). Similarly, the day of the week that Thursday 8.3562E-05 times less likely to attain severe outcome (to commit fatal and serious) than slight crashes than day of the week that is Sunday (reference group) holding other predictors effects are constant.

The log odd of severe outcome for day of the week Tuesday is increased by 1.982. The estimated odds ratio (OR =4.67768216) indicates that day of the week that is Tuesday are 4.67768216 times more likely to commit fatal crashes than day of the week of Sunday (reference group). Similarly, the day of the week Tuesday are 4.67768216 times more likely to attain severe outcome (to commit fatal and serious) than slight crashes than day of the week that is Sunday (reference group) holding other predictors effects are constant.

The reduction to log odd of severe outcome for driver experience is -0.896. The estimated odds ratio (OR = 0.49785187) indicates that driver experience are 0.49785187 times less likely to commit fatal injury than slight injuries. Similarly, driver experiences are 0.49785187 times less likely to attain severe outcome to commit fatal injuries than slight injuries.

Test of parallel lines

Table 4- 24 Test of Parallel Lines[a] of ordinal regression

Model	-2 Log Likelihood	Chi-Square	df	Sig.
Null Hypothesis	25.435			
General	.000[b]	25.435	22	.277

The null hypothesis states that the location parameters (slope coefficients) are the same across response categories.

a. Link function: Logit.

b. The log-likelihood value is practically zero. There may be a complete separation in the data. The maximum likelihood estimates do not exist.

One of the assumptions underlying ordinal logistic regression is that the relationship between each pair of outcome groups is the same. This is commonly referred to as the test of parallel lines because the null hypothesis states that the slope coefficients in the model are the same across response categories (and lines of the same slope are parallel). If we fail to reject the null hypothesis, we conclude that the assumption holds. From the above table shows parallel line test for general model with chi square value 19.891 and p-value= 0.703 which is greater than the 5% level of significance, fail to reject the null hypothesis. Therefore, there is no enough evidence to reject the null hypothesis for general model. Thus, the proportional odds assumption appears to have held for general model.

$$\text{Logit}(p \leq \text{slightly injury}) = 6.863 - [-0.896 * \text{driver\_experiance} - 0.609 * \text{age\_drivers} - 2.480 * \text{day\_week0} + 1.982 * \text{day\_week1} - 5.063 * \text{day\_week3} - 12.063 * \text{day\_week4} - 8.535 * \text{day\_week5} + 5.443 * \text{type\_(road\_surface1)}$$

$$\text{Logit}(p \leq \text{serious injury}) = 12.891 - [-0.896 * \text{driver\_experiance} - 0.609 * \text{age\_drivers} - 2.480 * \text{day\_week0} + 1.982 * \text{day\_week1} - 5.063 * \text{day\_ week3} - 12.063 * \text{day\_week4} - 8.535 * \text{day\_week5} + 5.443 * \text{type\_(road\_surface1)}$$

5. CONCLUSION AND RECOMMENDATION

5.1 Conclusions

According to findings revealed about evaluation of rural road traffic safety in East Gojjam specifically Bichena to Debre work, the following conclusions are drawn.

- A road traffic crash has happened mostly on the day of week; Saturday, Thursday and Tuesday. Crashes mostly happen on public holiday, and weekend rather than working days.
- Medium vehicles such as minibus, public Isuzu (24 seats), and automobiles has been identified as major causing road traffic crashes.
- The numbers of traffic polices are small.
- Public awareness is a more effective safety control methods.
- More than half of the respondent Drivers were involved in crashes; among these drivers 52.5% of them crashes has been reported to traffic police and 47.5% crashes were not reported to the traffic polices. Therefore, all traffic crashes happen on the study section have not been recorded by traffic polices.
- Around Bichena control terminal, Woynam del golma, Mahibere birhan, Yetemb yerez, Yeduha junction at Bichena town, Agulachi, and Gotera town has been identified as high crash spot segments.
- Corruptions are extending to all level of transport system.
- Drivers whose ages between 18-30 years were identified as the most affected groups and 31-50 years also affected next to that of 18-30 years.
- Most of the drivers (with 65%) have been perceived as speeding will be the causes of road traffic crashes and Drivers not give priorities for pedestrians.
- Crash severity is associated with driver age, driver experience, day of the week, and type of road surface.

5.2 Recommendations

Based on the findings of the study the following are the main recommendations, which will benefit the improvements of the rural Road traffic Safety;

- Road traffic safety has to be incorporated as a subject in academics.
- Road marking, road sign and speed limits should be posted.
- Periodic trees/vegetation removals on curves which secure sight distance mostly on Ethiopian summer. Provide ditches on required place and supervise continuously because it is filled with stones, soils, and any other derbies**.**
- Unsmooth connection on intersection should be corrected (leveled).
- At bridges guardrail and pedestrians cross should be provided.
- Drivers should be responsible for the life of passengers and pedestrians, obeying traffic rule, and reduce their speeding.
- On these black spot identified sections a strict enforcement should be applied.
- Corruptions should be stopped at all levels.
- From the analysis it was observed that road users did not obey traffic rule. Therefore, trainings for the community or awareness about road traffic safety should be given.
- Installing Speed breaker on selected segments and develops high enforcement on Saturday (public market day) and public holyday.
- Public vehicle drivers' minimum age requirement should be increased.
- Speed radar should be available to traffic police and transport officers.

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6.1 Appendices

6.1.1 Appendix 1

ADDIS ABABA UNIVERSITY
ADDIS ABABA INSTITUTE OF TECHNOLOGY (AAiT)
SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING
ROAD AND TRANSPORT ENGINEERING

Questionnaire Filled by Drivers.

A questionnaire is prepared for an academic purpose for the fulfillment of M.Sc Degree in road and transport engineering studies. The objective of the study is to evaluate the rural road traffic safety a case study Bichena to Debre work. Your response is very important for the success of the study. Hence, you are requested kindly to give your response by selecting or tick(√) your answer among the alternative choice or by describing your opinion. I would like to thank you for your cooperation.

1, gender: Male -------- Female------

2, Age: 17-24 years--- 25-30 years--- 31-45 years ---- 46-55 years--->56 years ---

3, Educational Level

Illiterate----------

Read and write / informal -------

Primary education (1-8) ----------

Secondary education (9-12) -----

Above preparatory----------

4, Level of License: None-- First Level-- Second Level-- Third Level-- Fourth level-- Fifth Level-

5, how long have you been driving from Bichena to Debre work?

Less than one year------ 6—7 years-------

1—2 years------ 8—10 years------

3—5 years-------- Greater than 10 years-----

6, how often do you make overloading? Always ---- sometimes----- never do ----

7, what is your normal speed (approximately) between Bichena to Debre work?(except Bichena and Debre work town)

20-40Km/hour--- 40-60Km/ hour---- 60-80Km/ hour---- 80-100Km /hour-- >100 Km/ hour----

8, Have you give priorities to pedestrians as required by law? Always----- Sometimes---Never----

9, have you drive while using drug? yes----- No-----

10, do you wear a seat belt when you drive? Always----- Sometimes----- Never----

11, if your answer is 'never wear a seat belt on question 10', what is the reason?

It is not comfortable--- I always miss it---- I don't know how to wear it----- No seat belt----

12, do you use mobile phone while driving? yes--- No----

13, do you drive when you drink any alcoholic beverages? usually----- Sometimes----- Never-

14, have you faced accidents while driving? Yes-----No-----

15, If yes, how often do you involved in accidents? Once---- twice--- 3 times-- 4^{+} times ------

16, In your understanding, which point of time traffic accident is more?

Working day---- Weekend----- on Public Holyday-----

17, Have you distracted by any means while driving? Yes------ No------

18, If you are involved in accidents have it reported with traffic police? Yes------No------

19, how often do you drive while you have got tired? Usually----- Sometimes----- Never----

20, do you think that speeding will lead to traffic accident? Yes------ No------

21, how do you rate the traffic police commitment to their duties? Very good---Good---Poor------

22, Have you got additional education/ training about road safety by concerned body? Yes--No--

23, while you have driving in Bichena and Debre work town, what is your speed approximately?

< 20km/hr--- 20-30 km/hr--- 30-40 km/hr---- 40-50 km/hr

24, recommend some possible solutions to prevent and reduce road traffic accidents?

A Questionnaire filled by pedestrians

1. Address (Kebele) ----------
2. Sex: Male ----- female----
3. Age ----------
4. Educational level
   - Illiterate----------
   - Read and write/informal-------
   - Primary education (1-8) --------
   - Secondary education (9-12) ----
   - Above preparatory--------
5. Occupation
   - Private Worker ------
   - Unemployed-------
   - Student------
   - Office worker--------

- Farmer ----------
- Other (specify) ------

6. Now how do you perceive the level of road traffic accident problems?

   A big problem ----- A moderate problem ---- Not a problem -----

7. Which types of road accidents or collision were highly prevailing?

- Motor vehicle with motor vehicle ---
- Motor vehicle with bicycle ------
- Motor vehicle with pedestrians -----
- Motor vehicle with static object -----
- Bicycle with bicycle ------
- Bicycle with pedestrians -----
- Bicycle with horse drawn carts -----
- Horse drawn cart with pedestrians ---
- Motor vehicle with animals ---

8. How frequent do you have to leave sidewalks and walk along roads?

   Always---- Sometimes---- Never do this----

9. Which one do you apply while you are walking along roads?

   Moving on the left side--- moving on the right side --- have not go around the road ---

10. Do you know traffic signs, road marks and rule very well? Yes--------- No----------
11. Have you give priorities to vehicles as required by law: Always-- Sometimes---- Never---
12. While you are crossing the main road how often do you use zebra crossing?

    Always---- Sometimes---- No zebra crossing--- cross everywhere ---

13. How do you rate drivers give priorities to pedestrians as required by law.

    Very good------ Good------- Poor-------- Very Poor------

14. Do you believe that following brings a significance improvement on accident mitigations?

- Improving road safety education
- prohibit walking along the roadway
- do not participate as a passenger above the capacity of vehicles seat
- obey traffic rules and signs,
- share traffic rule awareness to the children & others
- Avoid alcohol intoxication while walking
- use zebra crossing
- Avoid illegal crossing

15. How do you rate the traffic police commitment to their duties? Very good---Good---Poor-
16. Have you got education about road traffic safety rules by concerned officials? Yes--No--

17. Who is your source of knowledge and experience about road traffic safety rules?

    Myself ---- Parents----- Schools----- Traffic police---- Media---- others

18. Do you become as a passenger above the loading capacity of the vehicle? yes ---- no -----
19. Do you believe that overloading lead to traffic accident? yes--- no ---
20. Propose some road traffic accident prevention and reduction methods?

Questionnaire responds by traffic police officers, and road and transport officers

1. Age
2. Sex: Male--- Female-----
3. Educational level:
   - below grade 8
   - 10^{th} grade completed
   - 12^{th} grade completed
   - Diploma
   - Degree
4. Experience of service
   - Less than 3 years
   - 3- 5years
   - 5-8 years
   - 8- 11 years
   - above 11 years
5. Which type of vehicles is causing high number of road accidents?
   - heavy vehicles (trucks, buses)----
   - light vehicles (two wheels, three wheels)---
   - medium vehicles (minibus, automobiles)--
   - Others (specify) ----
6. Which types of road accidents or collision were highly prevailing?

   Motor vehicle with motor vehicle---
   Motor vehicle with bicycle---
   Motor vehicle with pedestrians---
   Motor vehicle with static object----
   Bicycle with bicycle---
   Bicycle with pedestrian---
   Bicycle with cart----
   Cart with pedestrian----

7. Do you think that the road has enough road traffic signs, marking and lights in all important areas? Yes----- No-----
8. Do you believe that there is enough traffic police? yes--- No-----
9. Do you think that woreda traffic police has created enough awareness about road traffic accidents for the population? Yes---- No----

10. Do you think that the current driving license award-ship by the concerned body is given after intensive training and tests? Yes---- No-----
11. Which one is more effective road safety control method to reduce the traffic accident in this woreda?
    - traffic light, signs and markings---
    - traffic police control---
    - student traffic police---
    - creating public awareness---
    - others (specify)---
12. How do you rate pedestrians expectation for vehicles in giving priorities where they using roads? very Good----- good ----- Poor---- very poor
13. How do you rate drivers in giving priorities for pedestrian?
    Very Good----- good ----- Poor---- very poor
14. Where does higher road accident happen from Bichena to Debre work? why?
15. Please propose some possible solutions to prevent and reduce road traffic accidents?
16. How do you rate the speed of drivers from Bichena to Debre work corresponding with speed limit.

Field inspection checklists

Check list	Comments
Function and surrounding	
Cross sections	
Alignment	
Intersections	
Traffic signals	
Railway crossings	
Service and rest areas	
Public transport	
Needs of vulnerable Road users	
Traffic signing, marking and lighting	
Road side features; Civil engineering structures Plantings and trees other obstacles	

6.1.2 Appendix 2

no	Region	Year in E.C.					total	percent
		2005	2006	2007	2008	2009		
1	Tigray	1037	1124	1267	1447	1391	6266	7.46
2	Afar	252	338	257	309	374	1530	1.82
3	Amara	3521	3736	3449	3915	4215	18836	22.43
4	Oromia	4690	3272	7357	4949	4485	24753	29.48
5	Somali	366	356	236	352	961	2271	2.70
6	B/gumz	382	358	205	487	652	2084	2.48
7	South	756	1390	1808	2037	2561	8552	10.19
8	Gambella	90	95	148	172	155	660	0.79
9	Hareri	144	198	370	256	460	1428	1.70
10	AA	3155	4022	3438	4040	3794	18449	21.97
11	D/Dawa	327	369	325	345	352	1718	2.05
	Total	14720	15258	16273	18309	19400	83960	100.00

Source: Ethiopian federal traffic police commissions

Major Causes of East Gojjam road traffic crashes in five years (E.C)

No.	Causes of traffic crashes	2005	2006	2007	2008	2009	Total
1	Drunk driving	1	1	2	0	0	4
2	Wrong way driving	1	7	7	5	1	21
3	Not giving priority to vehicles	5	9	17	3	9	43
4	Not giving priority to pedestrians	23	18	11	26	37	115
5	Not keeping right distance	5	9	6	8	14	42
6	Overtaking on a mound	0	0	0	0	1	1
7	Overtaking on a curve	0	0	1	0	0	1
8	Set off improperly	0	0	0	0	0	0
9	Over speeding	69	66	50	72	101	358
10	Inappropriate overtaking	3	6	3	1	0	13
11	Inappropriate turning	5	1	4	2	4	16
12	Violation of priority give way sign	1	0	8	1	0	10
13	Violation of traffic police order	1	0	1	0	0	2
14	Violation of red lights	0	0	0	0	0	0
15	Violation of stop sign	0	0	0	0	0	0
16	Incidental starting	3	2	10	3	0	18
17	Inappropriate parking on roads	1	3	1	0	0	5
18	Improper lighting	0	0	0	0	1	1
19	Overloading	2	6	5	2	0	15
20	Faulty breaks	0	0	0	6	5	11
21	Wheel blow away	0	0	0	1	1	2
22	Faulty steering	0	0	0	5	0	5
23	Faulty roads	0	0	0	4	2	6
24	Faulty pedestrians	0	0	0	3	6	9
25	Illegal driving	0	0	0	13	5	18
26	Others	0	0	0	16	11	27
27	Unknown	0	0	0	18	32	50
	Sum	204	193	169	191	230	987

Types of crashes on the study period on East Gojjam for five years (E.C)

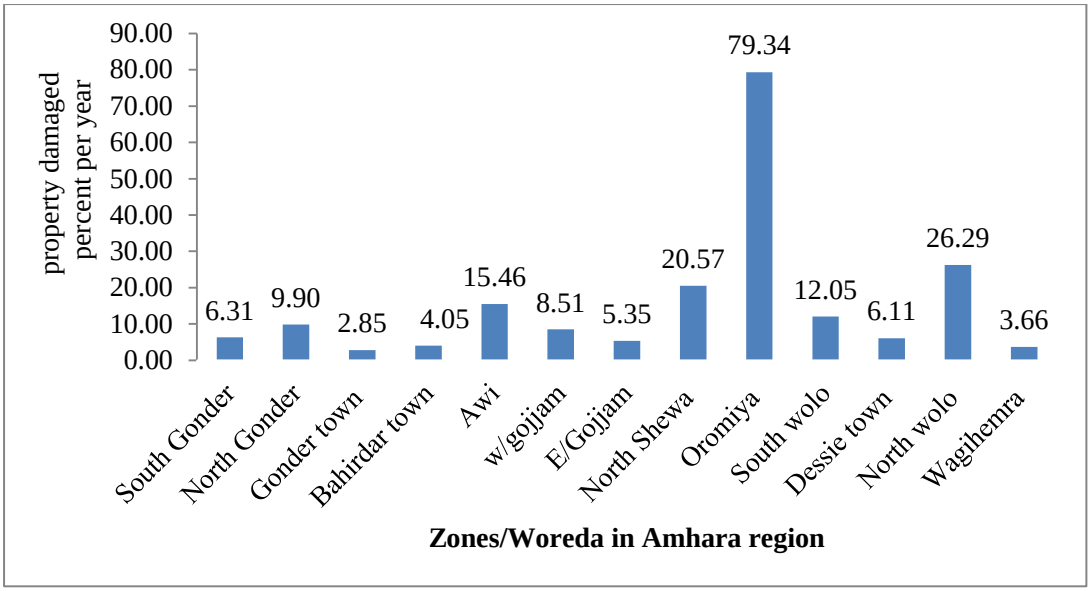
types of crashes	2005	2006	2007	2008	2009	Total	percent
Ordinary bicycle	2	4	3	6	2	17	1.73
Motor cycle	3	0	3	3	6	15	1.52
Automobile	5	0	4	3	4	16	1.62
Station wagen	7	18	5	7	3	40	4.06
Pick up 10 quntal	13	13	6	12	16	60	6.09
Truck 11-40 quintal	16	15	26	18	14	89	9.04
Truck 41-100 quntal	47	39	28	20	46	180	18.27
Truck and trailer	23	9	7	5	9	53	5.38
Liquid truck	2	4	2	2	2	12	1.22
Taxi	1	8	13	8	12	42	4.26
Bajaj	0	8	0	2	7	17	1.73
Public 12 seat	29	25	24	24	23	125	12.69
Public 13-45 seat	33	29	35	50	62	209	21.22
Public more than 46 seats	6	10	5	12	7	40	4.06
Special vehicles	1	6	4	2	3	16	1.62
Cart	5	0	1	2	1	9	0.91
Others	11	5	1	13	7	37	3.76
Unknown	0	0	2	0	6	8	0.81
Total	204	193	169	189	230	985	100.00

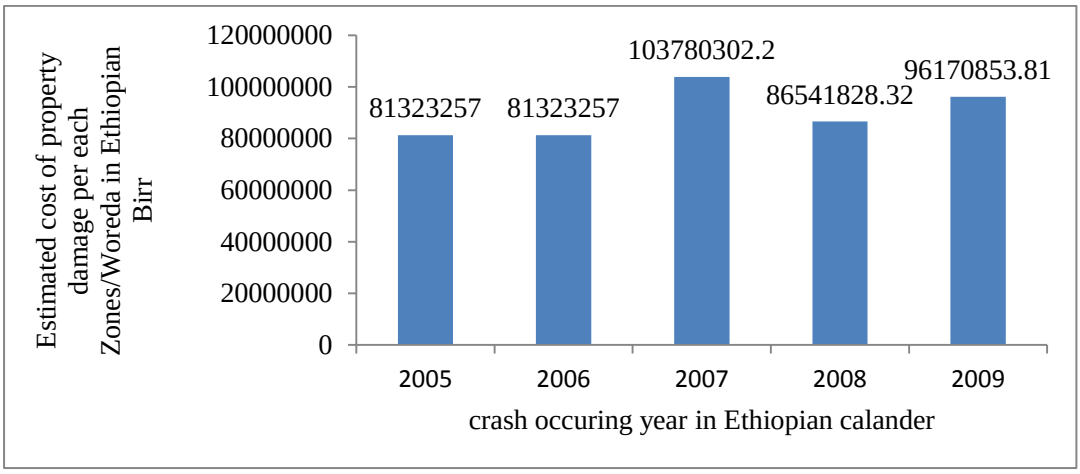
6.1.3 Appendix 3

Types of crashes in East Gojjam for the study period of five years (E.C)

type of crashes	2005	2006	2007	2008	2009	Subtotal	Percentage
Vehicle to vehicle	51	43	27	34	40	195	19.76
Overturn	56	50	23	27	43	205	20.77
Vehicle to pedestrian	66	73	88	91	99	417	42.25
Vehicle to animal	6	11	9	14	14	54	5.47
Fall from vehicle	11	4	2	7	10	34	3.44
Collide with stop vehicle	5	7	3	6	6	27	2.74
Vehicle to static object	1	3	4	6	11	25	2.53
Other	8	0	0	3	5	16	1.62
Unknown	0	2	2	2	2	8	0.81
Total	204	193	169	191	230	987	100

Zones / woreda	2005 E.C				2006 E.C				2007 E.C				2008 E.C				2009 E.C			
	Injuries on human being			Injuries on property	Injuries on human being			Injuries on property	Injuries on human being			Injuries on property	Injuries on human being			Injuries on property	Injuries on human being			Injuries on property
	Death	Serious	Slight	Damaged vehicles	Death	Serious	Slight	Damaged vehicles	Death	Serious	Slight	Damaged vehicles	Death	Serious	Slight	Damaged vehicles	Death	Serious	Slight	Damaged vehicles
South Gonder	75	33	46	88	73	38	43	50	59	33	32	26	69	77	69	63	97	53	136	57
North Gonder	58	25	28	68	67	18	24	78	69	31	18	72	91	96	123	18	94	79	83	0
Gonder town	18	32	125	116	27	29	154	197	13	29	113	77	38	57	99	69	40	36	77	77
Bahirdar town	32	29	51	169	16	30	122	192	36	34	62	183	57	30	66	119	61	55	54	148
Awi	38	23	13	56	43	21	9	38	60	27	10	21	86	63	59	59	85	59	84	49
w/gojjam	69	51	36	113	67	29	45	117	70	42	32	103	143	118	133	180	126	114	142	141
E/Gojjam	49	27	34	94	46	41	32	74	56	28	32	52	82	99	134	59	101	112	141	59
North Shewa	49	57	64	127	53	66	59	109	72	63	54	133	107	209	346	170	129	222	366	194
Oromiya	28	27	80	75	27	25	68	79	23	21	74	66	51	69	184	57	67	81	253	104
South wolo	50	30	76	51	52	45	85	72	64	41	63	63	58	55	168	63	103	106	200	49
Dessie town	16	13	43	84	14	21	50	104	18	27	63	127	23	47	138	196	23	97	96	200
North wolo	71	39	44	123	27	25	68	79	23	21	74	66	110	155	178	242	99	150	305	237
Wagihemra	5	6	8	13	3	6	12	12	2	2	8	16	19	44	95	50	10	26	53	0
Total	**558**	**392**	**648**	**1177**	**515**	**394**	**771**	**1201**	**565**	**399**	**635**	**1005**	**934**	**1119**	**1792**	**1345**	**1035**	**1190**	**1990**	**1315**


property damaged percent per year
90.00
80.00
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
6.31
9.90
2.85
4.05
15.46
8.51
5.35
20.57
79.34
12.05
6.11
26.29
3.66
South Gonder
North Gonder
Gonder town
Bahirdar town
Awi
w/gojjam
E/Gojjam
North Shewa
Oromiya
South wolo
Dessie town
North wolo
Wagihemra
Zones/Woreda in Amhara region


Estimated cost of property damage per each Zones/Woreda in Ethiopian Birr
120000000
100000000
80000000
60000000
40000000
20000000
0
81323257
81323257
103780302.2
86541828.32
96170853.81
2005
2006
2007
2008
2009
crash occuring year in Ethiopian calander