# Comparisons and Assess of Road Traffic Accidents Between Two Way-Two lane Trunk Roads and Six Lanes Expressway of Addis Ababa to Adama

**Advisor: Dr.Getu Segni Tulu (PH.D)**

**By: Darara Abdissa**

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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. Getu Segni and has not been presented as a thesis for a degree in any other university. All sources of materials used for this thesis have been duly acknowledged.

Name: Darara Abdissa

Signature: _____

Place: Addis Ababa Institute of Technology

Addis Ababa

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# Acronyms

AACRA: Addis Ababa City Road Authority

AADT: Annual Average Daily Traffic

ADT: Average Daily Traffic

AAP: Addis Ababa Police

AATA: Addis Ababa Transport Authority

AATP: Addis Ababa Traffic Police

AU: African Union

BAC: Blood Alcohol Concentration

EC: Ethiopian Calendar

EFY: Ethiopian Fiscal Year

ERA: Ethiopian road Authority

ETRE: Ethiopia Toll Road Enterprise

F: Fatalities

FIA: Foundation for the Automobile and Society

GC: Gregorian Calendar

GR: Growth Rate

LL: Likelihoods

LI: Light Injuries

MLR: Multinomial Logistic Regression

NRSP: National Road Safety performance

ORA: Oromia Road Authority

PD: Property Damage

RTA: Road Traffic Accident

SDG: Sustainable Development Goal

SI: Serious Injuries

UN: United Nation

VRU: Vulnerable Road Users

WHO: World Health Organization

WB: World Bank

# Abstract

World health organization and World Bank reported on the global burden of road traffic deaths that the number of road traffic deaths continues to rise steadily, reaching 1.35 million in 2016. Road traffic injuries are the eighth leading cause of death for all age groups. More people now die because of road traffic injuries than from HIV/AIDS, tuberculosis or diarrheal diseases. Ethiopia has a major road traffic accident. It becoming worse, and will continue to do so unless major institutional, policy, law enforcements and road designs minimum requirement reforms are established. Addis Ababa–Adama Expressway is a toll road that connects Addis Ababa to Adama. It is the first expressway in Ethiopia. Whereas, Addis Ababa to Adama old corridors pass through Galan, Dukam, Bishoftu and Modjo city.

The main aim of this thesis is to asses, compare, discuss, review and quantify traffic accident causes of Addis Ababa-Adama six lanes Expressways and two-way two-lane trunks road during July 2017/2018 to June 2019/2020 GC.

A secondary data were gathered from Ethiopia toll roads enterprise, cities police office and transport authority located between Addis Ababa and Adama. 2074(Two thousand seventy four) road crashes were collected from ETRE and Galan, Dukam, Bishoftu and Modgo Police station and those city transport authority, within three years..

Discrete Choice (Multinomial logit) model was used for assessing, comparing and factors contributing for road accident. In addition to this, descriptive statistics was used to conclude the nature and characteristics for all variables of traffic accidents on two corridors. The collected data were analyzed using n logit software.

This study identified that; unlike other independent variables, Road Geometry, Vehicles ownership and genders are not significant at 95% confidence interval on six lanes Expressways. Whereas, Except Day of weeks are not significant at 95% confidence interval two way two lane trunk roads.

Over speeding was the main cause of traffic accidents on six lanes expressways while on two-way two-lane trunk roads traffic accidents were mostly dominated by pedestrians' crashes.

As a result, all roads users, policy makers and road traffic regulators are expected to consider those significant determinant factors to minimize the level of accident from Addis Ababa to Adama.

**Key words**: Discrete Choice (Multinomial regression) model, Over speeding, pedestrian crashes; Severity injury, significant determinant; Expressways, Old ways. Ethiopia; Addis Ababa to Adama

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# 1. INTRODUCTION

World health organization and World Bank reported on the global burden of road traffic deaths that the number of road traffic deaths continues to rise steadily, reaching 1.35 million in 2016. However, the rate of death relative to the size of the world's population has remained constant. When considered in the context of the increasing global population and rapid motorization that has taken place over the same period, this suggests that existing road safety efforts may have mitigated the situation from getting worse. However, it also indicates that progress to realize Sustainable Development Goal (SDG) target 3.6, which calls for a 50% reduction in the number of road traffic deaths by 2020 remains far from sufficient.

The report prepared on a leading killer of children indicated that as progress is made in the prevention and control of infectious diseases, the relative contribution of deaths from no communicable diseases and injuries has increased. Road traffic injuries are the eighth leading cause of death for all age groups. More people now die because of road traffic injuries than from HIV/AIDS, tuberculosis or diarrheal diseases. Road traffic injuries are currently the leading cause of death for children and young adults aged 5–29 years, signaling a need for a shift in the current child and adolescent health agenda which, to date, has largely neglected road safety. (WHO, 2018, p. 4)

### 1.1 Overview of Traffic Accident in Ethiopia

The 2019 Reports of Ethiopian police commission 2019, shows that traffic accident report of indicated that the Increments frequency of Accidents from 2015 to 2019 for Fatal 43.4%,for serious injury 33.2%,for slight injury -11.55%, and for property damage 56.7% were recorded.. Similarly, thus Ethiopian Federal Police reports show us total of 44.2% increments road accidents from 2015-2019

*Table1. 1 Traffic accident recorded in Ethiopia from 2015-2019*

| Year | Frequency of Accident | | | | Total |
|---|---|---|---|---|---|
| | Fatal | Serious Injury | Slight Injury | Property Damage | |
| 2015 | 2664 | 3558 | 3474 | 18743 | 28439 |
| 2016 | 3172 | 4046 | 3561 | 21241 | 32020 |
| 2017 | 3475 | 4095 | 2819 | 23158 | 33547 |
| 2018 | 3606 | 4449 | 2803 | 27879 | 38737 |
| 2019 | 3820 | 4740 | 3073 | 29365 | 40998 |
| Total | 16737 | 20888 | 15730 | 120386 | 173741 |
| Increment in % (20015-2019) | 43.4 | 33.2 | -11.55 | 56.7 | 44.2 |

Source: Ethiopian federal police commission 2019

As National Road Traffic Safety Council of Ethiopia;2011 to 2020 reports, population growth rate of approximately 3% and estimated annual increases in the motor vehicle fleet of 10-15% is increasing upward pressure on road trauma suffered in Ethiopia. The current systems for collection of fatality, serious injury and related road safety data mean that firm conclusions are difficult to draw about the scale of the problem. For example, fatalities recorded in official statistics have varied to those published by the World Health Organization because report systems of Ethiopia is old system and file fragmentation, lack of full information are occurred at woreda and kebeles. As well, Figure below shows only

slightly more serious injuries than fatalities, whereas there are typically many times more serious injuries than fatalities in jurisdictions with good practice data systems. Nevertheless, the situation appears clear. Ethiopia has a major road traffic accident. It becoming worse, and will continue to do so unless major institutional, policy, law enforcements and road designs minimum requirement reforms are established.

The second Figure below shows, which illustrate the high proportion of trauma within all regions of Ethiopia and the importance of taking a national approach to the problem.

The NRSSP includes a road safety vision to stop fatal crashes on the nation's roads and a goal of halving road fatalities by 2020. A high-level review of the strategic plan concluded that this goal will be extremely difficult to achieve given current safety management and policy arrangements, particularly given considerable rates of population growth and motorization.

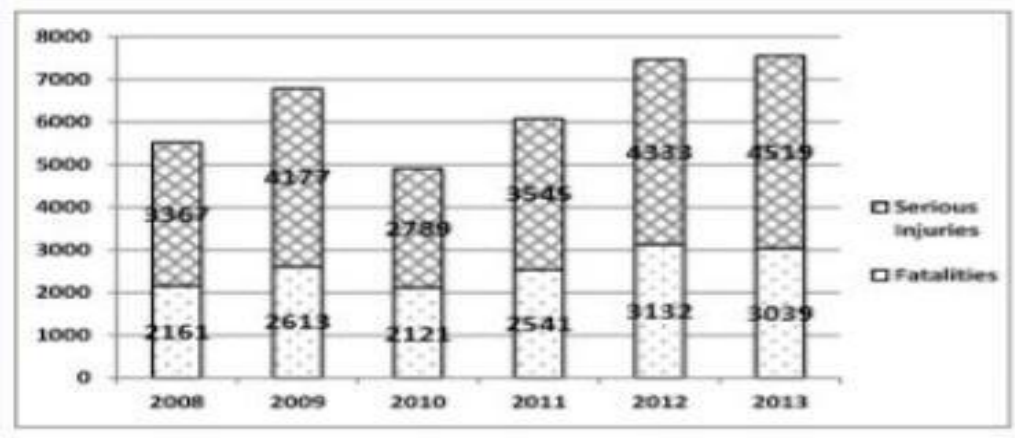


*Figure 1: Fatalities and serious Injuries 12 months to 30 June 2008-2013*

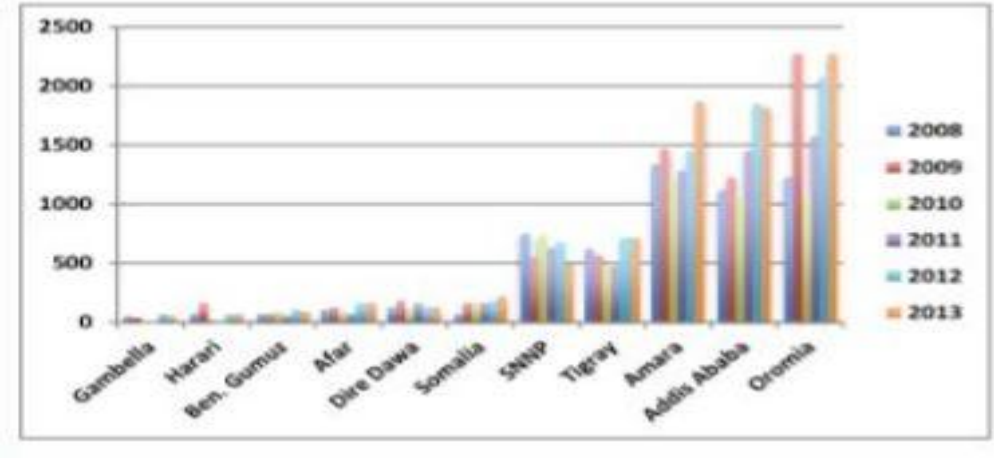



*Figure 2: Fatalities and serious Injuries by Region/City (12 months to 30 June 2008-2013)*

## 1.2 Statement of the Problem

Deaths and Injuries resulting from road traffic crashes remain a serious problem globally. Our world is witnessing serious fatal and injury accidents in recent years. Road traffic accidents take the highest share of these accidents. Currently RTAs is one of the major factors that brings death next to natural factor in sub Saharan Africa countries, particularly in Ethiopia. Serious injury/casualty means Injury does not cause death within 30 days of the accident. Either results in the casualty being detained in hospital as an in-patient, or any of the following injuries: fractures, concussion, internal injuries, crushing's, severe cuts and lacerations, severe general shock requiring treatment, or any injury which causes death more than 30 days after the accident is serious injury.

Road Traffic injuries are major problem that contributed to human death, injuries as well as related property damage. A road traffic crash usually occurs on vehicles travelling on public road or highway. Commonly known types of crashes include collisions between vehicles, single vehicles and vehicles with pedestrians.

The Addis Ababa–Adama Expressway is a toll road that connects Addis Ababa to Adama. It is the first expressway in Ethiopia. The road was built between 2010 and 2014 by the China Communications Construction Company. The highway, with six lanes on two sides aims to abate the heavy traffic between its two endpoints. It reduces the time required to reach Adama from Addis Ababa to 45 minutes, a reduction of more than 50 percent over the time on previously available routes. Addis Ababa-Adama Expressway is one of the first class roads in Ethiopia with significant road traffic accident since 2014. Data collected from the Ethiopian Toll Road Enterprises shows that there has been around 1,357 road crashes during the past three years.

Data collected from previously available routes, i.e. Galan,Dukam,Bishoftu and Mojo to Adama shows that there has been around 104 fatality road crashes during the past three years.

Thus huge difference data recorded from expressways and the old ones requires a research to identify major factors that contribute to traffic accidents.

Hence, this research will find out the main cause of road traffic accidents, factors contribute to the occurrence of a collision of Gelan to Adama towns from both old and expressways during night times and day times based upon data gained. Finally, this thesis compares traffic accidents of two corridors with different type of variables.

## 1.3 Objective of the Study

### 1.3.1 General Objective

The main objective of this research is to assess and compare Road Traffic Accidents in Case of Addis Ababa to Adama towns from both old and expressways. There is no prior RTA done on those corridors simultaneously.

### 1.3.2 Specific Objective

Specifically, the study tries to attend the following objectives:

- Describe the major factors that contribute to traffic accidents.
- To Identify and compare factors of traffic accidents recorded of Galan-Adama Expresses with the Old Corridors of Galan to Adama
- To compare Nighttime traffic accidents recorded with Daytime traffic accidents of Galan-Adama Expresses and the Old Corridors of Galan to Adama.
- To determine the significance factors that contribute traffic accidents of Expressways and old ways.

## 1.4 The Scope of Study

The study was limited to Addis Ababa-Adama from Expressway and old ways, which runs from Addis Ababa through Tulu Dimtu Customs checking point to Adama and connects Adama to Awash road and from Galan_Dukam_Bishoftu_Mojo_Adama. The study site (road) has a total length of around 77 kilometers from six lanes Expressway and 60 KM from two way two lane trunk roads.

The research also basis its assessment on the data collected for the period of three years since July 8, 2017 – June 8, 2020. The study mainly focuses on identifying factors for crash injury and comparisons for each causes of accidents along two of corridors and assess determinant of traffic accident on those corridors. It also compares nighttime accidents with daytime and expressway with old roadways.

### 1.5 Significance of the Study

This research and its findings are important for the following major reasons.

- The study will help to create awareness for road user about factors of traffic problems on those two corridors. Because, as a road user, they can play their own contribution in reducing road traffic accidents.
- The study will supplement the existing literature of road traffic accidents that will work to assess the situation of road traffic accidents in Ethiopia.
- The study assess existing situation and communicate readers how to act while using express roads and save their life and property through notifying the severity of road accidents on different part of the road segment.
- The study also helps to keep the road safety through creating awareness on the areas of higher accident of road user surveillance.

- The research will also give information to those who are interested in conducting research on traffic accidents.
- The study will analysis the effects of nighttime and daytime on traffic accidents, road user highly affected by expressways and old ways will determined.

### 1.6 Organization of the Study

This research was classified into five sections. The first chapter is introduction parts. The next chapter is a literature review of road traffic Accidents related to prior research of expressways and rural roads. The literature review examines prior research conducted on international road traffic accidents, National road traffic accidents, causes of road traffic accidents like human related, road related, vehicle related and Environmental related causes literatures, and literature of accident classification is concerned in this chapter.

The third chapter of this thesis includes Research Methodology. This chapter conducted on the study site situation, data source and collection method, research approach method, model selection, variables of this thesis definitions and method of analysis was described in this sections.

In the fourth chapter, result of analysis and discussion was presented. This analysis found that description analysis of road traffic accidents per each variable like age, gender, year of accidents, driver experience, causes of crashes, types of crashes, road geometry, light conditions, day of week, road condition and weather conditions were described for both expressways and old ways in these sections.

The last chapter of this thesis presents conclusions and recommendations for future research.

# 2. LITERATURE REVIEW

## 2.1 Introduction

In this part of the study, basic and important literatures reviewed to provide background information and current state of RTA in Addis Ababa to Adama towns.

Road transportation provides benefits both to nations and individual through facilitating the movement of people and commodity from place to place. Everybody travels either to work, play shop or market etc. Even if road transport has benefit in economic and social development, it has also a considerable burden on people health–in the form of road traffic injuries, such health consequences has its own impact on human physical activities. This chapter contains review of previous studies on causes of road traffic accidents. Road safety and road incident reduction are related to many other fields of activity such as education, driver training, publicity campaigns, police enforcement, road traffic policing, the court system and National Health Service.

Reports of (WHO, 2018, p. 4) suggests that, the number of road traffic deaths continuous to climb reaching a high of 1.35 million in 2016. That is nearly 3700 people dying on the world's roads every day. However, the rate of death relative to the size of the world population has stabilized and declined relative to the number of motor vehicles in recent years.

As shown in figure below despite the increase the absolute numbers the rate of road traffic deaths has remained constant at around 18 deaths per 100,000 populations over the last 15 years. While this does suggest that the problem is not worsening, the world is far from achieving SDG target 3.6, which calls for a reduction in the number of deaths by a half by

2020. The numbers are staggering. Road traffic crashes now represent the eighth leading cause of death globally. They claim more than 1.35 million lives each year and cause up to 50 million injuries. In addition, the fact is, every one of those deaths and injuries is preventable. (WHO, 2018, p. 4).

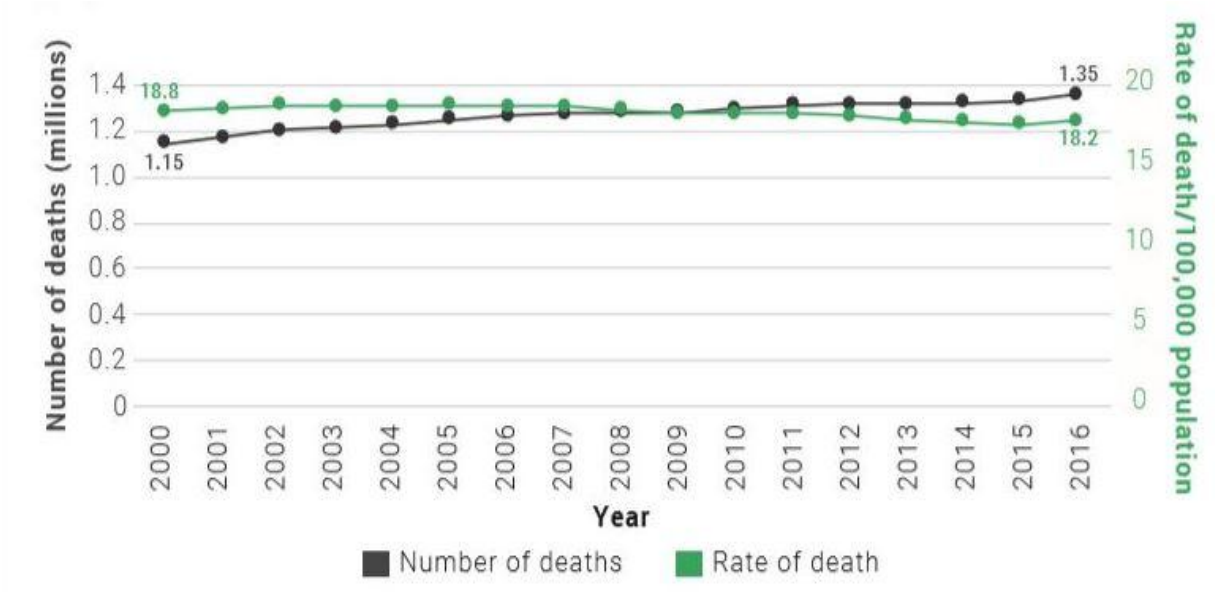



*Figure 3: Number and rate of road traffic death per 100,000 population: 2000-2016*

Source: (WHO, 2018, p. 4)

### 2.2. International road traffic accident and safety

"During the same period the number of vehicles worldwide has steadily increased, while death rates declined from 135 deaths for every 100,000 vehicles in 2000 to approximately 64 deaths for every 100,000 vehicles in 2016 (Figure below). This represents a reduction of more than 50% in the last 15 years suggesting some progress in mitigating the adverse effect of increasing motorized transport. Although progress has been made, these data show that it

has not occurred at a pace fast enough to compensate for rapid population growth and increase motorization worldwide." (WHO, 2018)

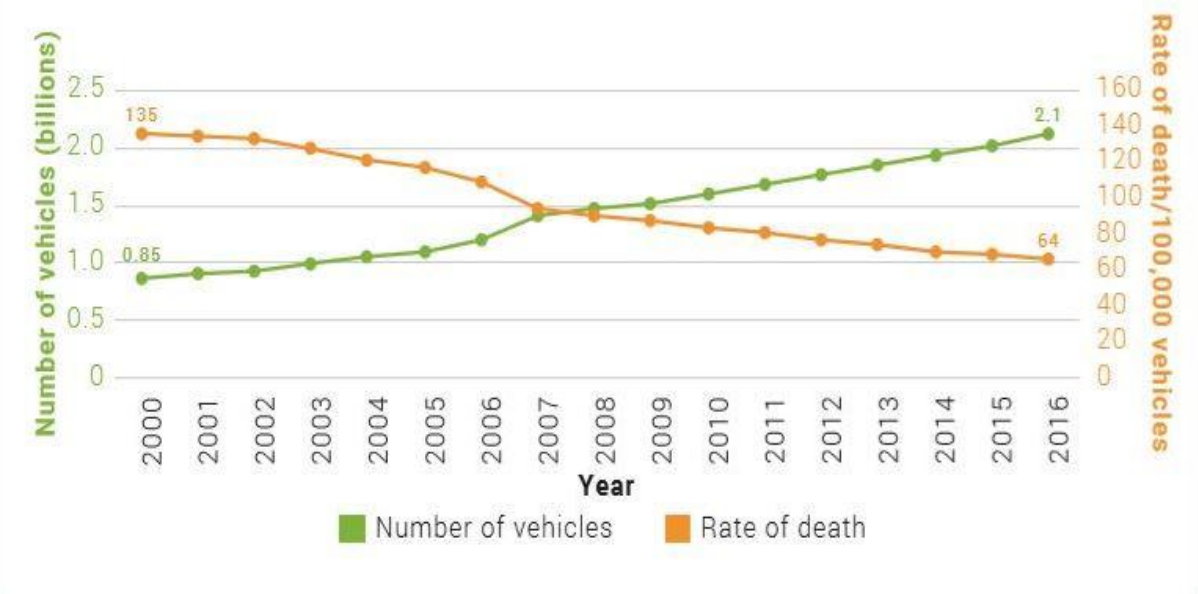



*Figure 4: Number of motor vehicles and rate of road traffic death per 100,000 vehicles: 2000-2016.*

Source: (WHO, 2018, p. 5)

Road traffic injury is the eighth leading cause of death for all age groups, up from the 9th leading cause of death (10). It is also now the leading cause of death for children and young Adults aged 5-29 years.

*Table 2. 1 Leading Causes of deaths, all ages, 2016*

| Rank | Cause | % of total deaths |
|---|---|---|
| | **All Causes** | |
| 1 | Ischaemic heart disease | 16.6 |
| 2 | Stroke | 10.2 |
| 3 | Chronic obstructive pulmonary disease | 5.4 |
| 4 | Lower respiratory infections | 5.2 |
| 5 | Alzheimer's disease and other dementias | 3.5 |
| 6 | Trachea, bronchus, lung cancers | 3.0 |
| 7 | Diabetes mellitus | 2.8 |
| 8 | Road traffic injuries | 2.5 |
| 9 | Diarrhoeal diseases | 2.4 |
| 10 | Tuberculosis | 2.3 |

Source: (WHO, 2018, p. 6)

### 2.3. National Road traffic accident

Ethiopia is one of those rising countries with low level of income accompanied by high rate of population growth and high number of traffic accident. As part of the developing world, Ethiopia is mostly an important country with low level of urbanization. The economic performance of different sectors of the national economy is not pleased. This low performance is due to a number of limitations such as low level of investment in different sectors of the national economy. On other hand, As World Health

Organization of 2018 reports, total vehicles registered 2015/16 were 708,416 vehicles in Ethiopia but the traffic accident rate too much as compared to the volume of traffic.

*Table 2. 2 Number of vehicles in the Regions (up to June, 2019) Registered vehicles*

| Addis Ababa | Amhara | AF | BN | Dire Dawa | SO | TG | GM | HA | SNNP | OR | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 596 084 | 94 001 | 6 598 | 8 842 | 21 938 | 15 160 | 52 751 | 5 558 | 8 000 | 91 105 | 171 308 | 1 071 345 |

NB: AF= Afar, BN= Benishangul, SO= Somali, TG= Tigray, GM= Gambela, SNNP= Southern Nations, Nationalities People, HA= Harari, OR= Oromia

Source: (2020)

"Since Ethiopia millennium the number of road traffic accident in Ethiopia was in alarming state. From 2007/08-2017/18, the numbers of road traffic accident were estimated around 291577. From those traffic accidents 36796, 54731, 58987 and 141063 road traffic accidents were fatality, serious injuries, light injuries and property damage respectively. The road network development and motorized vehicles increasable way from 2007/08-2017/18. Even if the government construct road and other infrastructure the severity of traffic accident in the country still in distressing stage. From 2007/08-2017/18, the Ethiopia government also construct around 912956km road network in the country to reduce road traffic accident in the country for having mobile and accessible road for the user. In case; growth of motorized vehicle was another issues that causes traffic accident in respect to road network coverage. Similarly, From 2007/08-2017/18, around 5592358 motorized vehicles was introduced in the country.

Data collected from Ethiopia federal police commission since Ethiopia millennium were reported from 2007/08-2017/18, depict that in average around 9.16% growth of road traffic accident were registered in the country yearly. Similarly; the road network coverage and motorized vehicle were grow in average around 10.4% and 9.34% respective yearly. The figure depict that the growth rate on road traffic accident, road network coverage and motorized vehicles were in parallel rate. As a result; the study indicated the growth of road network had no viable and significant impact in reduction of road traffic accident in the country. This implies that from 2007/08-2017/18, road traffic accidents were inversely proportional with road network coverage. While, the road network coverage directly related to the development of motorized vehicle in Ethiopia. Incase; the government and other stakeholder must concern on the issues to investigate the probable causes of accident in Ethiopia that affects the life of society daily and to curb the problem for last." (Debela Deme Jima, 29 June 2019)

"In the past consecutive eleven year (from 2007/08-2017/18) in Ethiopia more than 291577 traffic accident were registered. From those 36796, 54731, 58987, 141063 were fatality, serious injuries, light injuries and property damage respectively. The table below depict that the yearly road traffic accident and growth rate of road traffic accident in Ethiopia since Ethiopia millennium from 2007/08 to 2017/18

*Table 2. 3 Number and growth rate of road traffic accident in Ethiopia from 2007/08-2017/18*

| EFY | F | GR (%) | SI | GR (%) | LI | GR (%) | PD | GR (%) | Total | GR |
|---|---|---|---|---|---|---|---|---|---|---|
| 2007/08 | 1802 | - | 2156 | - | 2123 | - | 9005 | - | 15086 | - |
| 2008/09 | 2211 | 18.50 | 2276 | 5.27 | 2221 | 4.41 | 8987 | -0.20 | 15695 | 3.88 |
| 2009/10 | 2600 | 14.96 | 3494 | 34.86 | 4275 | 48.05 | 7098 | -26.61 | 17467 | 10.14 |
| 2010/11 | 2541 | -2.32 | 3545 | 1.44 | 4570 | 6.46 | 12130 | 41.48 | 22786 | 23.34 |
| 2011/12 | 3132 | 18.87 | 4333 | 18.19 | 4932 | 7.34 | 8444 | -43.65 | 20841 | -9.33 |
| 2012/13 | 3362 | 6.84 | 5042 | 14.06 | 6316 | 21.91 | 9117 | 7.38 | 23837 | 12.57 |
| 2013/14 | 3331 | -0.93 | 6039 | 16.51 | 5888 | -7.27 | 13181 | 30.83 | 28439 | 16.18 |
| 2014/15 | 4352 | 23.46 | 5918 | -2.04 | 6508 | 9.53 | 15639 | 15.72 | 32417 | 12.27 |
| 2015/16 | 3847 | -13.13 | 6886 | 14.06 | 7071 | 7.96 | 17977 | 13.01 | 35781 | 9.40 |
| 2016/17 | 4500 | 14.51 | 7288 | 5.52 | 7308 | 3.24 | 19132 | 6.04 | 38228 | 6.40 |
| 2017/18 | 5118 | 12.08 | 7754 | 6.01 | 7775 | 6.01 | 20353 | 6.00 | 41000 | 6.76 |
| Sum | 36796 | 92.84 | 54731 | 113.87 | 58987 | 107.64 | 141063 | 49.99 | 291577 | 91.62 |
| Average | 3345 | 9.28 | 4976 | 11.39 | 5362 | 10.76 | 12824 | 5.00 | 26507 | 9.16 |

Source: - Ethiopia Federal Police Commission from Article of (Debela Deme Jima, 29 June 2019)

Where; EFY- Ethiopian fiscal year, F- Fatality, SI- Serious injuries, LI- Light injuries, PD-Property Damage and GR (%) growth rate in percent respectively.

From the above table in average annually around 26507 road traffic accidents were registered in the past eleven year from 2007/08-2017/18. From those; in average yearly around 3345, 4976, and 5362 and 12824 road traffic accident were registered as fatality, serious injuries, light injuries and property damage respectively. Similarly; yearly average growth rate were depicted as 9.16 percent in the study period. Concomitantly, in average yearly around 9.28%, 11.39%, 10.76% and 5% growth rate were registered as fatality,

serious injuries, light injuries and property damage respectively in past eleven year in Ethiopia. The study also insist the variation on road traffic accident between commencement of study period (2007/08) or Ethiopia millennium (2000E.C) with end of the study period (2017/18) around 25914 road traffic accident were recorded." (Debela Deme Jima, 29 June 2019)

According to UN of Road Safety Performance Review: Ethiopia reports, The level of road crashes is increasing over time with the growth in the number of vehicles, the population, the road network and the vehicle kilometers driven. The impact of crashes that occurred in the country between 2016 and 2018 is as follows: 14,194 fatalities, 22,647 serious injuries and 21,159 minor injuries (Federal Police Commission, 2019).

*Table 2. 4 Road traffic Injury victim distribution among the regional states in Ethiopia (2016-2018)*

| Addis Ababa | 2018 | | | 2017 | | | 2016 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Deaths | Serious Injuries | Slight Injuries | Deaths | Serious Injuries | Slight Injuries | Deaths | Serious Injuries | Slight Injuries |
| Tigray | 386 | 854 | 381 | 374 | 858 | 584 | 371 | 664 | 356 |
| Afar | 56 | 73 | 20 | 72 | 49 | 31 | 131 | 164 | 79 |
| Amhara | 1 104 | 1 032 | 1 252 | 1 152 | 1 181 | 1 924 | 1 035 | 1 190 | 1 990 |
| Oromia | 1 478 | 1 448 | 1 386 | 1 882 | 1 710 | 1 586 | 1 541 | 1 459 | 1 485 |
| Somalia | 132 | 127 | 134 | 204 | 533 | 447 | 157 | 408 | 396 |
| Benishangul | 91 | 136 | 266 | 36 | 126 | 215 | 33 | 224 | 395 |
| Southern Nations | 712 | 1152 | 725 | 720 | 1121 | 922 | 634 | 990 | 937 |
| Gambela | 19 | 43 | 81 | 18 | 20 | 48 | 16 | 38 | 101 |
| Hareri | 55 | 203 | 188 | 34 | 224 | 507 | 53 | 123 | 284 |
| Addis Ababa | 528 | 2 210 | 1 274 | 585 | 1 804 | 1 232 | 477 | 2 085 | 1 232 |
| Dire Dawa | 36 | 129 | 242 | 41 | 128 | 279 | 31 | 141 | 180 |
| Total | 4 597 | 7 407 | 5 949 | 5 118 | 7 754 | 7 775 | 4 479 | 7 486 | 7 435 |

Source: (2020) taken from federal police commission of Ethiopia, 2019

## 2.4 Causes of Road Traffic Accident

Road traffic crash results from a combination of factors related to the components of the system including roads, the setting, vehicles and road users, and the way they interact. Some

factors contribute to the occurrence of a collision and are therefore part of crash causation. Other factors aggravate the effects of the collision and thus contribute to trauma severity. Some factors may not appear to be direct relates to road traffic injuries. Some causes are immediate, but they may be under pinned by medium-term and long-term structural causes. Identifying the risk factors that contribute to road traffic crashes is important in identifying interventions that can reduce the risks associated with those factors (Lisa and David & , 2005).

### 2.4.1 Human Related Causes of Road Traffic Accident

Human factors are without doubt the most complex and difficult to separate, as they are virtually all very momentary in nature. Sensory capabilities, knowledge, decision making, attitude, attentiveness, fitness, health, driving skill, age, weight, strength and freedom of movement. Of these, the emotional dynamics are the greatest variable attributes and the most difficult to ascertain. They are also subject to the most adjustment with the least remaining evidence (Lisa and David & , 2005). Human factors in vehicle collisions include all factors related to drivers and other road users that may contribute to a crash. Examples include driver comportment, visual and auditory acuity, decision-making ability, and reaction speed. Some of the human related causes of RTA are discussed as follows.

#### *2.4.1.1 Drink Driving*

Drink driving is one of the most contributing factors to RTA occurrences in many countries of the world. The study of (WHO, 2018) show that, It estimated that between 5% and 35% of all road deaths are reported as alcohol related.

As discussed by (WHO, 2018). Reducing blood Alcohol concentration (BAC) from 0.1g/dl to 0.05g/dl may contribute to a reduction of 6-18% in alcohol-related road traffic fatalities. Alcohol ingestion by drivers puts pedestrians and riders of motorized two-wheelers at risk.

#### *2.4.1.2 Non-Use of Seat-Belts*

A significant number of lives could be saved every year by using seat belts. Until these times, many drivers are not realizing how much seat belts could save the lives of themselves and the life of their customers. What makes this fact more complex is that, although it is the worst in most of the developing countries of the world, it is a usual phenomenon in some most developed countries to see drivers with no use of seat belts while driving on public roads. (WHO, 2018) Suggests that; wearing a seat belt reduces the risk of death among drivers and front seat occupants by 45-50%, and the risk of death and serious injuries among rear seat occupants by 25%.

#### *2.4.1.3 Speed*

The speed of motor vehicles is at the core of the road injury problem. Speed affects to both crash jeopardy and crash magnitude. In accordance to this, recent studies have proved that as speeds increase, so do the number and severity of injuries. For instance, a study reported at (WHO, 2018) shows that every 1% increase in mean speed produces a 4% increase in fatal crashes risk and a 3% increase in serious crash risk. Thus, study shows that A 5% reduction in average speed can reduce the number of fatalities by 30%.The higher the impact speed, the greater the likelihood of serious and fatal injury. The pedestrians hit by car fronts the death risk raises rapidly 4.5 times from 50 km/hrs to 60km/hrs.

Vehicles travel at speeds that suit the function and the level of safety of the road to ensure that crash forces are kept below the limits where fatal or serious injury results. This requires the setting of appropriate speed limits supplemented by enforcement and education.Four main crash types account for the majority of fatal and serious injuries:

Crash involving Vulnerable Road Users (VRU's). I.e. pedestrians, motorcycle riders, pedal cyclists, public transport users and roadside vendors.
Side impact crashes at intersections
Head on and Run-off. (African Development Bank Group, July,2014, p. 8)

Wramborg (2005) used in-depth crash data to plot collision speeds against fatality risk for three of the main crash types.

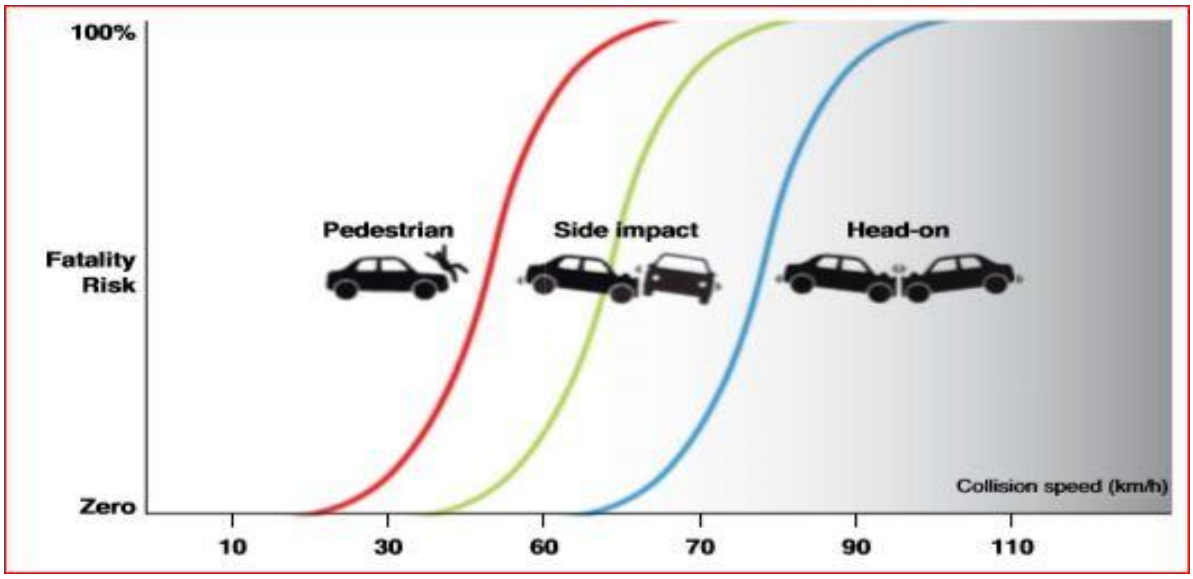



*Figure 5: Crash types and indicative fatality risk at speeds (source: Wramborg, 2005, p14)*

The safety benefits of lowered travel speeds include:

- Greater time to recognize hazards
- Reduced distance travelled while reacting to hazards
- Reduced stopping distance of the vehicle after braking
- Increased ability of other road users to judge vehicle speed and time before collision
- Greater opportunity for other road users to avoid a collision
- Less likelihood for a driver to lose vehicle control

#### *2.4.1.4 Age of Drivers*

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

In the Americas, road traffic injuries are the second leading cause of death for persons 15–24 years old. (PAHO, 2015, p. vii)

#### *2.4.1.5 The Use of Hand-Held Mobile Telephones*

The use of mobile telephones while driving could result in unexpected RTA risks. (WHO, 2018, p. 45) Suspects that, Telephone use while driving (whether hand-held or hands-free) increases the likelihood of being involved in a crash by a factor of four, while texting increases crash risk by around 23 times. Driver reaction times have also been shown to be

50% slower with Telephone use than without. Similarly, in car telephone conversations impair drivers more than listening to the radio or talking to passengers.

The use of hand-held mobile telephones can adversely affect driver behavior as regards physical as well as perceptual and decision-making tasks. The process of dialing influences a driver's ability to keep to the course on the road.

#### *2.4.1.6 Lack of Road User Information and Campaign*

Road users ought to acquire the knowledge needed to travel safely by means of formal training and their own experiences. However, inadequate knowledge of traffic regulations, traffic signs, vehicles and other elements may be some of the factors contributing to unsafe behavior and road calamities. Road user information and operations are intended to reduce accidents by promoting safer behavior in traffic, by giving road users better knowledge and more favorable attitude towards such behavior. Another objective are increased understanding of restrictive measures, which are introduced to increase safety, such as speed limits.

### 2.4.2 Road Related Causes of Road Traffic Accident

Since the entire process of road transport is conducted on roads, the quality, size and engineering characteristics of the roads will have considerable contribution to the increase or decrease of RTA risks. The road network has an effect on crash risk because it determines how road users perceive their environment and delivers instructions for road users, through signs and traffic panels, on what they should be doing. (WHO, 2018), Road Infrastructure is strongly linked to fatal and serious injury causation in road collisions and improvement to the road infrastructure are critical to improving overall road safety.

According to the Reports of (UNITED NATIONS ECONOMIC COMMISSION FOR AFRICA, 2020),sourced from Federal Transport Authority, In Ethiopia, road network increased from 26,550 km to 126,773 km starting from 1997 through 2018 (Ethiopian Roads Authority , 2018). As a result, road density per 1,000 sq. km increased significantly, from 24.1 km in 1997 to 115.2 in 2018. Also, substantial improvement has been registered in the condition of the country's road network, the proportion of road network in good condition increasing from 22 per cent in 1997 to 72 per cent in 2017 (Ethiopian Roads Authority , 2018).Vehicle populations in the country and kilometers travelled have increased substantially. In 2007, the vehicle population was 244,257 (WHO, 2009) and grew to 1,071,345 in 2018, a 338.6 percent increase (Federal Transport Authority, 2019).

Many traffic management and road safety-engineering measures work through their influence on human behavior. Some variables regarding the road related causes of RTA are discussed as to below.

#### *2.4.2.1 Road Environment*

Road environments have impacts on occurrences of road traffic accidents. In developed countries, there are continuous efforts to meet the safety standards of roads through safety audit during the planning, designing, and operation stage.

#### *2.4.2.2 Roadway Characteristics*

The roadway's conditions like the quality of pavements, shoulders, traffic control devices and intersections, can be a factor in a crash. Fewer traffic control devices and complex intersections with excessive signage lead to confusion. Highways designed for adequate sight distance for designed speed for the drivers to have sufficient perception reaction time.

The super-elevation on highways and especially ramps should be carefully laid with correct radius and appropriate transition zones for the vehicle to negotiate curves safely. Another important factor is the frictional force between the pavement and tires. If the tires lose contact with the pavement then the vehicle starts fishtailing.

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

#### *2.4.2.3 Road Lights*

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

### 2.4.3 Vehicle Related Causes of Road Traffic Accident

While vehicle design can have considerable influence on crash injuries, it must be studied in accordance to its contribution to RTA.

A small percentage of crashes are caused by mechanical failure of a vehicle, such as some form of tire failure, brake failure, or steering failure (Lisa and David & , 2005).The vehicle and roadway interaction like skid resistance play a major role in stopping the vehicle from encroaching the off road features like shoulder, median and other traffic signage. Improvements have been made in the manufacture of tires and vehicle design however; defects can still occur or be the product of poor vehicle maintenance.

Similarly, (Ung, 2007) stated that Vehicles have caused road accident because their owners did not properly maintain and regularly inspect the vehicle during the maneuver. So the road accident happened when brake failure, tire blowout, power steering failure, headlight failure. In addition to this defective or under inflated defective brakes, overloaded or poorly loaded vehicle or trailer, defective lights or indicators, defective steering or suspension and defective or missing mirrors are the factors for the frequent occurrence of RTA.

### 2.4.4 Environment Related Causes of Road Traffic Accident

The climatic and environmental conditions can also be a factor in transportation crashes. Supporting this idea (Lisa and David & , 2005); argued that, Weather on roads can contribute to crashes: Many several crashes have occurred during conditions of smoke or fog, which can reduce visibility. Vehicles travelling at high rate of speed are unable to see the slowing and or stopped vehicles in front of them, which can lead in to multi vehicle pileup. Glare can reduce driver visibility especially on east west roadway during the hours of sunrise and sun set. Wind gusts can affect vehicle stability. Slippery road (due to

weather), deposit on road, animal or object in carriageway, poor or defective road surface, Inadequate or masked signs or road markings are also responsible for the disaster caused by environmental characteristics to RTA.

## 2.5 Accident Classification

Estimation of road traffic accidents demands road accident statistics as a main input. In this regard assessing the definition of different category of road accident being used is very essential.

### 2.5.1. Current Accident Severity Definition in Ethiopia

In Ethiopia, even though a documented definition of different accident severity levels was not obtained for this study, the information obtained from the interview of some patrol and police officers shows that:

1. **A fatal accident** is the one in which one or more individuals die as a result of traffic accident within the same reporting 30 days of the occurrence of the accident.

2. **A serious injury** is one in which a victim sustains severe cuts, bleeding, breaks, and other damages which requires a medical treatment as “in-patient” in hospital.

3. **A slight injury** is the one as a result of which the victim sustains only small cuts, scratches, and other small damages which may be treated as an out-patient without requiring admission to a hospital.

4. **Property damage** only accident is the one as a result of which no person is injured only one or more vehicles involved in the accident are damaged.

# 3. RESEARCH METHODOLOGY

## 3.1 Introduction

Road Traffic accidents are the major cause of death and injuries worldwide. Expansion of road network, motorization and urbanization in the country has been accompanied by a rise in road accidents leading to road traffic injuries and fatalities as a major public health concern. Today road traffic injuries are one of the leading causes of deaths, disabilities and hospitalizations with severe socioeconomic costs across the world. The Ethiopian Federal Police Commission's report revealed that 2,161 road traffic deaths were registered nationwide in 2007 and this figure more than doubled in 2018, increasing to 3606 (Federal Police Commission, 2019; Federal Police Commission , 2011). The level of road crashes is increasing over time with the growth in the number of vehicles, the population, the road network and the vehicle kilometers driven.

"The trends imply that more Ethiopian lives are lost due to road traffic injuries than to other causes. Citizens die on the roads at an average of 4,732 persons per year; or every day, approximately 13 Ethiopians do not return home due to being victims of road traffic crashes. Road traffic injuries in Ethiopia, mostly affect passengers, and pedestrians. In other words, one person is killed on the roads every two hours. It is likely that actual fatality figures in the country are larger than those reported by the Ethiopian Federal Police Commission due to factors such as underreporting and misclassification of road traffic fatalities." (December2020)

### 3.2 The Study Site

The study site has two parts. The first Corridor was Addis Ababa-Adama expressway that starts from Tulu Dimtu Customs checking point ends on the east side of Adama that connects Adama Awash road. It has a total length of 76.3 kilometers. It has nineteen entrances and twenty-nine exist. The entrances gate serve for receiving bills while the exits use for charging services. The charge for the transportation can paid based on tonnage of vehicles, quantity and distance covered. The number of wheels, as well as the height of vehicles is considers for service charges. On the two way of the road, there are three lanes on each side serve for those vehicles traveling with 60-80 km/hr, 80-100 km/hr and above 100 km/hr driving speed. The expressway can also serve for those nearby towns as an entrances and exit, Tulu Dimtu custom check points 16km Dukem, 33km Bishoftu, 52km Modjo, 60A and 60B Adama and 64km Welenchity. The road section incorporates road Lay By with an interval of 3km that serve the road user during emergency cases and to take rest. Traffic flows for expressways from 2015 to 2021 were listed on table below.

*Table 3. 1 AADT for Expressways*

| Year(E.C/G.C) | Traffic flow Yearly | AADT |
|---|---|---|
| 2007/2015 | 3,037,817 | 10,262 |
| 2008/2016 | 5,043,463 | 13,815 |
| 2009/2017 | 6,788,741 | 18,599 |
| 2010/2018 | 7,810,351 | 21,398 |
| 2011/2019 | 7,796,276 | 21,360 |
| 2012/2020 | 8,347,038 | 22,869 |
| 2013/2021 | 9,156,390 | 25,086 |

The second corridor were Addis Ababa to Adama from the old roads which cross the towns like Galan,Dukam,Bishoftu and Mojo. It has a total length of 66 kilometers. Dukam and Gelan town were located in special zone of Oromia region of Ethiopia and kwon by industry areas and elevation of 1950m, 2142m respectively. One Terminal port located at center of them.

Whereas, Bishoftu and Mojo towns were located in east shewa zone of Oromia region, Ethiopia at elevation of 1,920m,1788m respectively.

The two routes pass through fertile lands that were suitable for agriculture. Products like large crops and other plants are produces along the sides of the road. The road is also a link between the capital cities with neighboring country and facilitates transactions of seaports and support movement to recreation centers.

## 3.3 Data Source and Collection

Traffic accident data on expressway have been collected and recorded by the traffic patrol assigned by Ethiopian Toll Road Enterprises. As a result, the raw data used for this research is obtained from the Traffic Safety and Security Department of Ethiopia Toll Road Enterprises. Traffic accident data on old roads from Addis Ababa to Adama have been collected and recorded by Gelan City police office and GelanTransport authority, Dukam City police office and DukamTransport authority, Bishoftu City police office and Bishoftu Transport authority, Mojo City police office and MojoTransport authority. But, reports of city police office for oromia police commission are guide this research. The overall data covers a period of three years (July 8, 2017 to June 8, 2020).

The road traffic accident data collected incorporated all relevant information including their cause, locations and types of accident in addition to number of fatalities, injuries and property damage in detail for the study period of three years.

### 3.3.1 Traffic Accident Data

The first Corridor (Addis Ababa to Adama Expressways) was found on non built–up areas (rural) areas and the second Corridor (Addis Ababa to Adama from Old Road ways) was

found on four towns built up areas (Urban). To acquire reliable data, a road traffic accident form was designed.

The form has the following major characteristics and these features are used for capturing data.

- Date, day and time of accident,
- Vehicle type
- Accident type,
- Degree of severity,
- Accident Causes
- Collusion types
- Number of victims (passenger)
- Location of accident,

### 3.3.2 Traffic Data

Traffic data is required to undertake analysis of road safety problems for roads under consideration. These data is helpful in determining the type of measures that is applicable at the site. Since the expressway registers the volume of traffic digitally, there is no need to undertake field traffic count. Vehicle is defined as carriage, chariot, bicycle, motor vehicle, semi-trailer and trailer operated on a road (1998).

In case, the study classified vehicles into six groups. These are Automobile, Public 1(12-45 seats: minibus, Medium Bus), Public 2 (above 46 seats), Freight 2 (11-100 quintal), Freight 5(above 100 quintal), and others. The research used vehicles classification as Automobile, Public 1, Public 2, Freight 2, Freight 5 and others for model development.

### 3.4. Research Approach

Both qualitative and quantitative research technique is used to systematically investigate the facts behind traffic accidents and to discover and analyze events, behaviors, or facts to draw logical conclusion that help to draft applicable rules, laws and theories for the area. As it is documented in different literatures, there are three main types of research approaches. These are:

1. **Explanatory Research:** A research helps to test hypotheses and theories that explain how and why a phenomenon operates.

2. **Constructive Research:** It is a type of research used to develop a new solution to a problem.

3. **Empirical Research:** Is a type of research that provides empirical evidence on the feasibility of an existing solution to a problem.

In this particular study, the intention of the research is to design appropriate techniques that help to identify factors of accidents of traffic that have been created on Addis Ababa to Adama Roads. As a result, this study can be categorized partly as **empirical research**, since it uses empirical technique to show the level of traffic accidents from Addis Ababa to Adama Roads in two ways.

### 3.5. Model Selection

Different models uses different data set to effectively perform analysis and draw logical conclusion. Researches on this area was indicates that Binary Logistic Regression requires dummy variables to run the model. Ordinal Logistic Regression

requires ordered polytomous data to run the model and execute the data. On the other hand, Multinomial Logistic and Probit regression requires nominal polytomous data to function properly. Given the nature and properties of data collected from Addis Ababa to Adama, which has nominal and polytomous nature, the study preferred the use of multinomial logit regression model. The main benefit of using this model is that it gives cumulative standardize estimating coefficient for each parameter.

## 3.6. Variables Definition

Depending on the objective of the study and the type of data collected from Galan City, Dukam city, Bishoftu city, Mojo city and Toll Enterprises, the study identified the following independent and dependent variables to be used for research under consideration.

### 3.6.1. Independent Variables

- Time of Day (Day Time, Night Time)
- Day of the week related variables (Monday, Tuesday, Wednesday, Thursday, Friday, Saturday and Sunday) for further analysis of model the research use day of the week as (Monday – Friday, Weekend)
- Accident Causes related variables (Driver Error, Pedestrian Error, Over Speeding, Vehicle defect and Others)
- Collusion related variables (Crash Vehicle to Vehicle, Car Overthrow, Crash Vehicle to Static Object)
- Vehicle types related variables: Automobile, Public 1(12-45 seats: minibus, Medium Bus), Public 2 (above 46 seats), Freight 2 (11-100 quintal), Freight 5(above 100 quintal), and others. The research used vehicles classification as

Automobile, Public 1, Public 2, Freight 2, Freight 5 and others for model development.

### 3.6.2. Dependent Variables

In line with the objective of the research, the dependent variable is Accident. This variable expressed categorically in terms of variables like Fatality, Series Injuries, Light Injuries, and Property Damage.

## 3.7. Method of Analysis

### 3.7.1. Descriptive Analysis

The traffic accident data collected from the enterprise is analyzed and characterized using descriptive analysis to examine the relationships among variables and to identify possible source of cause and contributing factors. This helps to know which accident variables frequency are significantly higher compared to crashes of other relative variables. In spite of this, accident frequency can be used to analyze the relationship between accident variables. Accordingly, graphs, charts, tables etc are used to support the findings and give logical meanings for the output, which can help for realization and clear interpretation.

### 3.7.2. Statistical Analysis

In order to characterize the populations of crash, statistical analysis will be applied to determine the uniformity of the collected data. Statistics is the science and art of experimenting, collecting, analyzing, and making inferences from data.

I will conduct n logit software to understand factors of traffic accidents and to compare distribution of injured persons from the accidents, which occurred on expressways and old ways, based on the accident characteristics. That is, this study compares expressway accidents and old corridors with respect to driver characteristics (Age, working experience), time characteristic (day of accidents, time, weather), and accident characteristics (accident causes, accident locations, accident types, driving conditions).

Multinomial Logit Model was employed with a confidence level of 0.05 and n logit software was applied to analysis the collected data. The data was cheeked and edited manually, after analyses by nlogit software interpreted in written documents and by tables.

# 4. RESULTS OF ANALYSIS AND DISCUSION

## 4.1 Analysis of Road Traffic Accident Addis Ababa to Adama

This research shows briefly to Study Comparison of the road traffic accident analysis done for 3 years( from 2018 to 2020) data from Addis Ababa to Adama of six lanes Expressways (Freeways) and two way two lane trunk roads (Galan- Dukam-Bishoftu-Mojo to Adama) of detail study on characteristics of traffic accident. This detail investigation show the cause of accidents, types crashes recorded, factor of Geometry , light conditions and Road Condition on Accidents, etc and recommendation to minimize the road traffic accident.

Road traffic accidents data were collected by Ethiopia Toll Road Enterprises located at Tullu Dimtu and Galan,Dukam,Bishoftu and Mojo police office. The ETRE and municipal police office are responsible for recording the details of Fatal, other road injuries including serious and minor injuries in their respective cities. After excluding records with missing variables, data's for this study included total accidents 1357 and 717 for six lanes expressways and two-way two lane trunk roads respectively.

From this Research totally, around 2074-road traffic accidents were registered in the above given duration and location. Out of these accidents; in average yearly around 49, 111, 256 and 1049 road traffic accident were registered on Freeways as fatality, serious injuries, light injuries and property damage respectively. Similarly, 104, 66,201 and 399 accidents were registered on two-way two lane trunk roads as fatality, serious injuries, light injuries and property damage respectively.

Thus, All Road traffic Accidents recorded for three years from 2017/2018 to 2019/2020 and collected from 77km (54 min) long for Freeways and 67 km (1 hrs and 58 min due to traffic conditions) for two-way two lane trunk roads.

Freeways are arterial highways with full control of access. They are intended to provide high levels of safety and efficiency in the movement of large volumes of traffic at high speeds. Control of access refers to the regulation of public access rights to and from properties abutting the highway. With full control of access, preference is given to through traffic by providing access connections with selected public roads only and by prohibiting crossings at grade and direct private driveway connections. (AASHTO, 2018, pp. 8-1)

The principal advantages of access control include preservation of freeways capacity, higher speeds, and low crash frequencies. Six lanes Expressway with fully controlled access has under pass and over pass at selected public crossroads.

On six lanes expressways; there are no front-to-front crashes, there are no accidents with pedestrians and animals as the fence is closed. It is easier to control the vehicle that caused the accident and to reach it immediately to provide medical assistances. Taxis, Motors and three wheeled vehicles are prohibited from entering the six lane expressways of Addis Ababa to Adama and there are no traffic accidents with them.

On two ways two lane trunk roads from Addis Ababa to Adama; the rate of accidents with pedestrians, Motorcycles, Bicycles, animals, three wheeled vehicles and traditional transport are high because they share roads together and cross each other when requested. It crosses four major cities, so the chances of accident happening inside built up area are high. There is traffic congestion since there is no alternative roads inside built up areas.

## 4.2 Description Analysis of Road Traffic Accidents Addis Ababa to Adama

Descriptive analysis was used to examine the relationships between variables. It was expressed in terms of tables, charts etc. to support the findings and give logical meanings for the output.

### 4.2.1 Distribution of Road Traffic Accidents on Ages

Human beings are the primary causes of RTA. Several studies have witnessed that the age of drivers have a greater impact over the occurrence of RTA scenes. This is due to the fact that, the age of drivers/Pedestrians/Passengers affects their driving behavior, concentration, sense of responsibility and patience.

Several studies have reported increased road crash rates for both younger and older drivers(under 25 and over 65 years old, respectively).The study of (Karoline and Gamos, 4 December 2020, p. 8) shows that, the risk of causing crash was higher for the young aged groups

The study of factors associated with risky driving behaviors for road traffic crashes among professional car drivers in Bahirdar city, north west Ethiopia show that majority of crashes occur persons in the in the greater than 30 ages. (Mekonnen, 2016, p. 5)

Table 4. 1 Distribution of RTA on Ages for Both corridors

| Drivers age/Pedestrains/Passengers | Expressways | | | | Oldways | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FI | SI | SLI | PD | FI | SI | SLI | PD | Total | Percents |
| 18-30 | 27 | 58 | 123 | 486 | 33 | 26 | 79 | 174 | 1006 | 45% |
| over30-50 | 21 | 44 | 105 | 506 | 46 | 40 | 106 | 197 | 1065 | 48% |
| over 50 | 1 | 9 | 28 | 57 | 17 | | 12 | 24 | 148 | 7% |
| Total | 49 | 111 | 256 | 1049 | 96 | 66 | 197 | 395 | 2219 | 100% |

From six lanes Expressways, 18 to 30 aged groups (youngest aged) was the highest risked group. This may related to inexperience and risk taking behaviors (driving under the influence of alcohol and other drugs, speeding). Unlike Expressway, two way two lane trunk road corridors show that the middle-aged group (from 31 to 50 aged) was the highest risks and needs further investigation.

Averagely, these studies show that, Drivers/Pedestrians/Passengers between the ages over 30 to 50 are more frequently engaged in road crashes than Drivers/Pedestrians/Passengers in the other age groups (Table 4.1). Drivers/Pedestrians/Passengers 30 to 50 contribute 1065 (48%) of all the RTA crashes in the study period followed by age groups between 18 and 30 which contributes 1006 (45%) to the misery. Drivers/Pedestrians/Passengers group above 50 years contributes only 148 (7%) road crashes for both freeways and two way two lane trunk roads during the study period.

### 4.2.2 Distribution of Road Traffic Accidents on Genders

Gender presents differentiation in crash involvements.Accidents involving female drivers result in more non-fatal injuries, relative to those involving male drivers, with the gender gap diverging over time. (Churchill, 08 Jully 2020., p. 13)

Studies of (Mekonnen, 2016, p. 4) show that, From total of 361 driver participated, the majority,98.9% accidents were occur by males and the level of risky driving behavior and road traffic crashes were high compared to females.

Over three years ,males and female drivers were involved in 2098(94%) and 19(1%) crash severity respectively. Gender in the remaining 118(5%) severity injury was not recorded in the crash report.

There are two possible reasons for the high proportion of male drivers involved in crashes. Firstly, male drivers, especially for jobs in remote areas or those that involve nighttime driving dominate as professional driving jobs. It is worth noting that female involvement in paid employment ( self-employment) is low in Ethiopia. Kilometers travelled per annum by women as drivers are most probably lower than men. (Getu S. Tulua, 2013, p. 3)

Table 4. 2 Distribution of RTA on Genders for Both corridors

| Genders | Expressways | | | | Oldways | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FI | SI | SLI | PD | FI | SI | SLI | PD | Total | Percents |
| Male | 42 | 97 | 238 | 971 | 96 | 66 | 197 | 391 | 2098 | 94% |
| Female | _ | 2 | 3 | 8 | 0 | 0 | 0 | 6 | 19 | 1% |
| Missing | 7 | 12 | 15 | 70 | 8 | 0 | 4 | 2 | 118 | 5% |
| Total | 49 | 111 | 256 | 1049 | 104 | 66 | 201 | 399 | 2235 | 100% |

Road Traffic Accidents from Addis Ababa to Adama shows a greater variation in terms of driver/passengers/pedestrians sex. As shown in table 4.2, the number of male driver/passengers/pedestrians involvement in RTAs greatly outnumbers females. The outstrip number of male driver/passengers/pedestrians could result in more frequencies of engaging in RTA events. From 2017/2018 to 2019/2020, male drivers cause 2098 (94%)

RTAs. In contrary, female drivers caused 19 (1%) road crashes and those missed data while recording were 118(5%).from this research perspective males are the main contributors to RTA than Females from Addis Ababa to Adama Corridors.

### 4.2.3 Distribution of Road Traffic Accidents on Year of Accidents

Like the variation in the distribution of RTAs within the 24 hours of a day and months of a year, there is disparity of RTA frequencies between years to years.

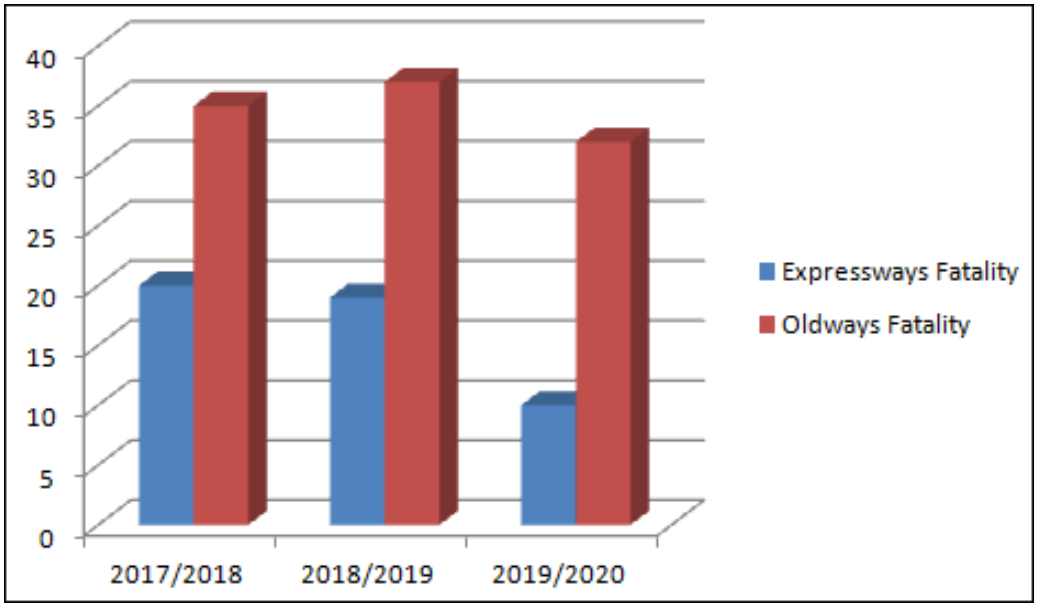



*Figure 6 fatality versus year of accidents*

From figure 4.1 above, fatality decreases from 2017/2018 to 2019/2020 on six lanes expressways. On two ways two lane trunks road fatality occurred in 2018/2019 were high compared to 2017/2018 and 2019/2020.

Table 4.3 describes that, there is a slight variation in the occurrence of RTAs among the years From Addis Ababa to Adama. Comparatively, 2017/2018 and 2019/2020 of highest RTA panorama in the Corridor recorded, they contribute 791 (35%) and 787 (35%) respectively of the total crashes during the study period.

Table 4. 3 Distribution of RTA on Year of Accidents for Both corridors

| Year Of Accidents | Expressways | | | | Oldways | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FI | SI | SLI | PD | FI | SI | SLI | PD | Total | Percents |
| 2017/2018 | 20 | 36 | 72 | 395 | 35 | 27 | 36 | 170 | 791 | 35% |
| 2018/2019 | 19 | 43 | 98 | 222 | 37 | 21 | 95 | 122 | 657 | 29% |
| 2019/2020 | 10 | 32 | 86 | 432 | 32 | 18 | 70 | 107 | 787 | 35% |
| Total | 49 | 111 | 256 | 1049 | 104 | 66 | 201 | 399 | 2235 | 100% |

In 2018/2019 Both of Corridors especially two way two lanes trunk roads (were under maintenance by Ethiopian Road Authority, Galan-Dukam-Bishoftu-Modjo Road Maintenance), most probably due to this case crashes occurred were lower than the other years, but it requires further researches/investigations to find out the reasons.

### 4.2.4 Distribution of Road Traffic Accidents on Driver Experience

It is believed that the experience of drivers play a paramount role in road traffic crashes. Table 4.4 summarizes the difference in RTA occurrences in relation to driving experience.

Table 4. 4 Distribution of RTA on Drivers Experience for Both corridors

| Drivers Exprience | Expressways | | | | Oldways | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FI | SI | SLI | PD | FI | SI | SLI | PD | Total | Percents |
| DR exp 2 & below | 20 | 38 | 82 | 299 | 13 | 12 | 60 | 106 | 630 | 34% |
| DR exp 2 to 5 | 21 | 41 | 87 | 366 | 15 | 12 | 29 | 83 | 654 | 35% |
| DR exp 5 to 10 | 4 | 19 | 36 | 157 | 10 | 14 | 15 | 31 | 286 | 15% |
| DR exp. Over 10 | 4 | 13 | 51 | 227 | _ | _ | 2 | 13 | 310 | 16% |
| **Total** | 49 | 111 | 256 | 1049 | 38 | 38 | 106 | 233 | 1880 | 100% |

Thus, table illustrates 630 (34%) RTA incidences have been exhibited by drivers whose driving experience is 2 and below 2 years. The drivers with driving experience between 2 and 5 years have caused the highest, 654 (35%) road crashes in the study period. In addition to this, with the exception of the drivers between 2 and 5-year experience, the result of RTA shows that the frequencies of Fatality and serious injuries occurrences decrease with increasing in driving experience in this investigations. Drivers with an experience of between 2 and 5 years cause 2.11 times more road crashes than drivers with driving experience over 10 years.

### 4.2.5 Distribution of Road Traffic Accidents on Causes of Crashes

Traffic accident can be caused by internal or external factors. Internal factors include technical faults of vehicles and drivers while external factors include road condition and road users.

Human factors are described as that which the person did, or did not do at the time of the accident. It includes speeding. in appropriate speed for circumstances, traffic violations, alcohols, drugs, negligence, driver error and age.

A vehicle factor refers to design or mechanical faults of vehicles, which include lack of maintenance. Road environments factors include all aspects of road design and maintenance, construction work, weather conditions and problems with signage and lightning.

According to (South Africa Department of Transport, 2004, p. 235) the three factors contribute to accidents in the following proportions

- Human factors (70-80%)
- Vehicle factors (10-15%)
- Road Environments factors (5-10%)

According to the results and findings of (Pakgohar, 2010, p. 765) studies, 93% of all road crashes really have driver distraction (Human factor) as their root cause whereas 34% of all road accidents had been occurred because of the road factor. This was followed by role of vehicle factor with contribution of 12%.

These show that human factors are critical for minimizing the level of accidents happening on the roads.

Table 4. 5 Distribution of RTA on causes of crashes for Both corridors

| Causes of Crashes | Expressways | | | | Oldways | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FI | SI | SLI | PD | FI | SI | SLI | PD | Total | Percents |
| Driver error | 14 | 33 | 75 | 310 | 51 | 33 | 93 | 137 | 746 | 33% |
| Overspeeding | 16 | 29 | 53 | 129 | 25 | 23 | 76 | 150 | 501 | 22% |
| Vehicle defect | 9 | 28 | 79 | 306 | 1 | _ | 1 | _ | 424 | 19% |
| Other | 10 | 21 | 49 | 304 | 19 | 4 | 15 | 79 | 501 | 22% |
| Pedestrain Error | | | | | 8 | 6 | 16 | 33 | 63 | 3% |
| **Total** | 49 | 111 | 256 | 1049 | 104 | 66 | 201 | 399 | 2235 | 100% |

The highest Causes of Crashes that cause fatality on freeways were over speeding, from 49 fatalities, 16(33%) were died by Over speeding and Driver Error were the highest fatality for old Corridors, from 104 Fatalities, 51(49%) were by driver errors. None of pedestrian crashes recorded on freeways and 63(3%) pedestrian were recorded on two way two lane trunk roads. From this pedestrians 8, 6, 16, 33 Fatality, Serious, Slight and Property damage respectively.

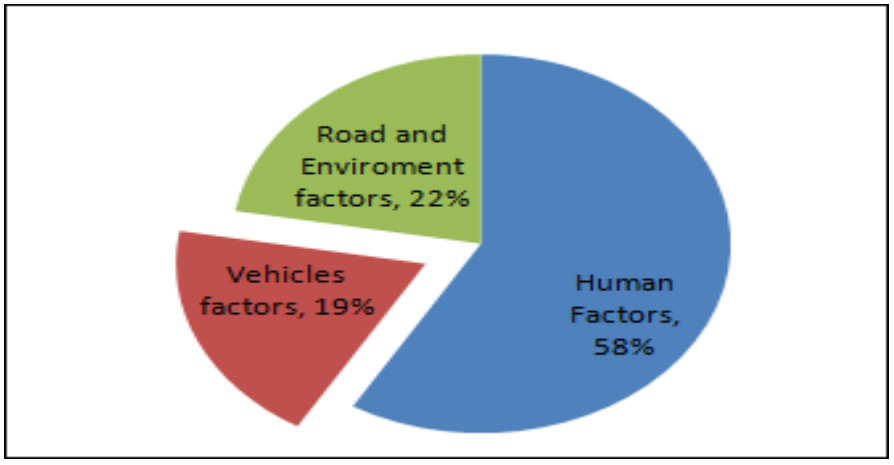



Figure 7the three factors that contribute to road accidents

Totally, on both corridors, 58% of all Road accidents were by human factors, 19% were by Vehicle defects and 22% were by others (Road environment factors and data not recorded).

### 4.2.6 Distribution of Road Traffic Accidents on Types of Collusions

*Table 4. 6 Distribution of RTA on types of crashes for Both corridors*

| Types of Crashes | Expressways | | | | Oldways | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FI | SI | SLI | PD | FI | SI | SLI | PD | Total | Percents |
| Over turning | 4 | 8 | 19 | 64 | 16 | 9 | 33 | 22 | 175 | 8% |
| Front_Rear crash | 44 | 98 | 220 | 859 | 7 | 11 | 18 | 134 | 1391 | 66% |
| Crash with fixed obstacle | 1 | 5 | 15 | 97 | – | 8 | 17 | 51 | 194 | 9% |
| Front-Front Crash | | | | | 3 | _ | 1 | 49 | 53 | 3% |
| Front-Side crash | | | | | 2 | 2 | 18 | 56..0 | 22 | 1% |
| side- side Crash | | | | | _ | 3 | 6 | 34 | 43 | 2% |
| pedestrain crash | | | | | 63 | 30 | 103 | 22 | 218 | 10% |
| **Total** | 49 | 111 | 254 | 1020 | 91 | 63 | 196 | 312 | 2096 | 100% |

According to an overview of recent studies (SWOV, April 2012 , p. 2) : at a collision speed of 20 km/h nearly all pedestrians survive a crash with a passenger car. About 90% survive at a collision speed of 40 km/h, at a collision speed of 80 km/h the number of survivors is less than 50%, and at a collision speed of 100 km/h only 10% of the pedestrians survive.After adjusting for sampling and statistical analysis bias in that research, a more recent study shows an adult pedestrian has approximately a 20% risk of dying if struck by a car at 60 km/h.

It is important to note that this risk analysis is a work in progress and has not yet been corroborated by other researchers but the undisputed issue is that speed is an important risk factor for pedestrian injury and that affects of above 30 km/h increase the likelihood of severe injury or death. (WHO, 2013)

Table 4.6 shows the distribution of injured person collision by types of crashes. Overall, collisions at Rear end of vehicles accounted for 66% of injured persons, Pedestrians crash accounted for 10% happened on old ways only. On six lanes expressways pedestrians cross roads by overpass or by underpass unlike two-way two lanes trunk roads by zebras.

Crash with fixed obstacles accounted for 9%, injured persons by over turning of vehicles accounted for 8%, Front –Front crash accounted for 3%. Not only this but also, Front side crash accounted for 1%, Side side Crash accounted for 2%.

From above table, types of collisions like Front- front, Front-side, Side-side, and Pedestrians Collisions were occurred only on two way two lane trunk roads, because two way two lane trunk roads was unlike six lanes Expressways of One directional freeways.

On Expressways, Front-Rear crash was the largest fatality and serious injuries, while pedestrian crashes, was the largest fatality and serious injuries one on Old ways.

### 4.2.7 Distribution of Road Traffic Accidents on Road Geometry

As depicted in table 4.7 below, the major road geometric alignments categorized as Straight, compound curves (including vertical and horizontal curves), Uphill/Upgrade and downhill/downgrade.

Studies of (Islam, 2019, p. 4)have concluded that downgrades have a significantly more effect on accidents rate compared to upgrades. Since steep grades are often short than mild grades, their influence on accidents occurrence is less effective than mild grades.

*Table 4. 7 Distribution of RTA on road Geometry for Both corridors*

| Road Geometry | Expressways | | | | Oldways | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FI | SI | SLI | PD | FI | SI | SLI | PD | Total | Percents |
| Staight | 16 | 35 | 90 | 281 | 80 | 58 | 169 | 294 | 1023 | 47% |
| Compound Curve | 4 | 6 | 22 | 79 | 4 | _ | _ | 3 | 118 | 5% |
| Down hill | 17 | 37 | 95 | 357 | 2 | 4 | _ | 29 | 541 | 25% |
| uphill | 6 | 21 | 34 | 116 | 9 | 2 | 19 | 41 | 248 | 11% |
| other/Missing | 6 | 12 | 15 | 216 | | | | | 249 | 11% |
| **Total** | 49 | 111 | 256 | 1049 | 95 | 64 | 188 | 367 | 2179 | 100% |

The Information in Table 4.7 above indicate that, The highest road traffic crashes were recorded on straight road with 47%, and followed by downhill with percentage of 25%. Speed could be main reason for road traffic crashes happened on straight and leveled road alignments. However, crash frequency on road gradients (i.e. Curves, upgrade and missing/others) consists of lower percentages.

### 4.2.8 Distribution of Road Traffic Accidents on Light Conditions

Table 4.8 below summarizes crash happened by different light conditions for duration of three years. Accordingly, light conditions shared different total crash frequency; Day light (1203), Darkness with street Lights (133), Darkness no streetlights (649), others/missing (151). Even though the existence of light is very important to reduce road traffic accidents, the analysis of this thesis show that most road traffic crashes happened during the day light.

Table 4. 8 Distribution of RTA on light condition

| Light Conditions | Expressways | | | | Oldways | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FI | SI | SLI | PD | FI | SI | SLI | PD | Total | Percents |
| Day light | 31 | 71 | 170 | 629 | 45 | 41 | 111 | 205 | 1303 | 58% |
| Darkness with street Lights | 1 | 1 | 8 | 57 | 8 | 5 | 14 | 39 | 133 | 6% |
| Darkness no street Lights | 11 | 27 | 62 | 251 | 49 | 20 | 77 | 152 | 649 | 29% |
| others/Missing | 6 | 12 | 16 | 112 | 2 | | | 3 | 151 | 7% |
| **Total** | 49 | 111 | 256 | 1049 | 104 | 66 | 202 | 399 | 2236 | 100% |

Above table show that, Traffic accidents from Addis Ababa to Adama by Light Conditions accounted 58% on Day light, followed by Darkness no street Lights accounting 29%, and 6% on Darkness with streetlights.

### 4.2.9 Distribution of Road Traffic Accidents on Day of Week

*Table 4. 9 Distribution of RTA on Day of Week for Both corridors*

| Day of Week | Expressways | | | | Oldways | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FI | SI | SLI | PD | FI | SI | SLI | PD | Total | Percents |
| weekday | 31 | 63 | 106 | 669 | 58 | 56 | 143 | 286 | 1412 | 63% |
| weekend | 13 | 36 | 76 | 280 | 46 | 10 | 58 | 113 | 632 | 28% |
| other | 5 | 12 | 74 | 100 | | | | | 191 | 9% |
| **Total** | 49 | 111 | 256 | 1049 | 104 | 66 | 201 | 399 | 2235 | 100% |

From Table 4.9 the characteristics of injured persons with respect to the day of week were tabled. The accident rates were higher on weekdays within percentage of 63% relatively low on weekends with a percentage of 29%. While looking at both the number of injuries per day and death per day, majority of them were recorded on Weekends.

### 4.2.10 Distribution of Road Traffic Accidents on Time of Accidents

Analysis made on the effect of brightness towards traffic accident indicated that large number of accidents was registered during daytime accounting 71.9 percent of the total. (Deme, October 2016, p. 5)

It is believed that during the daytime that more traffic accidents are occur. This is because that most of the people are moving for work and other activities at daytime than night and whatever. And also the driver's attentions are not concentrating due to noise pollutions and the nearby disturbance.

*Table 4. 10 Distribution of RTA onTime of Accidents for Both corridors*

| Time of Accidents | Expressways | | | | Oldways | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FI | SI | SLI | PD | FI | SI | SLI | PD | Total | Percents |
| Day | 32 | 73 | 174 | 639 | 43 | 41 | 110 | 208 | 1320 | 59% |
| Night | 12 | 26 | 66 | 309 | 61 | 25 | 91 | 191 | 781 | 35% |
| other | 5 | 12 | 16 | 101 | | | | | 134 | 6% |
| **Total** | 49 | 111 | 256 | 1049 | 104 | 66 | 201 | 399 | 2235 | 100% |

When we came to this thesis, Table 4.10 show that, Analysis made on time of accidents indicated that large numbers of accidents were registered during daytime accounted 59% and 35% during nighttime of the total for both of six lanes expressways and two way two lane trunk roads. This may indicate that drivers are conscious during nighttime while driving.

### 4.2.11 Distribution of Road Traffic Accidents on Road Condition

The analysis shows that about 87% of total crashes occurred at the time of good weather conditions whereas, only 13% of accident happened during moist-weather condition. Hence, the analysis confirms that the majority of traffic crashes happened under dry road surface conditions. (GERBA, FEBRUARY 2019 , p. 65)

*Table 4. 11 Distribution of RTA on road condition for Both corridors*

| Road Conditions | Expressways | | | | Oldways | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FI | SI | SLI | PD | FI | SI | SLI | PD | Total | Percents |
| Dry | 36 | 84 | 213 | 766 | 92 | 61 | 190 | 352 | 1794 | 80% |
| wet | 7 | 15 | 28 | 171 | 12 | 5 | 11 | 47 | 296 | 13% |
| other | 6 | 12 | 15 | 112 | | | | | 145 | 6% |
| **Total** | 49 | 111 | 256 | 1049 | 104 | 66 | 201 | 399 | 2235 | 100% |

From this research, Dry conditions accounting 80% of total crashes and followed by wet conditions, which accounts 13% of total crashes.

### 4.2.12 Distribution of Road Traffic Accidents on Weather Condition

*Table 4. 12 Distribution of RTA on Weather conditions for Both corridors*

| Weather Conditions | Expressways | | | | Oldways | | | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|
| | FI | SI | SLI | PD | FI | SI | SLI | PD | Total | Percents |
| Good Air | 25 | 60 | 151 | 494 | 72 | 57 | 156 | 333 | 1348 | 55% |
| Cold/Freeze/Frost | 9 | 21 | 54 | 279 | 15 | 2 | 8 | 34 | 422 | 17% |
| Cloudy | 4 | 7 | 18 | 47 | 5 | 5 | 7 | 5 | 98 | 4% |
| Rain | 4 | 8 | 13 | 100 | 12 | 2 | 30 | 26 | 195 | 8% |
| other | 7 | 15 | 236 | 129 | | | | | 387 | 16% |
| **Total** | 49 | 111 | 472 | 1049 | 104 | 66 | 201 | 398 | 2450 | 100% |

The Distributions of Injured persons by weather conditions are displayed in table 4.13. The total Accidents by weather condition of both Expressways and old ways in percentage was 55% on Good Airs, 17%on Cold/Freeze/Frost,4% on Cloudy,8% on Rainy days and 16% missed/not registered accordingly.

### 4.3 Statistical Analysis of Road Traffic Accidents Galan to Adama

Many engineering and scientific problems are concerned with determining a relationship between a set of variables. In many situations, there is a single response variable Y, also called the dependent variable, which depends on the value of a set of input, also called independent, variables x1,...,xr. The simplest type of relationship between the dependent variable Y and the input variables x1,..., xr is a linear relationship.

Varieties of methods are appropriate for analyzing road traffic accidents each with strengths and limitations. Discrete traffic injury data ordinal in nature are often modeled using ordered logit/probit and multinomial logit models. (Getu Segni Tulu, 2017, pp. 5-6) In some situations, even though the data are truly ordinal, the ordered probability model may be less intuitive to interpret than comparable, flexible unordered alternative models.

Most of the time multinomial logit (MNL) model is suitable for many applications; it also describes a number of weaknesses that can result in erroneous parameters estimates if underlying assumptions are not satisfied. The assumption made in the derivation and application of the standard MNL is that parameters are fixed across all observations.

Multinomial logistic regression analysis was used to develop statistical model that can predict the probability of severity injury from Addis Ababa to Adama using the traffic accidents occurrence data during 2017/2018-2019/2020.

These data were then analysed using multinomial logistic regression analysis in a nlogit software and relations between the occurrence of severity injury and causes of traffic accidents variables were evaluated and multinomial logistic regression models were constructed.

Multinomial Logistic regression was used to develop models to predict the probability of Severity injury occurrences from Addis Ababa to Adama. Data of 2074 traffic accident records that occurred during 2017/2018-2019/2020 in Galan, Dukam, Bishoftu, modjo and ETRE were evaluated. Independent variables associated with the occurrence of accidents like day of week, age, driver experience, cause of crash, Gender, relation with vehicles, Year of crash, types of crashes, weather condition, time of accidents, and Drivers License. The models were developed as follows:

i) Predicting severity injury on six lanes Expressways

ii) Predicting severity injury on two way two lane trunk roads

Logistic regression Analysis: Logistic regression (Madhu B, 09 – 12 December 2014, p. 194) is a statistical method that predicts the probability of an event occurring, in this case, the probability of occurrence of severity injury Logistic regression is conceptually similar to multiple linear regressions, because relations between one dependent variable and several independent variables are evaluated. Whereas multiple linear regression returns a continuous value for the dependent variable, logistic regression returns the probability of a positive binomial outcome (in this case, occurrence of severity injury) in the form:

$P = ex / (1+ex)$ (1)

Where

P is the probability of severity injury (Fatality, Serious and Slight injury) occurrence, in percent; x is $\beta 0 + \beta 1x1 + \beta 2x2 + \ldots + \beta ixi$;

$\beta i$ is logistic regression coefficients; xi is values for the independent variables, such as day of week, age, driver experience, cause of crash, Gender, relation with vehicles, Year of crash, types of crashes, weather condition, time of accidents, and Drivers License; i is the number of variables.

Logistic regression calculates several statistical parameters that determine the predictive success of the model (Madhu B, 09 – 12 December 2014, p. 194). The p-values calculated for each independent variable, indicates the statistical significance that each variable has on the overall logistic regression model.

### 4.3.1 Statistical Analysis of Old Ways Road Traffic Accidents (Galan-Dukam-Bishoftu-Modjo-Adama)

There were 717 road traffic accidents from Two way two lane trunk roads (Old way)s. Of which 104 (14.5%) were fatal, 66(9.2%) were serious injuries, 201(28%) were slight injuries and 399(55.65%) were property damage from 2018 to 2020.

| Variables | Fatal Injury | Serious Injury |
|---|---|---|
| **Day of week** | | |
| weekday | 58(55.8%) | 56(84.8%) |
| Monday | 10(9.6%) | 12(18.2%) |
| Tuesday | 21(20.2%) | 9(13.6%) |
| Wednesday | 10(9.6%) | 13(19.7%) |
| Thrusday | 11(10.6%) | 16(24.2%) |
| Frieday | 6(5.8%) | _ 6(9.1%) |
| weekend | 46(44.2%) | 10(15.1%) |
| Saturday | _ 26(25%) | 4(6.1%) |
| Sunday | _ 20(19.2%) | 6(9.1%) |
| **Year of crash** | | |
| 2018 | 35(33.6%) | 27(40.9%) |
| 2019 | 37(34.6%) | 21(31.8%) |
| 2020 | 32(30.8%) | _ 18(27.3%) |
| **Driver experience** | | |
| 2 and below | 13(12.5%) | 12(18.2%) |
| over 2-5 | 15(14.4%) | _ 12(18.2%) |
| over 5-10 | 10(9.6%) | 14(21.2%) |
| over 10 | _ | _ |

| Variables | Fatal Injury | Serious Injury |
|---|---|---|
| **Light Condition** | | |
| Day light | 45(43.3%) | _ 41(62.1%) |
| Darkness with street Lights | 8(7.7%) | 5(7.6%) |
| Darkness no street Lights | 49(47.1%) | 20(30.3%) |
| **Type of Crash** | | |
| Over turning | 16(15.4%) | 9(13.6%) |
| Front_Rear crash | 7(6.7%) | 11(16.7%) |
| Crash with fixed obstacle | _ | 8(12.1%) |
| Front-Front Crash | 3(2.9%) | _ |
| Front-Side crash | 2(1.9%) | 2(1.9%) |
| side- side Crash | _ | 3(4.5%) |
| pedestrain crash | 63(60.6%) | 30(45.4%) |
| **Land use ( crash location)** | | |
| builtup | 77(74%) | 58(87.9%) |
| non-builtup | 17(16.3%) | 2(3%) |
| **Gender** | | |
| Male | _ 96(92.31%) | 66(100%) |
| Female | 0 | 0 |
| **Relation with Vehicle** | | |
| owner | _ 8(7.7%) | 3(4.5%) |
| Employee | _ 86(82.7%) | 63(95.5%) |
| other | 10(9.6%) | _ |

Table 4.14 presents the discrete choice (Multinomial Logit) model results of Old ways Accidents. In the model, injury severity (fatal, serious and slight injuries) is the dependent variable, with slight injury used as the reference category. Parameters of each variable were tested to find evidence to accept or reject the “nil effect’ null hypothesis at 0.01, 0.05 and

0.1 critical p-values. Candidate models were also compared using the likelihood ratio test. As reported in Table 4.14, several factors were significant in explaining Fatalities, including types of crashes(Crash with Fixed obstacles), Crash Location(Built Up area), Day of Week(Sunday), Gender(Male), Relation with Vehicles( Employee and owners), Year of Crashes(2018,2019 and 2020) were contributed to road traffic accidents.

Discrete choice (multinomial logit) model
Dependent variable: Dependent variable : Severity Injury(Fatality, serious and light injury)
Log likelihood function -238.67696
Estimation based on N = 331, K = 19
Inf.Cr.AIC = 515.4 AIC/N = 1.557
---
Log likelihood R-sqrd R2Adj
Constants only -341.8717 .3019 .2812

Note: R-sqrd = 1 - logL/Logl(constants)

*Table 4. 13 Discrete Choise (MultinomialLogit) Model Estimate of RTA Two way two lane trunk roads (Galan-Dukam-Bishoftu-Mojo-Adama)*

| Independent Variables | Dependent Variables | Coefficient | Standard Error | Z | Prob.\|Z\|>Z* | 95% Confidence Interval | |
|---|---|---|---|---|---|---|---|
| Driver Age(18-30) | Slight Injury | 0.59784* | 0.34534 | 1.73 | -0.0834 | -0.07901 | 1.2747 |
| Day of Week(Thursday) | Slight Injury | 0.073885* | 0.40354 | 1.83 | 0.0671 | -0.05207 | 1.52977 |
| Crash Location(Non Built Up area) | Slight Injury | 1.28868** | 0.61454 | 2.1 | 0.036 | 0.0842 | 2.49316 |
| Causes Of Crash(Pedestrian Error) | Slight Injury | _1.20197** | 0.59224 | -2.03 | 0.0424 | -2.36275 | -0.0412 |
| Day of Week(Weekday) | Slight Injury | _0.28367 | 0.60903 | -0.47 | 0.6414 | -1.47735 | 0.91002 |
| Year of Crashes(2020) | Serious Injury | _4.37160*** | 1.07289 | -4.07 | 0 | -6.47443 | -2.26877 |
| Driver Experiences (Over 2-5 yrs) | Serious Injury | _0.62564** | 0.25975 | -2.41 | 0.016 | -1.13474 | -0.11653 |
| Day of Week(Weekday) | Serious Injury | 2.03598** | 0.87727 | 2.32 | 0.0203 | 0.31656 | 3.7554 |
| Day of Week(Friday) | Serious Injury | _2.44726*** | 0.83251 | -2.94 | 0.0033 | -4.07895 | -0.81556 |
| Light Condition(Day Light) | Serious Injury | _1.69079*** | 0.63104 | -2.68 | 0.0074 | -2.92761 | -0.45397 |
| Types of Crashes(Crash with Fixed obstacles) | Fatality | _1.65488* | 0.87379 | -1.89 | 0.0582 | -3.36747 | 0.05771 |
| Crash Location(Built Up area) | Fatality | 2.53668* | 1.34368 | 1.89 | 0.059 | -0.09688 | 5.17025 |
| Day of Week(Saturday) | Fatality | _1.06839 | 0.6788 | -1.57 | 0.1155 | -2.39882 | 0.26204 |
| Day of Week(Sunday) | Fatality | _3.51098*** | 1.09824 | -3.2 | 0.0014 | -5.6635 | -1.35847 |
| Gender(Male) | Fatality | _4.35405** | 1.41379 | -3.08 | 0.0021 | - | - |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| | | | | | | 7.12502 | 1.58309 |
| Relation with Vehicles( Employee) | Fatality | _1.89797 | 1.04928 | -1.81 | 0.0705 | -3.95451 | 0.15857 |
| Relation with Vehicles( Owner) | Fatality | _1.99972* | 1.18441 | -1.69 | 0.0913 | -4.32112 | 0.32167 |
| Year of Crashes (2019) | Fatality | 2.81572** | 1.11502 | 2.53 | 0.0116 | 0.63032 | 5.00112 |
| Year of Crashes(2020) | Fatality | 4.55202*** | 1.12853 | 4.03 | 0.0001 | 2.34015 | 6.76389 |

***, **, *, =➔ Significance at 1%, 5%, 10% level respectively

Model was estimated on Des 12, 2021 at 08:44:37 PM

Adjusted $R^2$ =28.12% means that, 28.12% of variation in dependent variable (fatality, serious and slight injury) is explained by differences in independent variables.

The Significant level for accident statistic of 1% and confidence interval of 99% implies that there is only a 1% chance of that statistic occurring due to random fluctuations and these types of significance show that highly significant. Significant level of 5% and 10% ( confidence interval of 95% and 90% respectively) implies that there is only a 5% and 10% chance of statistic occurring and shows significant and fairly significant respectively. Whereas when the significant level is more than 20%, means that the variables is not significant.

**Day of the week** is a significant factor in injury severity model with the probability of fatal injury about 10.94 % % higher for crashes occurring on weekends compared to weekdays on oldways. This thesis results show that Crashes occurred on Saturday were higher than Sunday by 5.8%.the study show that both Saturday and Sunday negative relationship to fatality Injuries. Fatal injury of pedestrians were 3.7% higher for crashes occurring on weekends than weekdays (Getu Segni Tulu, 2017, p. 14)

**With respect to Types of Crashes**, Crash with Fixed obstacles is negatively associated with fatal injuries of old-way road traffic accidents from Galan to Adama. Fatal injury of

pedestrian crash were the dominant one on this corridor, 63(60.6%) and followed by overturning 16(15.4%) due to over speeding.

**With Regard to Land use (Crash Location),** Built Up area is positively related to fatal injury (fatal injury of built up area like Galan town, Dukam town, Bishoftu town and Modgo town is 57.7% than none built up area or rural area.)

**Compared to driver's relationship with their vehicles**, Owner-driver is more severe than employer and followed by others (Family, friends etc...).Study show that Employer of vehicles is most risk full off fatal injuries. Insufficiently experienced drivers, authorizing improperly trained drivers and insufficient knowledge of traffic signs tend to increase the number of road traffic accidents. Driving of vehicle in drunken state, under the influence of alcohol and other intoxicated substances, the drivers lose the self-consciousness and control over vehicle, which ultimately forms the reason for accidents. (Ramesh and Palanisamy, July 28,2020) these all shows that due to lack of drivers ownership, chance of driving by carelessness is high and simultaneously chance of severity injury happened is high also.

**Gender** is one of demographic factors that influence the drivers to inflict traffic accidents. According to many researches finding in different years, males are accounting the largest percentage in committing more traffic accidents than females. This is because males are more emotional and more exposed to addictions of drugs and chat than females. (Endalkachew, April - June 2016, p. 16)

From this study of Gender perspective, Accidents by male is negatively associated with probability of fatal injuries of old ways. Fatal injuries of male were about 92.31 from total 104 fatalities. This indicates that, male fatality was more dominant than females and

followed by others (not recorded data). Whereas, on old ways this study shows there was no fatality recorded by female driver.

From year of crash, 2019 and 2020 were positively related and highly significant factor in injury severity model with the probability of fatal injury about 34.6% % and 30.4% respectively. Higher fatality injury was occurred on 2019 and little improved in 2020.The reason behind this invention is required further investigation.

### 4.3.2 Statistical Analysis of Expressways Road Traffic Accidents (Galan - Adama)

There were 1357 road traffic accidents from freeways. Of which 49 (3.6%) were fatal, 11 (8.2%) were serious injuries, 256 (18.9%) were slight injuries and 1049 (77.3%) were property damage from 2018 to 2020.

```
Discrete choice (multinomial logit) model
Dependent variable : Severity Injury(Fatality, serious and light injury)
Log likelihood function      -914.50296
Estimation based on N =   1358, K =  14
Inf.Cr.AIC  =   1857.0 AIC/N =    1.367
---------------------------------------
Log likelihood R-sqrd R2Adj
Constants only   -941.2939  .0285 .0183
Note: R-sqrd = 1 - logL/Logl(constants)
 R-sqrd is problematic. Use
model setup with ;RHS=one to get LogL0.
---------------------------------------
Response data are given as ind. Choices
```

*Table 4. 15 Discrete Choise (Multinomial Logit) Model Estimate of RTA six lanes expressways from Addis Ababa to Adama.*

| Independent Variables | Dependent Variables | Coefficient | Standard Error | Z | Prob.\|Z\|>Z* | 95% Conf-Interval | |
|---|---|---|---|---|---|---|---|
| Gender(Not Recorded data)X16S | Serious Injury | 0.59477* | 0.32787 | 1.81 | 0.0697 | -0.04785 | 1.23738 |
| Weather Condition(Cloudy)X54F | Fatality | _0.50448* | 0.26079 | -1.93 | 0.0531 | -1.01561 | 0.00665 |
| Relation with Vehicles( Not Recorded data)X33F | Fatality | 0.35671*** | 0.13209 | 2.7 | 0.0069 | 0.09783 | 0.6156 |
| Relation with Vehicles( Owner)X32F | Fatality | 0.65174*** | 0.16484 | 3.95 | 0.0001 | 0.32866 | 0.97481 |
| Driver Expriences(,,,,,,,,)X26F | Fatality | _0.01912** | 0.00925 | -2.07 | 0.0388 | -0.03725 | -0.00099 |
| Gender(Not Recorded data)X16F | Fatality | 0.81792** | 0.33435 | 2.45 | 0.0144 | 0.1626 | 1.47324 |
| Drivers Liscence (Automobile)X21F | Fatality | _0.59256*** | 0.19239 | -3.08 | 0.0021 | -0.96964 | -0.21547 |
| Drivers Liscence (Fright 5)X19F | Fatality | 0.49648** | 0.2379 | 2.09 | 0.0369 | -0.0302 | 0.96276 |
| Causes Of Crash(Vehicles Deffect)X59F | Fatality | _0.24257* | 0.12418 | -1.95 | 0.0508 | -0.48596 | 0.00083 |
| Time of Accident(Not Recorded data)X36F | Fatality | _0.49411** | 0.20751 | -2.38 | 0.0173 | -0.90082 | -0.08739 |
| Road Geometry( Compound curve)X45F | Fatality | 0.33456 | 0.21309 | 1.57 | 0.1164 | -0.08309 | 0.7522 |
| Vehicle Ownership (Private)X7F | Fatality | -0.11719 | 0.13261 | -0.88 | 0.3768 | -0.37709 | 0.14272 |
| Driver Age(18-30)X11F | Fatality | 0.16541* | 0.12143 | 1.36 | 0.1731 | -0.07259 | 0.40341 |
| Gender (Male)X14F | Fatality | 0.01293 | 0.16097 | 0.08 | 0.936 | -0.30255 | 0.32842 |

***, **, * ==> Significance at 1%, 5%, 10% level.

Model was estimated on Jan 21, 2022 at 05:05:51 PM

Adjusted $R^2$ =1.83% means that, 1.83% of variation in dependent variable (fatality and serious injury) is explained by differences in independent variables.

The Significant level for accident statistic of 1% and confidence interval of 99% implies that there is only a 1% chance of that statistic occurring due to random fluctuations and these types of significance show that highly significant. Significant level of 5% and 10% ( confidence interval of 95% and 90% respectively) implies that there is only a 5% and 10% chance of statistic occurring and shows significant and fairly significant respectively. Whereas when the significant level is more than 20%, means that the variables is not significant.

In general, the finding of the model clearly indicated that both internal as well as external factors play significant roles in the determination of accident. Especially, that Weather Condition, Relation with vehicles, Driver Experience, Drivers License, Cause of Crashes, Time of Accident, and driver's age have strong importance in the determination of accident. As a result, the expressway needs to focus on those factors to minimize the risk of accidents. Based on the above findings, the model that will help to determine the level of accident can be expressed using the following Fatality Injury predicting equation.

$$F = \beta + \beta 1X_1 + +\beta 2\ X_2 + \beta 3\ X_3 + \beta 4\ X_4 + \beta 5\ X_5 + \beta\ 6\ X_{6\,+} \beta 7\ X_7 + \beta 8\ X_8 + \beta 9\ X_9 + \beta 10 X_{10} + \varepsilon$$

This empirical estimation model can be used to assess traffic accidents on Addis Ababa – Adama Expressway. To enhance the level of accuracy, the coefficients of all independent variables are examined for their significance and those variables with higher significant relationship with Fatality Injury are used for developing an equation that helps to predict Severity Injury. Accordingly,

**Fatality =** $-0.50448\ X_1 + 0.35671\ X_2 + 0.65174\ X_3 - 0.01912\ X_4 + 0.81792\ X_5 - 0.59256 X_6 + 0.49411\ X_7 - 0.24257\ X_8 - 0.49411\ X_9 + 0.33456 X_{10} - 0.11719\ X_{11} + 0.16541\ X_{12} + 0.01293\ X_{13}$

| Variables | Fatal Injury | Serious Injury |
|---|---|---|
| **Gender** | | |
| Male | 42 (85.7%) | 97 (87.4%) |
| Female | _ | 2 (1.8%) |
| Not Recorded | 7 (14.3%) | 12 (10.8%) |
| **Weather Condition** | | |
| Good Air | 25 (51%) | 60 (54%) |
| Cold/Freeze/Frost | 9 (18.4%) | 21 (18.9%) |
| Cloudy | _ 4 (8.2%) | 7 (6.3%) |
| Rain | 4 (8.2%) | 8 (7.2%) |
| other | 7 (14.2%) | 15 (13.6%) |
| **Relation with Vehicle** | | |
| Empoyer | 13 (26.5%) | 41 (36.9%) |
| Owner | 5 (10.2%) | 15 (13.5%) |
| Not Recorded data | 31 (63.3%) | 55 (49.6%) |
| **Drivers Experience** | | |
| DR exp 2 & below | _ 20 (40.8%) | 38 (34.2%) |
| DR exp 2 to 5 | 21 (42.8%) | 41 (36.9%) |
| DR exp 5 to 10 | 4 (8.2%) | 19 (17.1%) |
| DR exp. Over 10 | 4 (8.2%) | 13 (11.8%) |
| **Gender** | | |
| male | 42 (85.7%) | 97 (87.4%) |
| Female | _ | 2 (1.8%) |
| Others(not recorded data) | 7 (14.3%) | 12 (10.8%) |
| **Drivers Licence Level** | Fatal Injury | Serious Injuru |
| Puplic-1 | 12 (24.5%) | 28 (25.2%) |
| Puplic-2 | 9 (18.4%) | 19 (17.1%) |
| Fright-5 | _ | 3 (2.7%) |
| Fright-2 | 1 (0.3%) | 16 (14.4%) |
| Automobile | _ 2 (2%) | 5 (4.5%) |
| Others | 25 (51%) | 40 (36.1%) |

| Variables | Fatal Injury | Serious Injury |
|---|---|---|
| **Causes of crash** | | |
| Driver error | 14 (28.6%) | 33 (29.7%) |
| Overspeeding | 16 (32.6%) | 29 (26.2%) |
| Vehicle defect | _ 9 (18.4%) | 28 (25.2%) |
| Other | 10 (20.4%) | 21 (18.9%) |
| **Time of Accident** | | |
| Day | 32 (65.3%) | 73 (65.8 %) |
| Night | 12 (24.5%) | 26 (23.4%) |
| other (not recorded data) | _ 5 (10.2%) | 12 (10.8%) |
| **Road Geometry** | | |
| Staight | 16 (32.6%) | 35 (31.5%) |
| Compound Curve | 4 (8.2%) | 6 (5.4%) |
| Down hill | 17 (34.8%) | 37 (33.4%) |
| uphill | 6 (12.2 %) | 21 (18.9%) |
| other | 6 (12.2%) | 12 (10.8%) |
| **Vehicle ownership** | | |
| Governments | 2 (4.1%) | 4 (3.6%) |
| Private | _ 35 (71.4%) | 80 (72.1%) |
| DF | _ | 1 (0.9%) |
| Others | 12 (24.5%) | 26 (23.4%) |
| **Driver age** | | |
| **18-30** | 27 (55.1%) | 58 (52.2%) |
| **over30-50** | 21 (42.9%) | 44 (39.6%) |
| **over 50** | 1 (2%) | 9 (8.2%) |

**Weather Condition:**

Weather is the day-to-day air conditions of an environment, which varies from time to time and it is more dynamic. According to (Endalkachew, April - June 2016), bad weather conditions as cool or cold, rainy and very hot weather conditions are causing more traffic accidents than normal weather conditions. More accidents occur during good air conditions

and followed by cold air. The good air condition accounts above 50 percent of traffic accidents.

From weather condition, Cloudy is a significant factor in injury severity model with the probability of fatal injury about 8.2 % for crashes occurring on Expressways. there is a negative relationship between weather condition(Cloudy) and fatality injury happened on this freeways.

According to this study, Most of fatality and serious injury occurred during good air conditions and followed by cold/freeze/frosts. Fatality recorded from 20180 to 2020 on expressways were, 51% on good airs, 18.4% on Cold/Freeze/Frosts,8.2% on Cloudy,8.2% on rain and 14.2% on others(including not recorded data)

The reason for the high accidents at good air conditions is that; proportion of drivers driving during bad weather conditions is low and they prefer to drive during good airs. Not only this but also, more vehicles are do business at good air conditions, hence the accidents are high.

**Regarding with Drivers Experiences**

It is known that the experiences of drivers are one contributing factor of road traffic accidents. Moreover, it was founded that the inexperienced drivers commit more traffic accident than the one who have more years of experiences (World Bank, July,2013). Drivers who have more experiences have best knowledge's of road signs, rules, vehicles nature, the weather condition and the behaviors of the passenger and pedestrians. This helped the drivers to take care off and reduce the impact of the accidents. Whereas the inexperienced drivers who have not adequate information about the nature of roads, weather, traffic laws and regulation are more likely to inflict traffic accidents.

This study shows that, relation between Probability of Fatality injury and driving experiences of drivers were negative and highly significant. Drivers experience of 2-5 years involving in accidents were the highest and recorded 42.8% of fatal injury on expressways of Addis Ababa to Adama during 2018 to 2020.In addition to this, Drivers Experience of 2 years and below reported 40.8% of fatal injuries and one of determinant factor of fatality on freeways.

**Genders:**

As (Dawit, February 2016), most of a younger man can create a traffic accident and put their life and others in danger than females.

This study shows that, males are the major in committing more traffic accident than females. However, it may be because of as various sources shows the number of female drivers in Ethiopia is far less than males drivers; for this reason, male drivers commit most of the accidents than female drivers. Fatalities recorded on this thesis were 85.7% on expressways and the rest one of 14.3% were others.

**Drivers License (Automobile):**

Type of Vehicle had their impact on accident severity. The study carried by (Dawit, February 2016) Accident data collected indicated that vehicles most frequently involved in accidents were Automobiles (27.8%). The second most frequently involved vehicle in accidents was Minibus and Bus that accounts for 27.7%.

The study site had six categories of vehicles.Puplic-1(Taxi, Minibus, High Roof), puplic-2(Bus), Fright-5(Train Truck), Fright-2, Automobile and Others (not recorded). From Drivers silences' both Automobile and Frieght-5 were determinants of fatalities on Expressways. As we observe from table 4.15 there is a significant and negative relation between driver's license of automobile and the probability of being Fatality.

**Causes of Crash (Vehicle defect):**

Traffic accident can be caused by internal or external factors. Internal factors include technical faults of vehicles and drivers while external factors include road condition and road users.

Analysis results of the study indicated that the major causes of Fatality on Addis Ababa – Adama Expressway associated with over speeding, accounting 32.6% of the total Fatal Injury and followed by Driver errors accounting 28.6%.

The report of the (World Bank, July,2013) shows that the contribution of the drivers to RTAs is increasing very rapidly through time and they identified that among the contributory factors deriver factors accounts the largest proportion. Those various factors identified by thus study that lead drivers to commit more traffic accidents were drunk

driving, not give way for vehicles passing, coming too close, over speeding, over loading, fatigue driving, improper passing.

Over speeding alone accounts 32.6 percent and followed by other driver errors (mentioned on above paragraph excluding over speeding) which accounts about 28.6 percent. Whereas, vehicles defect have significant effect and negative relationship for the driver to commit fatality, which accounts 18.4 percent and was one determinant of model created on expressways.

This shows that drivers are the major causes of traffic accidents due to unethical behavior on the use of roads.

**Time of Accident (Not recorded data)**

Study of (Fekede Asefa, 16 May 2020) revealed the RTAs fatality at Daytime was 70.4 percent and at nighttime was 29.6 percents. This means that, Daytime fatality injury was higher than nighttime fatal injury by 40.8 percents.

This Addis Ababa-Adama Expressways study results or Analysis made on the effect of brightness towards traffic accident indicated that large numbers of accidents were registered during daytime accounting 65.3 percent and 24.5 percent during nighttime for total fatality injury only. This may indicate that drivers are conscious during nighttime while driving on Expressways. As a result, the level of accident is low during nighttime.

**Driver Age (18-30 yrs)**

Economically active population 15-64 years of age contributes to nearly 85% of the RTA burden. Especially adults 15-29 years take the highest toll. This finding is suggestive of the high loss of productivity associated with road accidents in Ethiopia (Teferi Abagaz, August 1, 2018).

It is assumed that young drivers are more likely to commit more traffic accidents than old age. Because the old age divers are driving much more than the young age drivers and they became more experienced through their lifetime. However, the young drivers are new for the environment and they are not much more serving their life for driving, hence they commit more accidents than the old age drivers (World Bank, July,2013)

From result of this thesis perspective, Driving Age is a significant and a positive relationship with the probability of being fatality injury. Adults 18-30 ages account 55.1 percent and 31-50 ages account 42.9 percents of total fatality. Whereas, the numbers of fatality recorded by more than 50 age were 2 percent or too low because of they were highly experienced and they apply ethical behaviors during driving.

# 5. CONCLUSSION AND RECOMANDATIONS

## 5.1 CONCLUSSION

Road traffic crash was a probable cause of road traffic accident in worldwide. Mostly, Ethiopia was an area where a large number of traffic accident were registered. Road traffic accidents occur in all areas of Ethiopia, but the problems are more sever in central part of Ethiopia than any parts of the country. Addis Ababa to Galan - Adama hosts for many international and national organizations, huge industrial areas and business activities were there which makes traffic congestions.

The aim of the study was to compare characteristics of accidents with respect to two different road conditions, Expressways and old ways from the same origin to destinations Galan to Adama, Ethiopia within the same period.

On old ways, 92.4% accidents occurred by male and 0.8% female occurred accidents. Whereas, on Expressways, 97.2% accidents happened by male and 0.8% accidents happened by females also. This shows that on both corridors males are the dominant of traffic accidents. The same is true for fatality injuries.

On Old ways, 26.4% recorded by driver experience of 2 years and below ages,17.2% by over 2 years up to 5 years,8.1% by over 5 years to 10years and 46.3% by over 10 years experienced. Whereas, on Expressways, 29.3% recorded by driver experience of 2 years and below ages, 34.9% by over 2 years up to 5 years, 15% by over 5 years to 10years and 20.9% by over 10 years drivers experienced. Nevertheless, in case of fatality injuries, Age of above 2 years to 5 years driver experience is the most exposed one on both old ways and expressways.

With Regard to Relation with vehicles, accidents happened by drivers of their own vehicles were 8.8% and 17.2% of Old ways and Expressways respectively. When we came to accidents happened by drivers of employee, 87.9% for old ways and 47.8% for Freeways. From this investigation, we conclude that drivers who hired as employee were vulnerable of traffic accidents. In case of fatality injury also, employee drivers were the dominant ways.

The results of this study show those, Types of crashes registered on old way were highly different from expressways. Since median and guard post were available, there was only one direction of flow on expressways. The probabilities of types of accidents were overturning, front rear crash, side_ side and crash with fixed obstacles. From those, fronts to rear crash were 89.8% of accidents recorded and followed by crash with fixed obstacles were 8.3% of total crashes recorded on expressways.

The probabilities of types of accidents on old ways were overturning, front front crash, front rear crash, crash with fixed obstacles, front side crash, side side crash and pedestrian crash. Infrastructure facilities and traffic control mechanisms that separate pedestrians from motor vehicles and enable pedestrians to cross roads safely are important mechanisms to ensure pedestrian safety, complementing vehicle speed and road system management. (WHO, 2013). This study express that the highest types of crashes were pedestrian crash (26.2%) and followed by front rear crash (22.9%) on old ways.

Regarding fatality injury of types of crashes, from 49 total fatality of expressways, 44(89.8%) of them were passed away by front rear crashes. whereas, from 104 total fatality of old ways, 63(60.6%) of them were passed away by pedestrian crashes. From this innovation, we conclude that the main series problems that lead to fatality injury were over speeding for expressways and pedestrian crash for old corridors.

As the study shows, time of accidents was one of dependent variable that contribute traffic accidents. 62.3% of daytime total accidents and 28.4% of nighttime total accidents registered on expressways and simultaneously, 50.9% of daytime and 49.1% of Nighttimes were registered on old ways. In case of fatality injury, fatality happened on expressways were 65.3% daytime and 24.5% nighttime. In contrast, 41.3% fatality happened in daytime and 58.7% occurred in nighttime. From this result, we conclude that, since Alcohol Drinking houses like Grocery, Hotels and nightclubs available cities from Galan to Adama more of drivers exposed by drunk driving and drug driving which increase the probability of fatality crash during nighttime on old ways. Traffic control during nighttime from old ways may also low.

Finally variables like, Weather Condition, Relation with vehicles, Driver Experience, Drivers License, Cause of Crashes, Time of Accidents, and driver's ages was identified as independent variable to assess the level of Fatality Injury on the expressway. Whereas, variables like types of crashes, crash location (built-up area and non built-up area), day of week, gender, relation with vehicles and year of crashes were identified as independent variable to assess the level of fatality injury on old ways.

## 5.2 RECOMMANDATION

Based up on above findings, it is possible to propose the following recommendations. This recommendation will help cities of each transport authority, police stations and the Ethiopia Toll Road Enterprises, policy makers and road users to minimize the level of accident on Galan to Adama old ways and Expressway.

- Finding of the study revealed that fatality injury was high at old way corridors than expressways. As a result, transport Authority and police station cooperate and a revises how to monitor traffic condition and implement technical amendment to minimize fatality injury on old ways.
- Over speeding is the worst accident cause on Addis Ababa – Adama Expressway. Therefore, it is important to advocate training for drivers and ensure ethical behavior among those using the road, which may include enhancing personal driving capacity through participating different government and non-governmental initiatives towards the transport sectors. Also, it is advisable to use speed control technology like RADAR installation along the road way and others scientific based mechanism which helps to monitor speed of vehicles and implement punishment on those violating speed limit during exit. Advertising ethical way of driving regularly by Magazine, Radio, and TV also required. in particular, young male drivers.
- Pedestrian crash was the worst accident cause on Galan-Dukam-Bishoftu-Adama old ways. Pedestrian's risks are increased when roadway design and land-use planning

fail to plan for and provide facilities such as sidewalks, or adequate consideration of pedestrian access at intersections.

- There is not sufficient and comfort pedestrian walkways on main road of cities like Galan, Dukam, Bishoftu and Modjo.requires redesigning and implementing. It's preferable if Re design of Roadway in which facilities such as sidewalks and signalized crossings, zebras and traffic signs available to reduce risk for pedestrians in all built up area on sides of main roads.
- To give orientations, how to use Roads for pedestrian in any civil society, Schools, community etc. In particular, special attention should be paid to users of urban roads.
- Pedestrians sharing road space with fast-moving vehicles and Pedestrian using mobile phone while crossing roads should be reduced. In particular, adult male pedestrians
- To prepare enforcement of traffic laws based up on pedestrian
- In case of land use (Crash location), Fatality injury of built up area was higher than non built up area by 57.7% on old ways. Therefore, Cities (Built up area) requires more emphasizing to improve traffic accidents than non built up area.
- In addition to recommendations proposed above, this research advises the Oromia police commission, to modify ways of collecting and preserving accident data to have strong clarity, availability and to modify ways of storing data for a long period. This will also help researchers and other users to easily use data for road traffic accident related assessment.
- RTAs of Old ways were found to be the major severity injury (Fatal and Serious) problem than Expressways, that needs due attention by the government, transport minister, federal and regional police in collaboration.

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# Descreptive Analysis of Six lanes Expresways Addis Ababa to Adama

| Varaibles | Total | Fatal Injury | Serious Injury | Slight Injury | Property Damage |
|---|---|---|---|---|---|
| Total | 1357 | 49 (3.6%) | 111 (8.2%) | 256 (18.9%) | 1049 (77.3%) |
| **Vehicle ownership** | | | | | |
| Governments | 65 (4.8%) | 2 (4.1%) | 4 (3.6%) | 10 (3.9%) | 53 (5%) |
| Private | 1032 (76.1%) | 35 (71.4%) | 80 (72.1%) | 201 (78.5%) | 796 (75.9%) |
| DF | 12 (0.9%) | _ | 1 (0.9%) | 1 (0.4%) | 11 (1.1%) |
| Others | 248 (18.3%) | 12 (24.5%) | 26 (23.4%) | 44 (17.2%) | 189 (18%) |
| **Driver age** | | | | | |
| **18-30** | 636 (46.9%) | 27 (55.1%) | 58 (52.2%) | 123 (48%) | 486 (46.3%) |
| **over30-50** | 633 (46.6%) | 21 (42.9%) | 44 (39.6%) | 105 (41%) | 506 (48.2%) |
| **over 50** | 88 (6.5%) | 1 (2%) | 9 (8.1%) | 28 (10.9%) | 57 (5.4%) |
| **Gender** | | | | | |
| male | 1254 (92.4%) | 42 (85.7%) | 97 (87.4%) | 238 (93%) | 971 (92.6%) |
| Female | 11(0.8%) | _ | 2 (1.8%) | 3 (1.2%) | 8 (0.8%) |
| Others | 92(6.8%) | 7 (14.3%) | 12 (10.8%) | 15 (5.9%) | 70 (6.7%) |
| **Drivers Licence Level** | | | | | |
| Puplic-1 | 244(18%) | 12 (24.5%) | 28 (25.2%) | 65 (25.4%) | 170 (16.2%) |
| Puplic-2 | 282(20.8%) | 9 (18.4%) | 19 (17.1%) | 56 (21.9%) | 219 (20.9%) |
| Fright-5 | 90(6.6%) | _ | 3 (2.7%) | 10 (3.9%) | 78 (7.4%) |
| Fright-2 | 376(27.7%) | 1 (2%) | 16 (14.4%) | 46 (18%) | 319 (30.4%) |
| Automobile | 139(10.2%) | 2 (4.1%) | 5 (4.5%) | 22 (8.6%) | 117 (11.1%) |
| Others | 226(16.7%) | 25 (51%) | 40 (36%) | 57 (22.3%) | 146 (13.9%) |
| **Year of Accidents** | | | | | |
| 2018 | 481(35.4%) | 20 (40.8%) | 36 (32.4%) | 72 (28.1%) | 395 (36.7%) |
| 2019 | 343(25.3%) | 19 (38.8%) | 43 (38.7%) | 98 (38.3%) | 222 (21.2%) |
| 2020 | 533(39.3%) | 10 (20.4%) | 32 (28.8%) | 86 (33.6%) | 432 (41.2%) |
| **Drivers Experience** | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| DR exp 2 & below | 397(29.3%) | 20 (40.8%) | 38 (34.2%) | 82 (32%) | 299 (28.5%) |
| DR exp 2 to 5 | 474(34.9%) | 21 (42.9%) | 41 (36.9%) | 87 (34%) | 366 (34.9%) |
| DR exp 5 to 10 | 203(15%) | 4 (8.2%) | 19 (17.1%) | 36 (14.1%) | 157 (15%) |
| DR exp. Over 10 | 283(20.9%) | 4 (8.2%) | 13 (11.7%) | 51 (19.9%) | 227 (21.6%) |
| **Relation with Vehicle** | | | | | |
| Empoyer | 648(47.8%) | 13 (26.5%) | 41 (36.9%) | 102 (39.8%) | 529 (50.4%) |
| Owner | 234(17.2%) | 5 (10.2%) | 15 (13.5 %) | 46 (18%) | 181 (17.2%) |
| other | 475(35%) | 31 (63.3%) | 55 (49.5%) | 108 (42.2%) | 339 (32.3%) |
| **Time of Accident** | | | | | |
| Day | 846(62.3%) | 32 (65.3%) | 73 (65.7%) | 174 (68%) | 639 (60.9%) |
| Night | 386(28.4%) | 12 (24.5%) | 26 (23.4%) | 66 (25.8%) | 309 (29.4%) |
| other | 125(9.2%) | 5 (10.2%) | 12 (10.8%) | 16 (6.3%) | 101 (9.6%) |
| **Day of week** | | | | | |
| weekday | 865(63.7%) | 31 (63.3%) | 63 (56.7%) | 106 (41.4%) | 669 (63.8%) |
| weekend | 370(27.3%) | 13 (26.5%) | 36 (32.4 %) | 76 (29.7%) | 280 (26.7%) |
| other | 122(9.0%) | 5 (10.2%) | 12 (10.8%) | 74 (28.9%) | 100 (9.5%) |
| **Light Condition** | | | | | |
| Day light | 830(61.2%) | 31 (63.3%) | 71 (64%) | 170 (66.4%) | 629 (60%) |
| Darkness with street Lights | 66(4.9%) | 1 (2%) | 1 (10.9%) | 8 (3.1%) | 57 (5.4%) |
| Darkness no street Lights | 325(23.9%) | 11 (22.4%) | 27 (24.3%) | 62 (24.2%) | 251 (23.9%) |
| other | 136(10%) | 6 (12.2%) | 12 (10.8%) | 16 (6.3%) | 112 (10.7%) |
| **Road Geometry** | | | | | |
| Staight | 486(35.8%) | 16 (32.6%) | 35 (31.5%) | 90 (35.1%) | 281 (26.8%) |
| Compound Curve | 102(7.5%) | 4 (8.2%) | 6 (5.4%) | 22 (8.6%) | 79 (7.5%) |
| Down hill | 466(34.3%) | 17 (34.7%) | 37 (33.3%) | 95 (37%) | 357 (34%) |
| uphill | 164(12.1%) | 6 (12.2 %) | 21 (18.9%) | 34 (13.3%) | 116 (11.1%) |
| other | 139(10.2%) | 6 (12.2%) | 12 (10.8%) | 15 (5.9%) | 106(10.1%) |
| **Road Condition** | | | | | |
| Dry | 1015(74.8%) | 36 (73.5%) | 84 (75.7%) | 213 (83.2%) | 766 (73%) |
| wet | 207(15.3%) | 7 (14.3%) | 15 (13.5%) | 28 (10.9%) | 171 (16.3%) |
| other | 135(9.9%) | 6 (12.2%) | 12 (10.8%) | 15 (5.9%) | 112 (10.7%) |

| | | | | | |
|---|---|---|---|---|---|
| **Weather Condition** | | | | | |
| Good Air | 665(49%) | 25 (51%) | 60 (54%) | 151 (59%) | 494 (47.1%) |
| Cold/Freeze/Frost | 347(25.6%) | 9 (18.4%) | 21 (18.9%) | 54 (21%) | 279 (26.6%) |
| Cloudy | 67(4.9%) | 4 (8.2%) | 7 (6.3%) | 18 (7%) | 47 (4.5%) |
| Rain | 120(8.8%) | 4 (8.2%) | 8 (7.2%) | 13 (5.1%) | 100 (9.5%) |
| other | 158(11.6%) | 7 (14.3%) | 15 (13.5%) | 236 (92.2%) | 129 (12.3%) |
| **Causes of crash** | | | | | |
| Driver error | 405(29.8%) | 14 (28.6%) | 33 (29.7%) | 75 (29.3%) | 310 (29.5%) |
| Overspeeding | 192(14.1%) | 16 (32.6%) | 29 (26.1%) | 53 (20.7%) | 129 (12.3%) |
| Vehicle defect | 394(29%) | 9 (18.4%) | 28 (25.2%) | 79 (30.9%) | 306 (29.2%) |
| Other | 366(27%) | 10 (20.4%) | 21 (18.9%) | 49 (19.1%) | 304 (29%) |
| **Type of Crash** | | | | | |
| Over turning | 86(6.3%) | 4 (8.2%) | 8 (7.2%) | 19 (7.4%) | 64 (6.1%) |
| Front_Rear crash | 1127(83.1%) | 44 (89.8%) | 98 (88.3%) | 220 (85.9%) | 859 (81.9%) |
| Crash with fixed obstacle | 113(8.3%) | 1 (2%) | 5 (4.5 %) | 15 (5.9%) | 97 (9.2%) |

# Descreptive Analysis of Oldways(Two way Two lane Trunk Roads) Addis Ababa to Adama

| Varaibles | Total | Fatal Injury | Serious Injury | Slight Injury | Property Damage |
|---|---|---|---|---|---|
| Total | 717 | 104 | 66 | 201 | 399 |
| **Driver Age** | | | | | |
| 18-30 years | 288(40.2%) | 33(31.7%) | 26(39.4%) | 79(39.3%) | 174(43.6%) |
| over 30-50 years | 360(50.2%) | 46(44.2%) | 40(60.6%) | 106(52.7%) | 197(49.4%) |
| over 50 years | 53(7.4%) | 17(16.3%) | - | 12(6%) | 24(6%) |
| **Gender** | | | | | |
| Male | 697(97.2%) | 96(92.3%) | 66(100%) | 197(98%) | 391(98%) |
| Female | 6(0.8%) | 0 | 0 | 0 | 6(1.5%) |
| **Driver License Level** | | | | | |
| level 1 | 32(4.5%) | 4(3.8%) | 7(10.6%) | 10(5%) | 19(4.8%) |
| level 2 | 50(7%) | 7(6.7%) | 3(4.5%) | 20(10%) | 25(6.3%) |
| level 3 | 295(41.1%) | 42(40.4%) | 35(53%) | 84(41.8%) | 158(39.6%) |
| level 4 | 148(20.6%) | 17(16.3%) | 7(10.6%) | 47(23.4%) | 87(21.8%) |
| level 5 | 126(17.6%) | 15(14.4%) | 6(9.1%) | 29(14.4%) | 80(20.1%) |
| without license | 40(5.6%) | 9(8.7%) | 8(12.1%) | 7(3.5%) | 18(4.5%) |
| **Year of crash** | | | | | |
| 2018 | 245(34.2%) | 35(33.7%) | 27(40.9%) | 36(17.9%) | 170(42.6%) |
| 2019 | 262(36.5%) | 37(35.6%) | 21(31.8%) | 95(47.3%) | 122(30.6%) |
| 2020 | 210(29.3%) | 32(30.8%) | 18(27.3%) | 70(34.8%) | 107(26.8%) |
| **Driver's education level** | | | | | |
| Elementary & below | 176(24.5%) | 33(31.7%) | 27(40.9%) | 41(20.4%) | 100(25.1%) |
| highschool | 218(30.4%) | 22(21.2%) | 24(36.4%) | 54(26.9%) | 128(32.1%) |
| collage & above | 307(42.8%) | 41(39.4%) | 15(22.7%) | 102(50.7%) | 267(66.9%) |
| **Driver experience** | | | | | |
| 2 and below | 189(26.4%) | 13(12.5%) | 12(18.2%) | 60(29.9%) | 106(26.6%) |
| over 2-5 | 123(17.2%) | 15(14.4%) | 12(18.2%) | 29(14.4%) | 83(20.8%) |
| over 5-10 | 58(8.1%) | 10(9.6%) | 14(21.2%) | 15(7.5%) | 31(7.8%) |

| | | | | | |
|---|---|---|---|---|---|
| over 10 | 15(2.1%) | _ | _ | 2(1%) | 13(3.3%) |
| **Relation with Vehicle** | | | | | |
| owner | 63(8.8%) | 8(7.7%) | 3(4.5%) | 22(10.9%) | 37(9.3%) |
| Employee | 630(87.9%) | 86(82.7%) | 63(95.5%) | 175(87.1%) | 352(88.2%) |
| other | 24(3.3%) | 10(9.6%) | _ | 4(2%) | 10(2.5%) |
| **Time** | | | | | |
| Day | 365(50.9%) | 43(41.3%) | 41(62.1%) | 110(54.7%) | 208(52.1%) |
| Night | 352(49.1%) | 61(58.7%) | 25(37.9%) | 91(45.3%) | 191(47.9%) |
| **Day of week** | | | | | |
| weekday | 501(69.9%) | 58(55.8%) | 56(84.8%) | 143(71.1%) | 286(71.7%) |
| weekend | 216(30.1%) | 46(44.2%) | 10(15.2%) | 58(28.9%) | 113(28.3%) |
| | | | | | |
| Monday | 77(10.7%) | 10(9.6%) | 12(18.2%) | 20(10%) | 47(11.8%) |
| Tuesday | 140(19.5%) | 21(20.2%) | 9(13.6%) | 53(26.4%) | 73(18.3%) |
| Wednesday | 98(13.7%) | 10(9.6%) | 13(19.7%) | 29(14.4%) | 49(12.3%) |
| Thrusday | 115(16%) | 11(10.6%) | 16(24.2%) | 22(10.9%) | 73(18.3%) |
| Frieday | 71(9.9%) | 6(5.8%) | 6(9.1%) | 19(9.5%) | 44(11%) |
| Saturday | 123(17.2%) | 26(25%) | 4(6.1%) | 36(17.9%) | 66(16.5%) |
| Sunday | 93(13%) | 20(19.2%) | 6(9.1%) | 22(10.9%) | 47(11.8%) |
| **Land use ( crash location)** | | | | | |
| builtup | 609(84.9%) | 77(74%) | 58(87.9%) | 192(95.5%) | 326(81.7%) |
| non-builtup | 48(6.7%) | 17(16.3%) | 2(3%) | 4(2%) | 29(7.3%) |
| **Light Condition** | | | | | |
| Day light | 364(50.8%) | 45(43.3%) | 41(62.1%) | 111(55.2%) | 205(51.4%) |
| Darkness with street Lights | 61(8.5%) | 8(7.7%) | 5(7.6%) | 14(7%) | 39(9.8%) |
| Darkness no street Lights | 287(40%) | 49(47.1%) | 20(30.3%) | 77(38.3%) | 152(38.1%) |
| **Road Geometry** | | | | | |
| Staight | 553(77.1%) | 80(76.9%) | 58(87.9%) | 169(84.1%) | 294(73.7%) |
| Compound Curve | 7(1%) | 4(3.8%) | _ | _ | 3(0.8%) |
| Down hill | 35(4.9%) | 2(1.9%) | 4(6.1%) | _ | 29(7.3%) |
| uphill | 66(9.2%) | 9(8.7) | 2(3%) | 19(9.5%) | 41(10.3%) |

| | | | | | |
|---|---|---|---|---|---|
| **Road Condition** | | | | | |
| Dry | 647(90.2%) | 92(88.5%) | 61(92.4%) | 190(94.5%) | 352(88.2%) |
| wet | 70(9.8%) | 12(11.5%) | 5(7.6%) | 11(5.5%) | 47(11.8%) |
| **Weather Condition** | | | | | |
| Good Air | 581(81%) | 72(69.2%) | 57(86.4%) | 156(77.6%) | 333(83.5%) |
| Cold/Freeze/Frost | 59(8.2%) | 15(14.4%) | 2(3%) | 8(4%) | 34(8.5%) |
| Cloudy | 17(2.4%) | 5(4.8%) | 5(7.6%) | 7(3.5%) | 5(1.3%) |
| Rain and Hot | 60(8.4%) | 12(11.5%) | 2(3%) | 30(14.9%) | 26(6.5%) |
| **Causes of crash** | | | | | |
| Driver error | 286(39.9%) | 51(49%) | 33(50%) | 93(46.3%) | 137(34.3%) |
| Overspeeding | 254(35.4%) | 25(24%) | 23(34.8%) | 76(37.8%) | 150(37.6%) |
| Vehicle defect | 2(0.3%) | 1(1%) | _ | 1(0.5%) | _ |
| Pedestrain Error | 63(8.8%) | 8(7.7%) | 6(9.1%) | 16(8%) | 33(8.3%) |
| Other | 112{15.6%) | 19(18.3%) | 4(6.%) | 15(7.5%) | 79(19.8%) |
| **Type of Crash** | | | | | |
| Over turning | 69(9.6%) | 16(15.4%) | 9(13.6%) | 33(16.4%) | 22(5.5%) |
| Front_Rear crash | 164(22.9%) | 7(6.7%) | 11(16.7%) | 18(9%) | 134(33.6%) |
| Crash with fixed obstacle | 74(10.3%) | _ | 8(12.1%) | 17(8.5%) | 51(12.8%) |
| Front-Front Crash | 53(7.4%) | 3(2.9%) | _ | 1(0.5%) | 49(12.3%) |
| Front-Side crash | 76(10.6%) | 2(1.9%) | 2(3%) | 18(9%) | 56(14%) |
| side- side Crash | 43(6%) | _ | 3(4.5%) | 6(3%) | 34(8.5%) |
| pedestrain crash | 188(26.2%) | 63(60.6%) | 30(45.5%) | 103(51.2%) | 22(5.5%) |