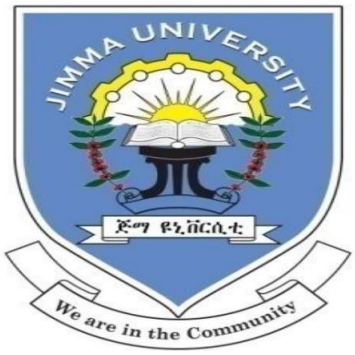

Jimma University

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Highway Engineering Stream

Safety Evaluation of Pedestrian at Road Crossing a Case Study in Addis Ababa Kirkos Sub City

A thesis submitted to the School of Graduate Studies of Jimma University in Partial fulfillment of the requirements for the Degree of Masters of Science in Civil Engineering.

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By:

Teshome Asfaw Zenebe

March, 2018

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Main Advisor: Prof. Emer Tucay Quezon

Co Advisor: Mr. Girma Fikre (Msc.)

March, 2018

Jimma, Ethiopia

DECLARATION

I, the undersigned, declare that this thesis entitled "Safety Evaluation of Pedestrian at Road Crossings a Case Study in Addis Ababa Kirkos Sub city." is my original work, and has not been presented by any other person for an award of a degree in this or any other University, and all sources of material used for theses have been duly acknowledged.

TESHOME ASFAW ZENEBE _____ _____

Researcher Signature Date

As Master's Thesis Advisors, we hereby certify that we have read and evaluated this MSc Thesis prepared under our guidance, by TESHOME ASFAW entitled: Safety Evaluation of Pedestrian at Road Crossings a Case Study in Addis Ababa Kirkos Sub city."

We recommend that it can be submitted as fulfilling the MSc Thesis requirements.

Prof. Emer T. Quezon  26/03/2018

Advisor Signature Date

Engr. Mr. Girma Fikre (Msc.). _____ _____

Co- Advisor Signature Date

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Finally, I would like to express my thanks to all academic staffs of civil and environmental engineering faculty of Jimma University Institute of Technology and Addis Ababa police commission for their assistance in data preparation.

ABSTRACT

In Ethiopia, pedestrian fatalities are the dominant type of road accidents, accounting for 55% of total deaths. Local authorities and police officers of Kirkos sub-city had tried to demonstrate that the sub-city recorded the worst pedestrian crashes while they were crossing on the roads and streets. Hence this research sought to identify the main cause of pedestrian crashes and the place of the highest pedestrian crash in Kirkos sub city which can be the basis for the possible remedial measure at this identified place.

The main aim of this study was to evaluate the safety of pedestrian crossing on the road in Kirkos sub-city. Primary data and secondary data collections were used in this study to gather relevant information about the study area. The causes of high pedestrian crash had been identified through questionnaire survey and interviews. There were 16 causes of crashes identified from secondary data and from literature review which also utilized in this study. Statistical tool such as Likert Scale and Relative Index (RI) were used to rank the different factors causing pedestrian crashes. The targeted population respondents were pedestrian, driver and Kirkos sub city's traffic police officers. The researcher adopted random sampling method to obtain representative data from targeted population. The significance of this study was recommending the possible remedies to reduce pedestrian crash.

Based on the results of the study, Road segment from Getu commercial to Wello sefer roundabout was identified as the highest pedestrian crash place in sub-city. For identification of causes of pedestrian crash secondary, literatures data and questionnaire was used. The ranks of those causes crash was done based on both secondary data and questionnaire response. The result obtained was almost similar rank. The main causes of pedestrian crashes were over-speeding of vehicles (RI=0.800) from questionnaire result and 132 pedestrian crash, pedestrian illegal crossing (RI= 0.779), and 121 pedestrian crash, absence of median and pedestrian refugee island (RI=0.732) and alcohol impaired driving (RI= 0.681) as presented in table 4.8 and table 4.15.

Possible remedies for crash reduction were providing different speed reduction, implementing pedestrian punishment legislation and separating pedestrian and vehicle completely were some of recommended remedial measures. Since younger pedestrians of age 18 to 30 were associated with a greater probability of severe injuries younger population could be one of the main target age groups in the education programs.

Key Word: *Pedestrian crash, pedestrian crossing the road & pedestrian safety*

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ACRONYMS

AA	Addis Ababa
AASHTO	American Association of State Highway and Transportation Officials
AATPR	Addis Ababa Traffic Police Report
AU	African union
CSA's	Central statistics authority
DCs	Developing countries
ERA	Ethiopian Road Authority
ETB	Ethiopian Birr
HIAC	High Intensity Activated Crosswalk
UN	United nation
WHO	World health organization
Ped.	Pedestrian
PSO	Pedestrian Safety Operation
SI	Sever injury
slI	Slight injury
F	Fatality
RI	Relative index

CHAPTER ONE

INTRODUCTION

1.1. Background

A pedestrian is any person who is traveling by walking for at least part of his or her journey. In addition to the ordinary form of walking, a pedestrian may be using various modifications and aids for walking such as wheelchairs, motorized scooters and etc. Walking is a basic and common mode of transport with benefits to health and the environment. We all are pedestrian so measures must be taken to improve the safety of walkers. This research focuses on safety of pedestrian crossing the road in Addis Ababa specifically Kirkos sub-city.

Pedestrian is one of the important component in the urban transportation system and also vulnerable at un-protected road crossing. And, they are the most vulnerable road users and are at a greater risk of being injured in a traffic crash than vehicle occupants. In developing countries, like our country pedestrian represent the group of road users with the largest number of fatalities (Getu, S. Tulu 2015)

Addis Ababa is a capital city of the Federal Government of Ethiopia and the head office of African Union (AU) and also found more than 100 diplomatic embassies in this city. The city lies at 9°1'48″N latitude and 38°44'24″E longitude. Geographically the city is located at the heart of the country, an altitude ranging from 2,100 meters at Akaki in the south of the city 3,000 meters at Entoto Hill in the North. The city has a total population of approximately 3.5 - 4.0 million according to CSA's projected estimate on 2006 E.C. In the inner area of the city, there is a concentration of government administrative institutions and commercial activities mixed with residences (Google Map 2018).

The city is growing with five intercity road networks. Especially the south route along Addis Ababa to Adama Road corridor is experiencing high growth according to the Office of Addis Ababa road and transport bureau. The office also stressed that the city had experienced a horizontal growth in unorganized approach in recent years. Kirikos sub city is one of the ten sub-city of Addis Ababa. As of 2011 G.C. the sub-city's population was about 235,441 and 5.645 ml^2 area (Dawit O, 2015). Because of the high growth of Addis Ababa city, the traffic volume and population, the road traffic

accidents especially pedestrian traffic accident increasing from time to time in the city. Factors associated with the pedestrian crashes, were discussed in chapter 4 of this research.

1.2. Statement of the problem

Road traffic crashes kill about 1.24 million people each year. More than one-fifth of the people killed on the world's roads each year were not traveling in a car, on a motorcycle or even on a bicycle they were pedestrians. Pedestrian deaths and injuries were often preventable, and proven interventions exist, yet in many locations, pedestrian safety did not attract the attention it merits (WHO, 2013).

In developing countries, pedestrian crashes were becoming an increasing public health issue. The problem of pedestrian crashes was severe in Ethiopia too. For instance, 1,296 pedestrians were killed, and 3,003 pedestrians were injured during (2007 E.C.) in Ethiopia (Federal Police Commission of Ethiopia report, 2008).

Six years (July 2005 - June 2011) of police-reported crash data were analyzed and consisted of 12,140 fatal and 29,454 injury crashes on the country's road network. The 12,140 fatal crashes involved 1,070 drivers, 5,702 passengers, and 7,770 pedestrians, totaling 14,542 fatalities, an average of 1.2 road user fatalities per crash. An important and glaring trend that emerges was that more than half or more than 50% of the fatalities in Ethiopia involve pedestrians (Getu .S.Tullu, 2013)

Pedestrian traffic crashes pose a significant burden in Ethiopia, as it was the case for other developing countries. Currently, developing countries contribute to over 90% of the world's road traffic fatalities (WHO, 2009)

Local authorities and police officers of Kirkos sub-city tried to demonstrate that, the sub city has recorded the worst pedestrian crashes. The majority of this crash was occurring when they were crossing the road. The initial estimates for the main reason behind the accident of pedestrian crashes at this sub city was a high speed of vehicle, pedestrian illegal crossing and etc. As per observation and information gained from media and some resident's pedestrian crashes have increased from time to time at this place. Hence this research identifies the place where the frequent pedestrian crash was occurred in Kirkos sub-city and find out the main cause of pedestrian crashes the crossing the road and recommend possible solution.

1.3. Research Question

The main premise of this research was that identifying highest pedestrian crash place, identifying the main causes of pedestrian crashes and their potential countermeasures to mitigate pedestrian crashes in Addis Ababa kirkos Sub-city. It addresses the issue with the following research questions that promise to provide a better insight into means of mitigating pedestrian crashes in the sub-city.

The research questions were:

2.What is the nature and characteristics of pedestrian crashes distribution looks like in Kirkos sub-city?

3.Which road segment represents the highest road crossing pedestrian crash location in Kirkos sub-city?

4.What is the factor causing the pedestrian crashes crossing the road at identified place?

5.What are the engineering remedial measures to reduce pedestrian crashes and make the pedestrian safe while they cross the road?

5.1. Objectives of the study

5.1.1. General Objective

The main objective of this study was evaluating pedestrian safety at road crossing the in Addis Ababa Kirkos sub-city.

5.1.2. Specific Objectives

The above research aims was also broken down into some specific research objectives.

Those specific objectives were:

- To explore the nature and characteristics of pedestrian crash in Kirkos sub city
- To identify the place where high pedestrian crash occurs at road crossing.
- To identify the factors causing pedestrian crashes at road crossing the particularly at identified place.
- T o suggest possible Engineering remedial measures that can reduce pedestrian's crashes and increase pedestrian safety at road crossing depending on the results of finding.

5.2. Significance of the study

Now a day's Pedestrian crash has a serious effect on once country development because a lot of

young people are dying so, without any doubt the research on evaluation of pedestrian safety has a wide range of benefit for the researchers, for a sub city administration as well as for the city's decision makers by identifying causes of pedestrian crashes, places of high pedestrian crashes in the sub-city and recommending, possible measure to reduce the problem. The other significance of this study is for transport planners and professional engineers who designing infrastructures by assisting in identification of the factor contributing to pedestrian crash and locations of high pedestrian crash on existing infrastructure in this sub-city.

In Africa, there are only two or three research papers on crashes of pedestrians, and in Ethiopia, the risk factors for accidents involving pedestrians have not yet been assessed. (Getu S. Tullu, 2015). The identification of crashes factors of pedestrians in this study fills some of these gaps in developing countries, and particularly Addis Ababa.

5.3. Justification/ Rationale

In our country pedestrian fatalities were the dominant type of road traffic fatalities, accounting for 55% of total deaths. Much of the researcher has focused on estimating the safety performance of roads from the perspective of general traffic crashes. For several good reasons, relatively little research has explored pedestrian crashes occurring in less developed countries like Ethiopia especially pedestrian safety crossing the road (Getu.S.Tullu, 2013). The recommendations of this study will benefit the public at large on prevention of pedestrian accidents crossing the road and increasing safety performance of the road, and also it will help policy maker, transport planner during decision making and future researchers as literature. The intent of this paper is to fill some of the gaps in knowledge and to gain additional insight into the relationship between the frequency of pedestrian crashes and explanatory contributing or causal variables. And contributing in preserving pedestrian from severe injury and fatal when they are crossing the road by recommending different crash reducing mechanism as a professional person and depending on research result.

5.4. Scope

The scope of this study covers the evaluation of pedestrian safety at road crossing the in Addis Ababa Kirkos sub-city by identifying the place where high pedestrian crashes were occurred and explore the main causes of this big crashes at this place specifically. And it also includes information from various sources relating to the study topic to answer the research question. The study focuses on

the specific area known as Getu commercial road Wello sefer roundabout road segment after identification of this place as the highest pedestrian crash area from secondary data and common question. The road segment was around 1.8km long.

5.5. Organization of the study

This thesis consists of five chapters, and the contents of each chapter was presented as follows.

Chapter one this chapter comprised the background of the study, problem statement, objectives, research question, significance and limitations of the study, and organization of the research.

Chapter two the literature review started with literature exploration of the electronic and hard copy and media in answering the research objectives. And reviewing an existing literature related to pedestrian crashes around the world and criticize the literature.

Chapter three discusses the methodology of the research.

Chapter four is about the analysis of gathered data. This chapter constituted the analysis of data gathered with the research instruments. It analyzed data from the desk studies, questionnaire and the interview.

Chapter five this was the final chapter of the research in which conclusions and recommendations were drawn based upon the analysis and linking them to the problem statement and objectives of the study.

Generally, the research was written following a certain structure. Though step order may vary depending on the subject matter and researcher, the steps outlined in Figure 1.1 below were followed in this study.

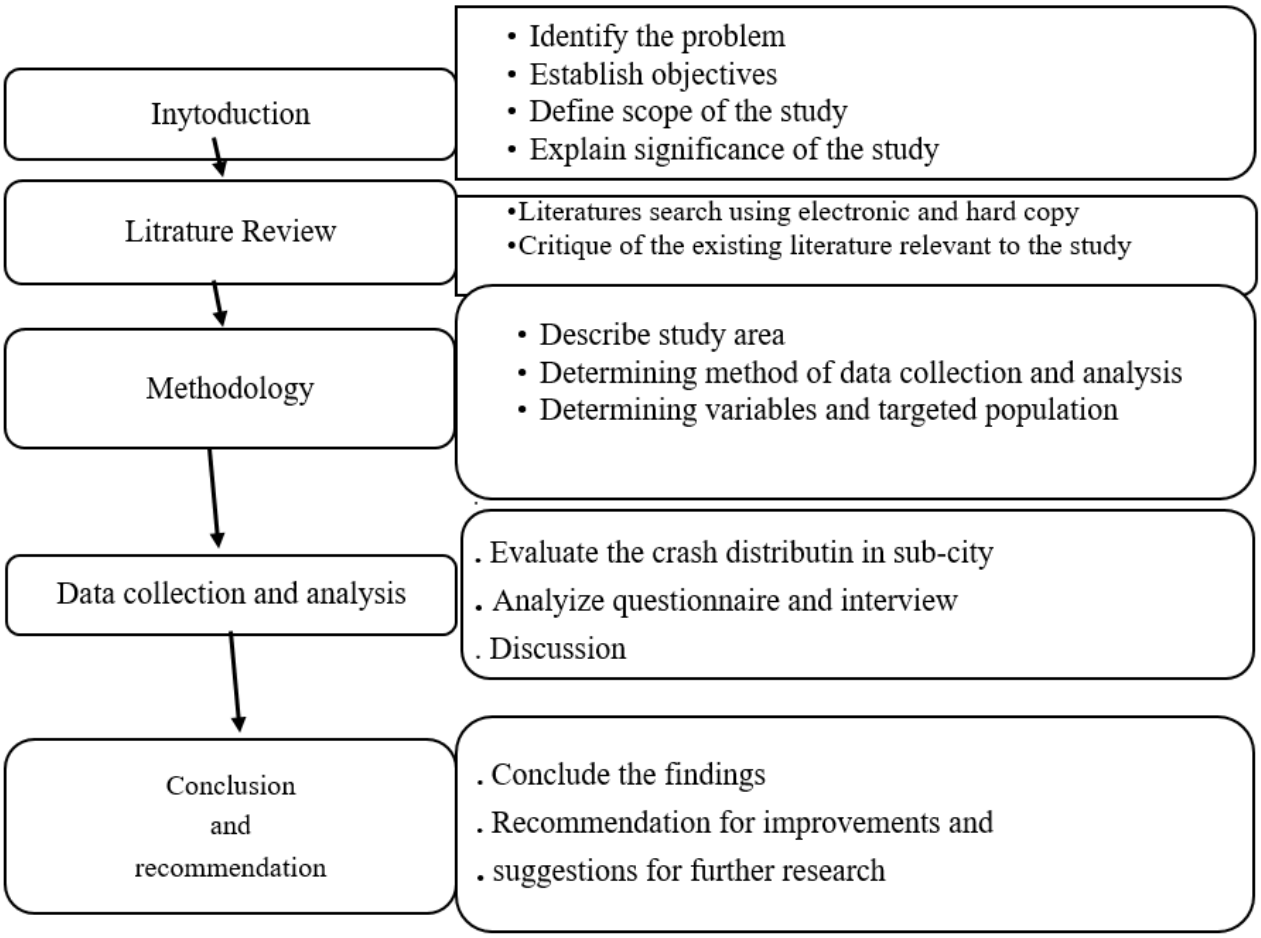


Figure 1.1 structural flowchart of the document

CHAPTER TWO

REVIEW OF LITERATURE

2.1. Theoretical review

This chapter provides a detailed review of previous researchers' point of view relevant to mitigating pedestrian crashes.

Road traffic injuries remain a major public health problem and a leading cause of death, injury and disability around the world. Each year, nearly 1.24 million people die and between 20 million and 50 million or more were injured as a result of road crashes. More than 90 per cent of these deaths occur in low-income and middle-income countries, which have less than half of the world's vehicles. Road traffic injuries are among the three leading causes of death for people between 5 - 44 years of age (WHO, 2013).

Road traffic injuries threaten to hinder achievements in economic and human development. It has been estimated that global losses due to road traffic injuries total $518 billion and cost governments between 1 and 3 per cent of their gross national product. In some low- and middle-income countries, the loss is more than the total amount of development assistance they receive. Road traffic injuries place a heavy burden on a country's economy as a result of their direct impact on health-care and rehabilitation services, as well as through indirect costs. They also can put considerable financial stress on affected families, who often must absorb medical and rehabilitation costs, funeral costs and such other costs as the lost earnings of the victim, in addition to extensive emotional strain (UN Decade of Action for Road Safety 2011-2020)

In Brazil, pedestrians accounted for 24% of all traffic fatalities reported in 2005. In urban areas, where 35% of all trips are made on foot, pedestrians accounted for 40% of the reported traffic fatalities (Getu .S.Tullu 2015).

Most pedestrian collisions occur when pedestrians are crossing the road. For example, one study in Ghana found that 68% of the pedestrians killed were knocked down by a vehicle when they were in the middle of the roadway. Information provided by 73 pedestrians in a study in Kenya showed that 53 (72.6%) were injured when crossing the road, 8 (11%) when standing by the road, 6 (8.2%) while walking along the road and 6 (8.2%) while engaging in other activities, including hawking. An assessment of roads in low- and middle-income countries in Asia, Africa, Eastern Europe and

Latin America revealed that 84% of the roads surveyed had no pedestrian footpaths though they carried motor vehicle traffic moving at 40km/h or more (WHO 2013).

A considerable effort is required to understand the unique features of pedestrian crash risk. For instance, pedestrian fatalities globally were estimated to total more than 400,000 per year, out of which 55.3% and 39.2% occur in low- and middle come countries respectively per year. (Risser. R, and R. Methorst).

Although the pedestrian crash risk is a major concern in DCs' road traffic crashes, the problem has not been sufficiently investigated. This neglect has stimulated a call by the World Health Organization for a global focus on pedestrians, particularly in DCs. Recently, WHO's Global Status Report confirmed that 88 countries with a total population of 1.6 billion people had shown a decline in road traffic deaths, whereas 87 countries with a total population of 5.2 billion have experienced higher fatality rates. Most of the increases in traffic deaths have occurred in low and middle-income countries.

In Ethiopia, pedestrian fatalities are the dominant type of road traffic fatalities, accounting for 55% of total deaths. Human levels of exposure to risk are not known with certainty. In spite of these high numbers, policy makers in DC have failed to remediate the growing scale of pedestrian crash risk, which is exacerbated by the rapid motorization in DCs. Given these trends, it is worthwhile to scrutinize the problem of pedestrian crash risk in DCs by providing a comprehensive synthesis of the factors which expose pedestrians to crash risk. The figure 2.1 show that proportion of pedestrian and drivers fatalities. It shows in Ethiopia pedestrian holds around 55%. of crashes (Getu S. Tullu, 2013)

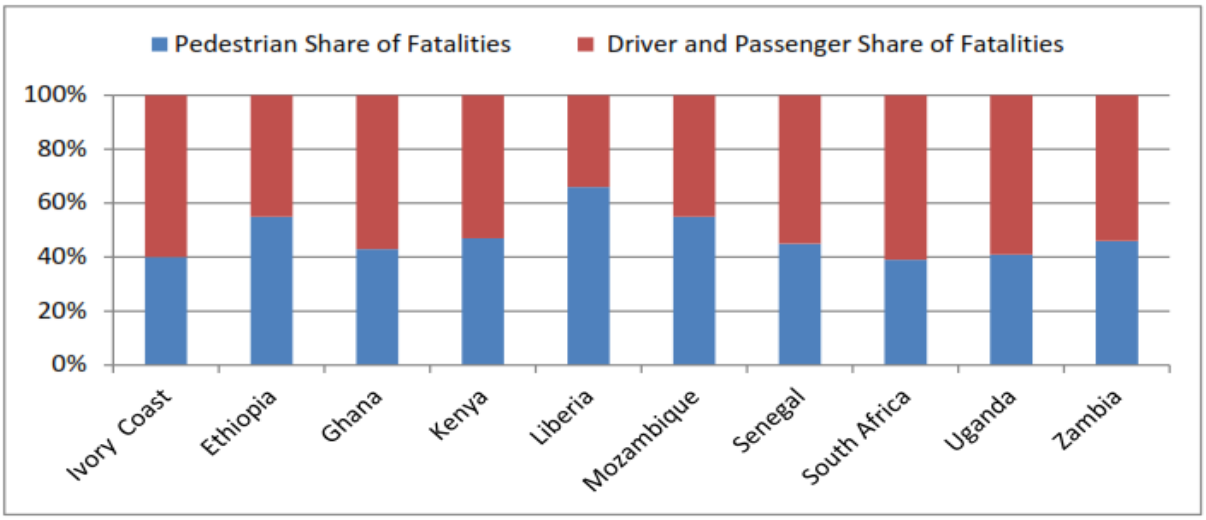


Figure 2.1 Proportion of Pedestrian fatality in African country WHO 2009 p 99

Six years (July 2005 - June 2011) of police-reported crash data were analyzed, consisting of 12,140 fatal and 29,454 injury crashes on the country's road network. The 12,140 fatal crashes involved 1,070 drivers, 5,702 passengers, and 7,770 pedestrians, totaling 14,542 fatalities, an average of 1.2 road user fatalities per crash. An important and glaring trend that emerges is that more than half of the fatalities in Ethiopia involve pedestrians. (Getu.S, Tullu. 2015)

Developing countries have embarked on achieving the United Nations Millennium Development Goals as a primary objective; however, these goals do not explicitly include road safety. Despite the lack of a specific mention of road safety within economic targets, road crashes and economic productivity are linked because primary income earners within families are disproportionately represented among fatalities.

Sisiopiku and Akin verified that most drivers of right- or left-turning vehicles fail to yield to pedestrians when all share the same traffic signal green phase. Tiwari collected pedestrian behavior data at intersections in Delhi, India, and noticed that a long wait time plays an important role in the unsafe behavior of pedestrians. (Sisiopiku, V. P., and D. Akin 2003).

Knoblauch conducted a before-and-after study to determine the effect of crosswalk markings on driver and pedestrian behavior at non signalized intersections. They concluded that drivers seem more cautious at marked crosswalks and drive slightly slower there than elsewhere. Marked crosswalks also channel the pedestrian flow to intersections.

At unprotected locations, some of the vehicles may yield to pedestrians who are already at crosswalk location. Promoting and creating proper facilities for non-motorized (pedestrian and bicycle) trips is very important in an urban transportation system to enhance pedestrian safety. Pedestrian-vehicle conflicts on urban roads are increasing, particularly at road crossings, because of the tremendous rate of growth in vehicle traffic in developing countries. Accident statistics indicate the need to improve pedestrian safety and to analyze the pedestrian-vehicle interactions and collisions more deeply (P. Vedagiri and B. Raghuram K 2016).

Developing countries studies reveal that there is differences in driver a n d pedestrian behaviors, road design, site characteristics, pedestrian demography, and crossing group effect compared to western countries. In general, they also have less developed and contiguous pedestrian facilities, have poorly integrated land use and transport planning, are subject to frequent illegal pedestrian crossings (Mara C and Luis .A, 2010).

The studies suggests that difficulty in crossing increases with vehicle volume, vehicle speed, crossing width, and the length of traffic signal cycles; it decreases with the presence of marked crosswalks, traffic signals, and wide, restricted medians (P. Vedagiri and B. Raghuram K, 2016)

Crossing behavior of pedestrians in Addis Ababa City, Ethiopia is rarely in compliance with the pedestrian regulations, though drivers contribute to this as they do not yield at pedestrian crossings. There are also infrastructure factors that contribute to illegal crossing behavior there are relatively few legal crossing points. At other locations, there are interactions between behavioral and infrastructure factors. For example, the Addis Ababa City ring road traverses through mostly densely populated areas and has a central New Jersey barrier which makes it impossible for pedestrians to cross. As a consequence, there is fencing to prevent pedestrians using the road and overpasses are provided. However, pedestrians are often reluctant to use pedestrian overpasses. Instead, they jump over the fences and median barriers to cross the roadways. As a result, many pedestrians have been seriously injured or killed by fast-moving vehicles. It is worth noting that, according to the Ethiopian traffic rules, drivers are not liable for such pedestrian injuries or fatalities because it is a fully access-controlled road (Getu.S.Tullu, 2013).

Most pedestrians in developed countries can afford to buy retro-reflective clothing which is both available and has been demonstrated to enhance visibility at night, but such clothing is neither commonly available nor affordable in DCs. Also, m o s t locations in developed countries with

high pedestrian traffic have sufficient street lighting to facilitate the visibility of pedestrians at night and thereby reduce road crashes whereas the same does not apply as widely in DCs. Researchers in Ghana, for example, have found that the night-time pedestrian crash rate is higher than the daytime rate since many built-up areas have not been provided with sufficient street lighting. But in Ethiopian this is not working, most of pedestrian crashes were occurred at day time and in good weather condition.

Pedestrian safety is a multi-dimensional problem that requires a comprehensive view when examining determinants, consequences, and solutions. While different agencies may have responsibility for specific aspects of pedestrian safety, the reality is that a coordinated approach involving collaboration among policy-makers, decision-makers, researchers, political leaders, civil society and the public was required in order to improve pedestrian safety, especially in low- and middle-income countries. Collaboration may take many forms, one of them being sharing responsibilities or activities in a pedestrian safety program collaboration among various agencies and sectors is a cornerstone of the safe system approach (WHO).

2.2. Causes of Pedestrian crashes

Roadway design affects pedestrian safety in multiple ways, e.g., the impact of lane width and direction of traffic. For example, the time it takes for pedestrians to cross the street depends on the lane width and number of lanes, and the direction of traffic directly impacts the number of conflicts between vehicles and pedestrians. Some of the countermeasures related to roadway design include bicycle lane installation, lane narrowing, reduction in number of lanes, installation of pedestrian refuge areas such as raised medians, conversion of two-way streets to one-way streets, and reduction in curb radius.

Narrowing a roadway can be done by removing travel lanes, narrowing lane widths, adding on street parking, or by curb relocation. Narrowing a roadway will provide safer pedestrian movements by reducing vehicle speeds (VN Engineers, 2012).

In busy cities, aggressive driving is a main cause of many pedestrian accidents. This is because drivers are more likely to violate traffic signals and display fits of road rage that result in unsafe speeds and unlawful turning. The study found that drivers were making a left turn, making a right turn, backing up or making a U-turn immediately before hitting or injuring a pedestrian. Gårder concluded that, the higher the driving speed, the lower the percentage of drivers that yields to pedestrians at non signalized crosswalks.

Pedestrians must be aware of these potentials danger whenever they walk on the roads, and must do their part to follow safety laws. A pedestrian can be responsible for their injuries when they ignore the "walk" signal at an intersection or choose to not use the designated crosswalk areas to cross the road or intersection. A pedestrian is also likely to be involved in an accident when he or she darts in front of a vehicle, doesn't wear reflective cloth at night, or disrupts the normal flow of traffic. Regardless of the circumstances surrounding your accident, it is important for you to contact a pedestrian accident attorney if you have suffered injury as a pedestrian (Givens Givens Sparks, PLLC, 2013).

There are a lot of causes that increase the pedestrian crash in Addis Ababa. Among the main causes of those crashes, the most important ones as indicated by (AATPR, 2011) was as follow.

- Driving beyond speed limit.
- Negligent pedestrians crossing or walking on the wrong side of the road and rushing in to the road way.
- Mechanical defects of vehicles such as brakes, lights, etc.
- Violating traffic rules and regulation.
- Driving irresponsibly, dangerously or without due regard for other road users and lack of experience.
- Driving under the influence of alcohol or / and drug.
- Condition of road, (roads unsuitable for vehicles, such as narrow, low quality dangerous curves).

Addis Ababa police commission 2011 report shown that the causes of pedestrian crash 74% was drivers fault, 9% Pedestrians fault, 8% Vehicles technical problem, 6% Others and 3% was condition of roads (AATPR 2011).

The high rate of pedestrian collisions is common in developing countries and has been attributed to factors including poor land use planning, poor pedestrian behavior, poor enforcement of traffic regulations, inadequacy of the road network and poor road maintenance, and inadequate provision of pedestrian facilities (Damsere-Derry, 2010).

The major risk factors that contribute to the occurrence of pedestrian injury crashes are speed, inadequate visibility, driving and walking while intoxicated by alcohol, road environment, and land use. In addition, there are other factors responsible for the high level of pedestrian crashes, particularly in developing countries. With respect to understanding the influencing factors of

pedestrian injury severity, an in depth review of the literature revealed that speed, vehicle weight, vehicle design features, age of pedestrians, weight and age of pedestrians, driver factor and road environment are the main causes of injury severity (Getu.S.Tullu, 2013).

2.3. Pedestrian Crash reduction measure

Pedestrians have been largely ignored or given minimal consideration in the design of much of the nation's roadway system. When the built environment assigns low priority to pedestrians, it can be difficult for vehicles and pedestrians to share the road safely. Modifications to the built environment can reduce the risk and severity of vehicle–pedestrian crashes. Engineering modifications generally can be classified into 3 broad categories: separation of pedestrians from vehicles by time or space, measures that increase the visibility and conspicuity of pedestrians, and reductions in vehicle speeds. Separation countermeasures reduce the exposure of pedestrians to potential harm both on the roadside and when they are crossing streets (Brude & Larsson, 2000).

At present, engineering treatments for pedestrians are not common practice in DCs, as there is a lack of awareness of the wider economic benefit of these measures, so this area has unexplored potential. In many pedestrian crashes the driver reportedly does not see the pedestrian before the accident, measures are needed to increase the visibility and conspicuity of pedestrians. Higher vehicle speeds are strongly associated with a greater likelihood of crashes involving pedestrians as well as more serious pedestrian injuries (Richard A. Retting, MS, and Susan A.2014)

Traffic calming measures are engineering tools used with the goal of reducing vehicle speed and improving the safety of motorists, pedestrians, and bicyclists. Traffic calming objectives include: achieving slow speeds for motor vehicles, reducing collision frequency and severity increasing safety and the perception of safety for pedestrians and bicyclists, reducing the need for police enforcement, increasing access for all modes of transportation and reducing cut-through motor vehicle traffic (National Center for Safe Routes to School: www.saferoutesinfo.org/2016).

Common pedestrian traffic calming measures include pedestrian islands, curb extension, raised cross walk, speed hump, over/ under pass, mid-block crossing and etc.

Crossing islands: also known as center islands, refuge islands, pedestrian islands, or median slow points are raised islands placed in the center of the street at intersections or midblock crossings to help protect crossing pedestrians from motor vehicles. They allow pedestrians to deal with only

one direction of traffic at a time, and enable pedestrians to stop partway across the street and wait for an adequate gap in traffic before crossing the second half of the street. Crossing islands can be constructed at an angle to the right so that crossing pedestrians are forced to the right to view oncoming traffic as they are halfway through the crossing (Max A. Bushell, Rodriguez 2013).

Raised Cross walking: raised intersections and crosswalks encourage motorists to yield to pedestrians because the raised crosswalk increases pedestrian visibility and forces motorists to slow down before going over the speed.

Speed humps: are vertical traffic control measures that tend to have the most predictable speed reduction impacts. Speed humps are paved (usually asphalt) and approximately 3 to 4 inches-high at their center, and extend the full width of the street with height tapering near the drain gutter to allow unimpeded bicycle travel.

Speed bumps are typically smaller with a more extreme grade, which forces automobiles to more significantly reduce speeds but can more significantly impede bicyclists.

Figure 2.2 pedestrian raised cross walk and hump Harkey and Zegeer, 2004

Constructing raised medians is another countermeasure that can be implemented to improve pedestrian safety. Raised medians provide a place of refuge for pedestrians crossing a wide intersection or a midblock section. High speed and high volume roads can benefit from raised medians with respect to pedestrian safety. Gan et al. (2005)

Grade Separated Crossings (Overpass/Underpass): Pedestrian overpasses and underpasses completely separate pedestrians from vehicular traffic and provide safe pedestrian accommodation

Pedestrian overpasses (bridges) and underpasses (tunnels) allow pedestrians and bicyclists to cross streets while avoiding potential conflicts with vehicles. Because they are expensive to construct, grade separated crossings should be reserved for locations where there is high demand for crossings by pedestrians, bicycles and individuals with physical disabilities and the hazards of crossing the roadway are high. Ideally, overpasses and underpasses should take advantage of the topography of a site. Grade separations are less expensive to construct and more likely to be used if they can help pedestrians avoid going up and down slopes, ramps, and steps.

Grade separated crossings should be located conveniently so that pedestrians are not forced to go out of their way to use them. When a long detour is necessary, pedestrians and bicyclists will often choose to cross at-grade regardless of the safety conditions on the street. The overpass or underpass should provide adequate width (for users to pass each other comfortably), lighting, and surveillance to increase pedestrians' perceptions of security and comfort.

Collaboration with partners: Pedestrian safety is a multi-dimensional problem that requires a comprehensive view when examining determinants, consequences and solutions. While different agencies may have responsibility for specific aspects of pedestrian safety, the reality is that a coordinated approach involving collaboration among policy-makers, decision-makers, researchers, political leaders, civil society and the public was required in order to improve pedestrian safety, especially in low- and middle-income countries. Collaboration may take many forms. One of them is sharing responsibilities or activities in a pedestrian safety program collaboration among various agencies and sectors is a cornerstone of the safe system approach (WHO)

Curb extensions extend the sidewalk out to the parking lane, and help reduce the crossing distance, improve visibility between motorists and pedestrians, and reduce crossing time. Curb extensions also reduce vehicle turning speeds.

Traffic control devices such as traffic signals and pedestrian signals can be used to improve pedestrian safety. Using Traffic signal enhancements such as automatic pedestrian detectors traffic signals to create gaps for pedestrians to cross at midblock locations on high-speed multi-lane arterials will also increase pedestrian safety. This automatic pedestrian detectors traffic signals observe the pedestrian on the road and flash to vehicle to give way for pedestrian. Pedestrian signals eliminate the conflict between vehicles and pedestrians Priyanka A (2013).

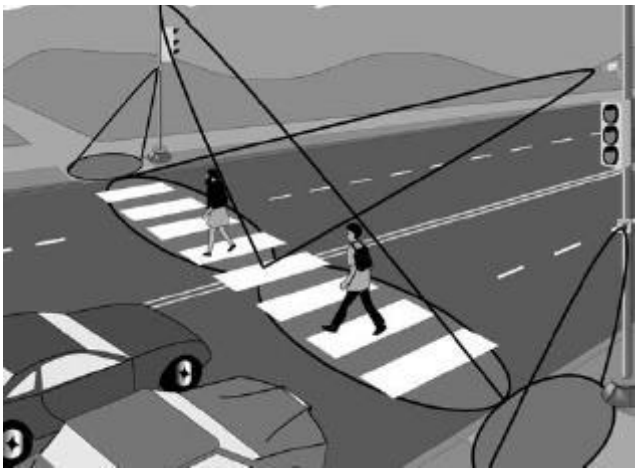


Figure 2.3 Enhanced automatic pedestrian detectors signal (Harkey and Zegeer, 2004)

2.3.1. Safety Directions for Addis Ababa

Addis Ababa City Administration has put the following safety direction to provide access to safe, affordable, accessible and sustainable transport systems for all road users by 2030 G.C

Pedestrian

- Should get the highest design priority
- Should be the rationale to determines improvements schedules
- Protection of pedestrians' primary consideration for enforcement and awareness campaign

Provide comprehensive and safe pedestrian networks

- Reduced traffic speed, speed calming measures, enforcement
- Safe, accessible and continuous footpaths
- Frequently spaced safe at-grade crossings with refuge spaces

2.3.1.1. Safety Directions

Seven safety direction was forwarded as follow

- Developing a road safety management system
- Focusing on the main roads, where trauma is most concentrated
- Prioritizing pedestrians first, second and third
- Enforcing key safety laws
- Improving Crash and Injury Data Management

- Improving Post-crash trauma response
- Demonstrating, and scaling up investment

2.3.1.2. Developing a road safety management system

Lead the process of developing a road safety management system, and strengthening it over time

- Have a strong and consistent voice for road safety
- Brings stakeholders together and coordinate their contributions
- Review key safety standards and rules - strengthen enforcement
- Identify required road safety funds; lead fund raising ensure proper allocation

Focusing on the main roads where high pedestrian crashes were most concentrated and apply the following measurements on the main road.

- Reduce speed limits in areas of high pedestrian activity
- Provide good quality footpaths, safe at-grade crossings;
- Improve pedestrian signals
- Identify hotspot locations and carry out safety improvement countermeasures

2.3.1.3. Enforcing key safety laws

Capacity building improvements to strengthen enforcement

- Defined enforcement strategies and targeted operational plan
- Allocate sufficient human and equipment resources
- A dedicated team to systematically process, analyze and use data for planning enforcement operations
- Extensive, ongoing leadership and operational training to deliver and sustain good enforcement practices

Support for strategic communication, i.e. media campaign (Daniel M. 2017)

2.3.2. Experiences of another country regarding to pedestrian crash reduction

2.3.2.1. Oregon City

Oregon City is a coastal of U.S. state in the Pacific Northwest, have been able to reduce pedestrian crashes by increasing pedestrian law enforcement. Under the Pedestrian Safety Operations program, a decoy police officer attempts to cross in a crosswalk, with a video camera recording the

event. If passing motorists fail to stop and yield as required by law, they have issued either a warning or a citation. Three years since the program was established crosswalk pedestrian injuries declined by 16% (from 348 to 293) and fatalities declined 19% (from 16 to 13) (Google 10/20/2017, 11:00 AM)

2.3.2.2. Sharing responsibilities in a pedestrian safety program in São Paulo

In 2010, Companhia de Engenharia de Tráfego the agency responsible for managing transport in the Brazilian city of São Paulo, launched a pedestrian safety program aimed at reducing the number of pedestrians killed by 50% by the end of 2012 Interventions included media campaigns and awareness raising, engineering measures and traffic law enforcement. To coordinate implementation, various agencies were brought together and assigned responsibility for specific activities: The City Transportation Secretariat coordinated the overall implementation of the program; CET was responsible for engineering, education and enforcement measures; the Municipal Government of São Paulo, through the Department of Communication, was responsible for media campaigns; the Labour Secretariat was in charge of supervisors at pedestrian crossings; the traffic police was responsible for law enforcement; and São Paulo Transport (SPTrans) – the company that manages bus transportation – was responsible for supervising and training bus drivers. By doing this they have reduce pedestrian crash by 50% at the end of 2012 (WHO 2013).

2.3.2.3. South Africa

In South Africa, the Provincial Government of the Western Cape leads the “Safely Home” initiative, which seeks to reduce road traffic fatalities by 50% by 2014. To better protect pedestrians at particularly hazardous locations, measures such as controls on BAC for drivers, speed cameras, pedestrian overpasses, and the “Crash Witness” public awareness campaign have been used, leading to a 29% reduction in road traffic fatalities in three years.

2.4. Critique of the existing literature relevant to the study the existing literature

The literature review indicates a lack of specific models to evaluate pedestrian safety crossings the roads. Also, the existing models and indexes cannot be used to assess pedestrian safety in most developing countries where weather, traffic flow, and the walking culture vary widely. Some studies have been carried out to model road traffic crashes particularly in western countries. Most of this research has focused on general vehicle crashes not on pedestrian crashes especially about pedestrian crashes in developing country like Ethiopia.

A limited number of studies have done on pedestrian crash modeling, and most of them concentrated on identifying the contributing factors for pedestrian safety at intersections. In summary, there has been relatively little research focused on identifying causes and contributing factors of pedestrian crashes in developing countries.

Pedestrian deaths and injuries are often preventable, and proven interventions exist, yet in many locations, pedestrian safety does not attract the attention it merits. Successful interventions to protect pedestrians and promote safe walking require an understanding of the nature of pedestrian crashes and its distribution. So this literature review promotes the understanding of distribution nature and crash causing factors of pedestrian from different researcher's point of view.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1. Introduction

The methodology is a plan of action that shows how the problems will be investigated, what information will be collected using which methods, and how this information will be analyzed to arrive at conclusions and to develop recommendations. The methodology describes the practical way in which the whole research project has been organized. This chapter presents the methodology adopted and identifies the tools and techniques employed in conducting this study.

The research follows some steps and procedures when conducted. Once the problem of statement has been formulated, it should become evident what kind of data will be required to study the problem, and also what kind of analysis would be most appropriate to analyze the data. The problem investigated in this study was the pedestrian crash in Kirkos sub-city specifically road segment from Getu commercial center to Wollo Sefer round about.

3.2. Study area

The study was conducted in Addis Ababa Ethiopia Kirkos sub-city. The geographical coordinates of Kirkos sub-city is at 9° 0’15.12”N latitude and 38°45’31.28”E longitude with an estimated area of 14.62 km^2 google map (14/03/2018)

The road segment under study was around 1.8km in length from Getu Commercial and business center to Wollo Sefer roundabout. The criteria for selection of the area was the number of pedestrian crash accidents in the Kirkos sub-city at this place. The other criteria for selection the study area was the road is one of most important road segment of sub-city because, it is the road connecting Bole international airport with 4 kilo palace. The road segment was two way divided road segment with eight lanes. The satellite image of study area looks like figure 3.1.

Figure 3.1 Satelite image of study area(Google earth 01/02/2018)

It was selected because there was high pedestrian crashes records at this place. As shown in table 4.1 and 4.5 there was 1,134 fatality, 4350 severe injuries and 2803 slight injury pedestrian crash recorded in the sub-city within four years and particularly at this road segment 112 fatality 211 severe injury and 208 slight injury totally 531 pedestrian crash was recorded at this place.

3.3. Research Design

The research was conducted by using both descriptive and analytical research method. This was selected because such study method selects a small geographical area and limited number of individuals/groups as the subjects of study. And also the method enables the researcher to examine the data within a specific context and to relate to the topic.

The following activities were entailed in this research to evaluate pedestrian safety.

- Identifying the problem by reconnaissance survey.
- Describing the magnitude, trends and patterns of pedestrian fatalities and injuries in sub-city.
- Identifying the places where highest pedestrian fatalities and injuries frequently occur in the sub-city.
- Assessing factors for pedestrian injuries and fatalities crashes at an identified place.

○ Identifying and assessing existing pedestrian safety measures based on the analysis result by considering the objective of the research.

○ Recommending possible and economical engineering measures that make pedestrian safe when they are crossing the road.

3.4. Population

Determining the population targeted was the first step in the sampling strategy, and it is dependent on the study objective.

The targeted population in this study was:

Pedestrian crossing the road.

Driver.

Traffic police of the sub-city

This population enabled the researcher to obtain the necessary data for the study.

3.5. Sample and Sample Size

Random sampling techniques was used to obtain representative data from all the target population like Pedestrians, drivers, and traffic polices.

3.5.1. Sample size

This was the formula used in this research and in most statistics textbooks, especially descriptive statistics dealing with probability to determine simple size.

$$SS = \frac{z^2(1-p)*p}{c2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots.. \; equn\ 3.1$$

SS = Sample Size for infinite population where the population is greater than 50,000)

Z = Z-value confidence level

P = Percentage of population picking a choice, expressed as decimal

C = Confidence interval, expressed as decimal

Z-values for confidence levels are:

Z 1.645 = 90 % confidence level

Z 1.96 = 95 % confidence level

Z 2.576=99% confidence level

3.6. Sample and sampling technique

The research uses probability sampling method of sampling which gives the probability that the sample is representative of a population. The researcher has used random sampling procedure to gather information from driver, pedestrian and traffic polices about causes of pedestrian crash by rating the cause through Likert scale, etc. The researcher was asked the sub city's drivers, pedestrians and police officers for consult and support during the data collection process. Also, interviewees was included in the data collection from drivers, pedestrian and police officer.

3.7. Study variables

3.7.1. Dependent Variable

Dependent variable of this study was Pedestrian safety crossing the road

3.7.2. Independent variables

- Number of pedestrian crashes
- Traffic controlling sign
- Driving behavior
- Traffic rules and regulation
- Crossing facility

3.8. Data collection process

3.8.1. Primary Data

During data collection process both descriptive and analytical primary data and secondary data was collected. The primary data were collected through questionnaires, face to face interview and observation on study site.

3.8.1.1. Questionnaires

Questionnaires are one of the most frequently used data collection self-designed research tools in basic and applied research. A Likert scale named after the psychologist Rensis Likert is used in this research; because this method is preferable to evaluate belief or attitude to being measured.

3.8.1.2. Interviews

The interview is a useful technique for collecting data which would probably not be accessible using techniques such as observations and questionnaires, and also to clarify different unclear idea which was difficult to address by questionnaire. The interview was conducted face-to-face with the interviewee asking questions individuals who have good willing to answer the questions. A semi-structured interview was conducted with police officers and follow up to pedestrian and driver to gather information on causes of the pedestrian crash at the study area and possible solution. The interview questions were attached to this document on appendix.

3.8.2. Field Observation

The data collected during field observation were road width, Presence of a marked crosswalk, the presence of a traffic signal and etc. During data collection on the site taking images, and visually understanding the situation was tried by the researcher.

3.8.3. Secondary Data

The secondary data include different literature, traffic police document and database and sometimes different newspaper. Pedestrian crash recorded over four years period from 2006, 2007, 2008 and 2009 E.C in the sub-city were included in this secondary data. These data include fatal, severe and slight pedestrian injury crashes.

According to the Ethiopian practice, a road traffic fatality refers to a road user who was involved in a vehicular crash and died within 30 days of the traffic crash. Serious injury is determined when a person is hospitalized for 24 hours or more, and slight injury is designated when a person suffers from a road traffic injury and is hospitalized for less than 24 hours (Getu. S. Tullu, 2013).

This research employed the following approaches to managing cost and time constraints for the collection of pedestrian crash data. The first approach was to use the Ethiopian Federal Police Commission pedestrian crash database to characterize pedestrian crashes in the sub-city, which provides summarized information on four years of collected data.

The second approach involved gathering causes of pedestrian crash data on the identified road segment through questionnaire, interview and observation on site.

The final approach was collecting pedestrian crash data from Kirkos sub-city police station hard copy document for the last four years. This was used to analyze pedestrian injury severity and

determine the place where high pedestrian crashes were recorded in sub-city and distribution nature of this crashes throughout the sub-city.

3.8.3.1. Gathering Crash Data from Police Crash Database

The database contains all pedestrian crashes reported in Kirkos sub-city for the last four years before the research started. Details of the data include the date of the occurrence, time of day, weather conditions, pedestrian age and gender, specific places of accident and severity level in all pedestrian crashes. The researcher didn't include all information in the database as it was, instead it was selected and organized it to meet the objective of the research.

3.9. Data Processing and Analysis

Data processing is series of actions or steps performed on data to verify, organize, transform, integrate, and extract data in an appropriate output form for subsequent use. After processing the data analysis were carried out and gathered data was evaluated to come up with the research output by considering the research objective.

The main approach used to analyze the primary data was by using the Relative Index (RI) technique to determine how often the listed causes of pedestrian crashes occurred at this place. The frequency of the causes of pedestrian crashes was identified by using a 5 point Likert scale, namely Never = 1; rarely = 2; Sometimes = 3, Often = 4; and Always = 5. The causes of pedestrian crashes were ranked by comparing their relative index (RI).

The responses were analyzed using the Microsoft Excel software package. The analysis included ranking the factors regarding to the degree of frequency of occurrence; i.e., Never, rarely, sometimes, often and always. In the computation of the relative index the following formula was used.

$$\text{RI} = \left(\frac{5 * n_5 + 4 * n_4 + 3 * n_3 + 2n_2 + n_1}{5(n_5 + n_4 + n_3 + n_{2+}n_1)}\right) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots equn\ 3.3$$

Where:

RI: Relative Index

n_5, n_4, n_3 ... number of responding

4.9.1. Spearman's Correlation

The Spearman (rho) rank correlation coefficient was used for measuring the differences in ranking between two groups of respondents scoring for various factors (i.e., Pedestrian versus traffic police, pedestrian versus driver and traffic police versus driver).

The Spearman (rho) rank correlation coefficient for any two groups of ranking was given by the equation 3.4

$$Rho(\rho) = 1 - (\frac{6*\sum(di^2)}{N*(N^2-1)})$$.....equation 3.4

Where:

Rho (ρ): Spearman's rank correlation coefficient;

di: the difference in ranking between each pair of factors; and

N: number of factors (variables).

The value of the Spearman (rho) rank correlation coefficient varies between -1 and +1. A correlation coefficient of *+1* implies perfect positive correlation, *0* implies no correlation and *-1* implies perfect negative correlation. Secondary data was analyzed by tables, graphs and explanation of the graphs and tables was given detail.

3.9.2. Severity Index

The pedestrian Severity Index establishes a means for comparing the severity of crashes occurring at one intersection or certain road segment with another. While reducing all crashes is important, identifying where the more severe crashes occur assists with the identification of road segment of greater concern. The Severity Index introduces to the analysis a layer of information which contributes to ranking high crash place.

The Severity Index assigns a numeric value to crashes which result in an injury or fatality. How to weight the severity of crashes has, for many years, been a topic of debate, study and discussion around many conference tables (Transportation Policy Committee 2015).

The formula used to determine an intersection's or road segment's Severity Index was

Severity Index (SI) = (12Ftl + 3Inj + 1PDO) / N……..……..3.5

Ftl = A crash resulting in at least one fatality along the given segment

Inj = A crash resulting in at least one injury along the given segment

PDO = A crash resulting in property damage only or did not result in any injuries or fatalities along the given segment

N = The Total number of crashes (Fatal + Injury + No Injuries or Fatalities) along the given segment

CHAPTER FOUR

RESULT AND DISCUSSION

4.1. Introduction

This chapter review the analysis of pedestrian crash briefly in the previous four years. This detail analysis was done by collecting data from Kirkos sub-city's police office and made detail study on characteristics of the pedestrian crash in this sub-city. The detail investigation and diagnosis shown the cause of pedestrian crashes and finds out a better solution and recommendation to minimize the pedestrian crashes. Starting from data collected from different institutions and complies with a scientific way to make it easily understandable for anyone. The data was presented in the form of tables, percentages and different graphs. The interpretation and discussion of data collected through questionnaires, interviews and as a secondary data from different institution was given in detail.

4.2. Exploring the nature and characteristics of pedestrian crash in Kirkos sub city

In this sub-topic the pedestrian crash distribution was discussed and explained from different perspective of classification system. In total, 11,659 pedestrian crashes were recorded in this four years. As much as possible for each vehicle-pedestrian crash, the following information was collected.

- Location of crash by name place
- Age, sex, date and time of crash
- Severity level (fatal, severe injury or slight injury)
- Job of pedestrian and health condition of pedestrian.

The above information were used to describe the classification and distribution of pedestrian crash in the sub city.

4.2.1. Distribution of pedestrian crash based on their work.

The following table shows detail distribution of pedestrian crash data based on their work group for the last four years. As it is shown in the table 4.1 below worker pedestrian group of society was the most affected group. The second most affected group was student, because this two groups were more exposed to crashes, because this pedestrian groups were lose their time out of their house on the road. The worker groups were go to work place and come back to home at least two time per

day that means four journey per day which increases exposer to traffic accident. The student also do the same things.

Table 4.1 Distribution of pedestrian crash based on their status

Year		2006			2007			2008			2009		
No	Pedestrian Work	Severity Level			Severity Level			Severity Level			Severity Level		
		F	SI	slI	F	SI	slI	F	SI	stI	F	SI	slI
1	Student	50	186	158	68	103	104	69	156	107	72	152	119
2	Worker	207	898	625	300	1061	497	185	1254	752	306	1301	792
3	Farmer	21	28	13	18	3	2	54	3	1	52	10	4
4	Jobless	30	223	161	17	149	250	28	193	77	35	191	203
5	Other	5	14	14	5	10	-	2	8	13	6	13	12
6	Unknown	23	11	5	19	24	8	53	26	16	52	32	20
Sum		336	1360	976	407	1350	861	391	1640	966	523	1699	1150
Total		2672			2618			2997			3,372		

Source: Kirkos sub-city police station

4.2.2. Distribution of pedestrian crash based on Severity Level

As it can be observed from the bar chart below through all four years, pedestrian crash was increasing which shows urgent remedial measure must be taken by concerned body. The possible remedies was put in chapter five of this research as recommendation.

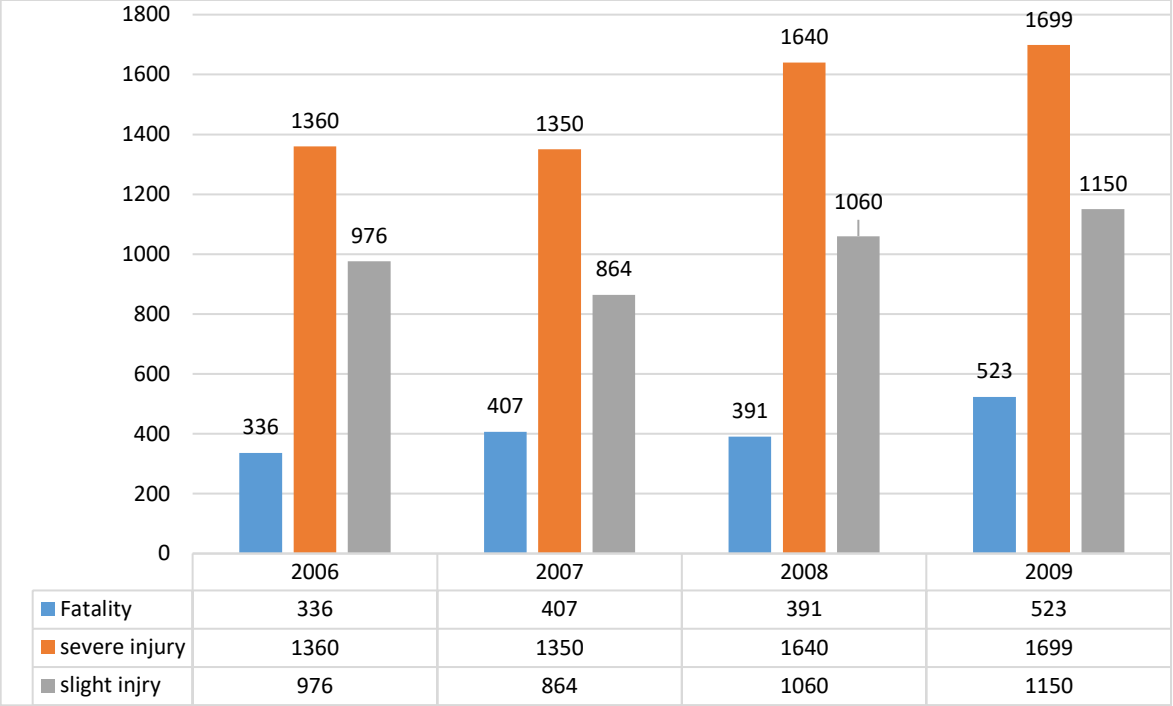


Figure 4. 1 distribution of pedestrian crash based on severity level

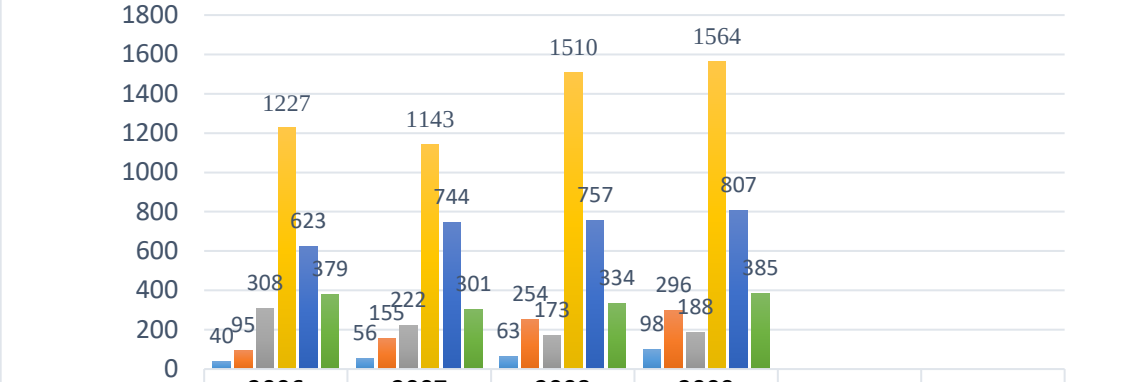
4.2.3. Distribution of pedestrian crash by age group and sex

The Table 4.2 and figure 4.2 shown that there was a higher number of younger pedestrian crashes of people age group of 18-30 years with an average of 45% pedestrian crash and in the 31-50 year age group (35%). On this age group, most of the young people participate in a society actively, and due to this high activity and movement, they will put their lives in danger from all group of pedestrians.

Table 4.2 Distribution of pedestrian crash based on age group.

Year	Age (year)	Fatal		Severe injury		slight injury		Sum	Total (%)
		M	F	M	F	M	F		
2006	< 7	4	2	15	2	17	-	40	1.50
	7-13	12	3	25	16	24	15	95	3.56
	14-17	9	5	99	48	112	35	308	11.53
	18-30	110	19	540	115	334	109	1227	45.92
	31-50	76	10	252	77	152	56	623	23.32
	>50	66	20	120	51	84	38	379	14.18

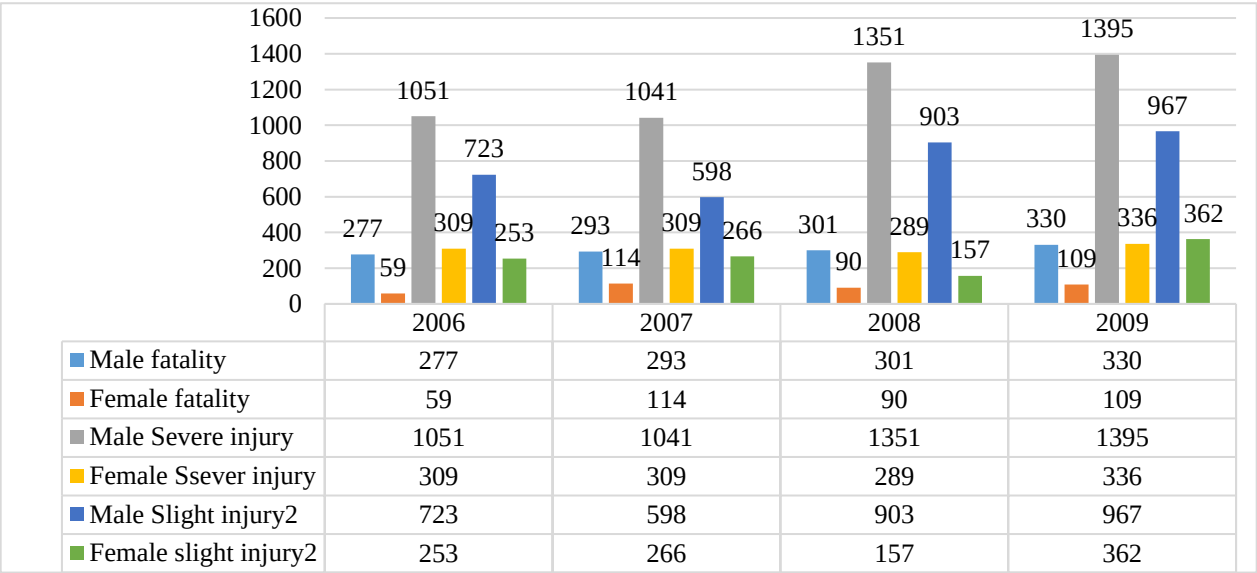
	Sum	277	59	1051	309	723	253	2672	100.00
2007		Male	F	M	F	M	F		
	< 7	5	3	5	17	18	8	56	2.14
	7-13	8	5	30	26	45	41	155	5.91
	14-17	2	6	34	59	85	36	222	8.47
	18-30	107	42	633	111	158	92	1143	43.61
	31-50	96	26	246	66	252	58	744	28.39
	>50	75	32	93	30	40	31	301	11.48
	Sum	293	114	1041	309	598	266	2791	100.00
2008		M	F	M	F	M	F		
	< 7	5	1	24	3	30	0	63	2.04
	7-13	9	11	100	18	110	6	254	8.22
	14-17	3	2	95	29	26	18	173	5.60
	18-30	122	28	651	129	492	88	1510	48.85
	31-50	94	19	378	76	160	30	757	24.49
	>50	68	29	103	34	85	15	334	10.81
	Sum	301	90	1351	289	903	157	3091	100.00
		M	F	M	F	M	F		
2009	< 7	9	3	28	13	37	8	98	2.80
	7-13	13	13	110	28	121	11	296	8.46
	14-17	7	3	85	39	31	28	188	5.37
	18-30	125	29	671	139	502	98	1564	44.70
	31-50	98	29	388	86	171	35	807	23.06
	>50	78	32	113	32	105	25	385	11.00
	Sum	330	109	1395	336	967	362	3,372	100.00



	2006	2007	2008	2009		
< 7	40	56	63	98		
7 to 13	95	155	254	296		
14 to 17	308	222	173	188		
18 to 30	1227	1143	1510	1564		
31 to 50	623	744	757	807		
> 50	379	301	334	385		

Figure 4. 2 distribution of pedestrian crash based on age group

As it can observed from figure 4.3 female pedestrian was less affected than male pedestrian, the reason behind this was females were more responsible by nature for their action than male and in our country's culture most of the female are staying in home for a long period of time than male. So the exposure of female to accident was less than male.



	2006	2007	2008	2009
Male fatality	277	293	301	330
Female fatality	59	114	90	109
Male Severe injury	1051	1041	1351	1395
Female Ssever injury	309	309	289	336
Male Slight injury2	723	598	903	967
Female slight injury2	253	266	157	362

Figure 4.3. Distribution of pedestrian crash based on sex severity level

Composition of Fatal, Severe injury and Slight injury crashes was 1657, 6,049, and 3,953 respectively. In terms of gender, males accounted for 76.35% and females for 23.65% of the fatalities during the period. Table 4.2 shows pedestrian crashes based on gender and age. The trends for male and female road users in various age categories are different. As shown in table and bar chart above males were more vulnerable to death and roughly 3 times as many male killed.

Figure 4.4. Total Pedestrian crash of the last 4 years

Figure 4.4 above shown that the patterns of overall pedestrian crashes of Kirkos sub-city over the last four years. As it was shown pedestrian crash increase from year to year which is a critical problem.

4.1.3. Distribution of pedestrian crash by health condition

In table 4.3 it was shown that there was a higher number of healthy pedestrian crashes compare to deaf, blind, handicapped and alcoholic impaired pedestrian group. This pedestrian group most of the time participate in a society actively and their high movement will put their lives in danger from all group of pedestrians. The data shows that the main problem in of pedestrian crash was not the cases of disability because the pedestrian endangered by traffic accident was healthy pedestrian.

Table 4.3. Distribution of pedestrian by health condition

Year		2006			2007			2008			2009		
No	physical condition	Severity Level			Severity Level			Severity Level			Severity Level		
		F	SI	slI	F	SI	slI	F	SI	slI	F	SI	slI
1	Deaf	-	-	-	-	2	2	-	-	-	1	-	1
2	Blind	-	-	-	-	-	55	-	-	-	-	3	-
3	Handicap	-	-	-	2	2	1	-	-	-	3	-	-
4	Healthy	313	1349	971	420	1319	795	338	1617	950	438	1657	980
5	Alcoholic	-	-	-	-	3	-	-	2	1	-	1	2
6	Unknown	23	11	5	5	24	8	53	21	15	73	28	32
Total		336	1360	976	427	1350	861	391	1640	966	515	1689	1015

Source Federal police commission report

4.2.4. At-fault Road User

For each pedestrian crash, the at-fault road user (i.e., driver, or pedestrian, or both) was identified based on the descriptions in the police reports. Table 4.4 provides these statistics. Drivers were found to be at fault in 41.12% of the crashes while pedestrians were at fault 26.06 % of the crashes.

Table 4.4 Police report statistics by at-fault road user

At fault road user	F		SI		slI		Total	
	No	%	No	%	No	%	No	%
Both Driver and Pedestrian	279	16.72	682	11.293	865	22.66	1826	15.84
Driver	661	39.60	2910	48.187	1168	30.59	3106	41.12
Pedestrian	495	29.66	1277	21.146	1232	32.27	4637	26.06
Not sure	234	14.02	1170	19.374	556	14.56	3395	17.01
Total	1669	100	6039	100	3818	100	11,526	100

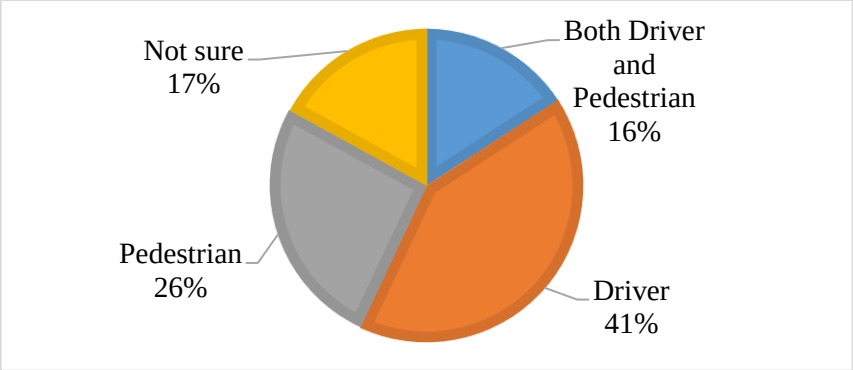


Figure 4.5 Diagrammatic representation of at fault road user

When the driver was found to be at fault, over speed, absence of pedestrian sign, careless driving, failed to yield right-of-way for pedestrian and disregarded traffic signal or other traffic control were the most frequent contributing causes of crash.

When the pedestrian was found to be at fault, the most frequent contributing causes were crossing out of pedestrian cross walk under alcohol influence, and disregarded traffic signal or other traffic control.

4.3. Identification and analysis of highest pedestrian crash location in sub-city

In this section, the overall top sub-city wide high crash pedestrian crash location were identified based on number of pedestrian crash and severity index for detailed analysis. This research study cover detail identification of the place where the high pedestrian crash was registered by the sub-city through collecting data from daily traffic accident record book of police commission for the last four years and by interviewing some police officers.

4.3.1 Severity Index

The Severity Index introduces to the analysis a layer of information which contributes to ranking high crash place. Table 4.5 shows the ranks of top severe place for pedestrian in the sub-city based on severity index. Based on this Getu commercial and business center-Wello sefer roundabout was the first ranked place with SI= 2.087 and Meskel adebabay was the second sever place with 1.722

Table 4.5 Ranks of hazardous place based on Severity index (SI)

2006 – 2009							
Rank	Name of Hazardous place	Severity level					
		F	SI	slI	PDO	Total	SI
1	Getu Commercial – Wello sefer roundabout	112	211	208	217	748	2.087
2	Meskel Adebabay	72	100	220	262	654	1.722
3	Legehar-stadium	56	188	173	479	896	1.285
4	Welosefer – Ayibex hotel	16	32	91	401	540	1.098
5	Biherawi betemengist- Gabriel	23	132	86	345	586	1.060
6	Meskel Flower – Olympia	21	104	121	433	679	1.009
7	Mexico Keker building	18	201	57	309	585	0.897

Source Own calculate from Secondary data

High pedestrian crashes were often located at nodes of the road but in this sub-city the highest pedestrian crash was recorded on road segments of the road network (at the straight road segment). The high pedestrian crash places that were identified in this research from secondary and primary data was listed below by rank. The rank was given based on number of pedestrian crash occurred and severity index in the last four years. Getu commercial-Wollo sefer round about road segment was first ranked place with 112 pedestrian fatality 211 severe injury, 207 slight injury and total of 530 pedestrian crash within this four years 2006- 2009 E.C. The severity index of this place was 2.87. The second high pedestrian crash place was Meskel Adebabay with 72 fatality, 100 severe injury 220 slight injury and totally 392 pedestrian crashes in four years. Based on this data the study area of this research was selected as Getu commercial to Wello Sefer round about road segment. Even if the objective of the research was concentrated on the highest pedestrian crash place Meskel Adebabay was also critical pedestrian crash place with the total pedestrian crash of 392.

Table 4.6 Distribution of pedestrian crashes based on places of crashes

2006 – 2009					
Rank	Name of Hazardous place	Severity level			
		F	SI	slI	Total
1	Getu Commercial – Wello sefer roundabout	112	211	208	531
2	Meskel Adebabay	72	188	173	453
3	Legehar-stadium	56	100	220	376
4	Biherawi betemengist- Gabriel	23	104	121	248
5	Meskel Flower - Olympia	21	201	57	279
6	Mexico Keker building	18	132	86	236
7	Welosefer – Ayibex hotel	16	32	91	139

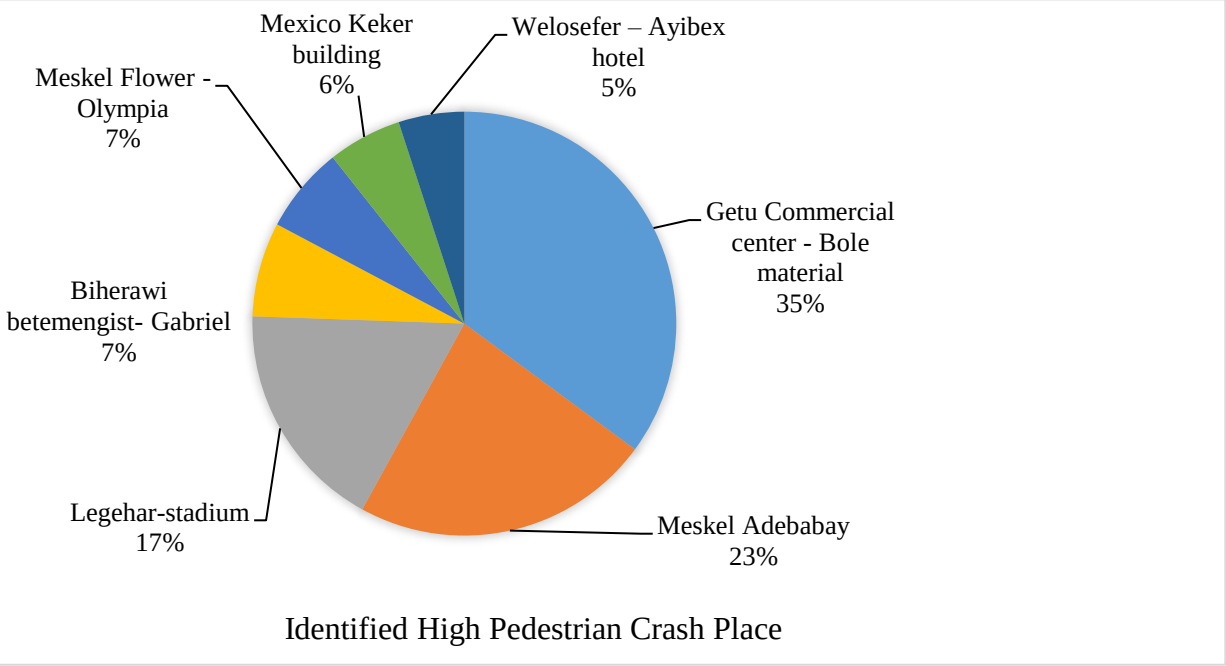


Figure 4.6 Identified high Pedestrian crash places

Source Own count from Kirkos sub-city police office daily traffic record book.

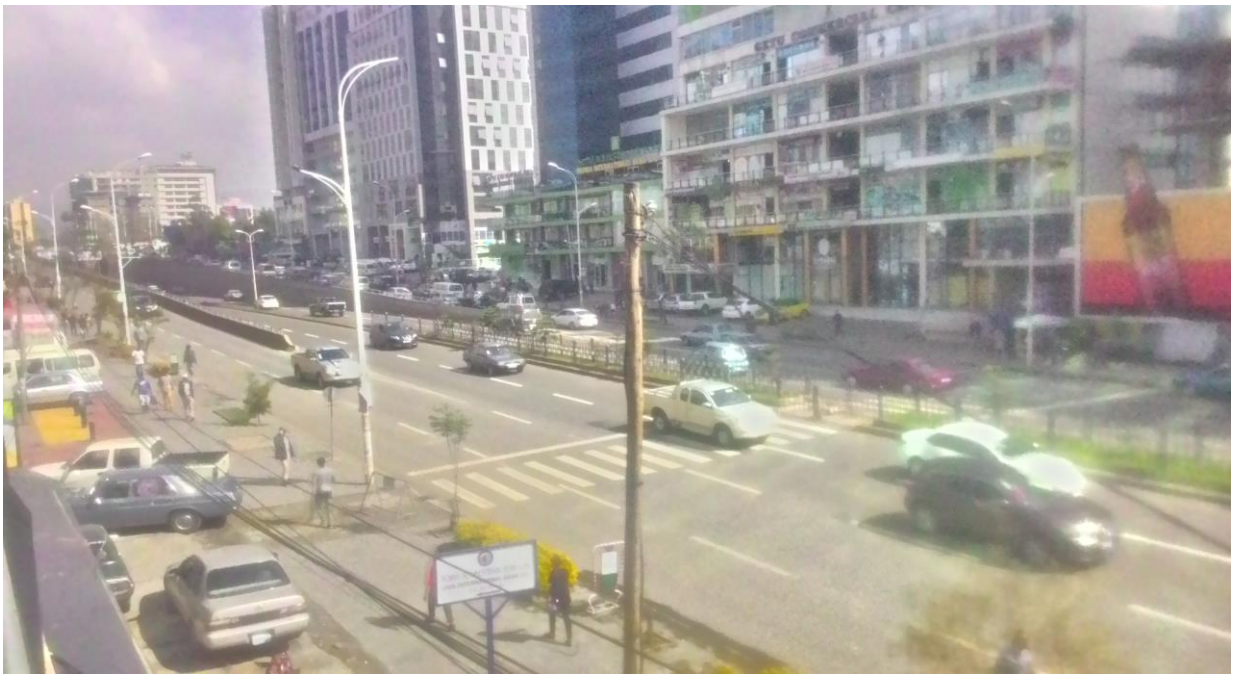


Figure 4.7 Place of highest pedestrian crash in front of Getu commertial center.

As it was tried to shown on figure 4.7 the distance of zebra pedestrian cross from strictly prohibited for pedestrian was 25m. But the vehicle approaching this pedestrian cross was very speedy because they were coming from free road way. The upper stream of the road was completely prohibited for pedestrian this means there was no interruption to traffic flow which invites driver to drive over speed.

The following table 4.7 shown that the summary of pedestrian crashes of four years based on severity level and it were increasing tremendously from year to year.

Table 4.7. A summary of pedestrian crash in Kirkos sub-city for the last three years

2006			2007			2008			2009		
Severity Level			Severity Level			Severity Level			Severity Level		
F	SI	slI	F	SI	slI	F	SI	slI	F	SI	slI
336	1360	976	407	1350	861	391	1640	966	515	1689	1015

Source Own calculated from Kirkos sub-city police station documentation

4.4. Identifying Causes of Pedestrian crash crossing the Road at identified place

Observational studies undertaken in Ethiopia indicate that disobeying traffic control devices is a major problem (Miranda. M, 2011). The speed limit in urban and village sections of road in Ethiopia is 30 km/h; however, the drivers on these road segment didn't obey this requirement. On this road segment they come up with higher speed as they approach this place from fully restricted area for pedestrian and then do not reduce their speed sufficiently at pedestrian crossing. The other observed problem was, invisibility of pedestrian. So increasing caution driver is important. The main contributor to this behavior was lack of provision of speed reduction mechanism before reaching pedestrian crossing area. The place where frequently pedestrian crash occurred which was identified in this study was at the end of concrete barrier provided to separate traffic flow in the same direction. As it was tried to show on figure 4.6 at the end of this concrete barrier there is zebra pedestrian cross which was the main crash place. This show improper provision of pedestrian crossing facility.

4.4.1. Distribution of pedestrian crashes based on causes of crashes

The following table 4.8 below shows the movements of pedestrian as causes of crashes and respective number of pedestrian crashes with their respective severity level. As can be observed from this table most of pedestrian crashes (32.12%) were occurred on zebra crossing. This implies that the driver was not willing to give right of-way for pedestrian crossing the road, even at right cross walk. Secondly 16.26% of pedestrian crashes were occurred when they were crossing the road out of zebra cross and this shown that a lots of pedestrian crosses the road illegally which was one of the main causes of pedestrian crash identified in this research.

Table 4.8. Distribution of pedestrian crashes based on condition of crashes (kirkos sub-city police station)

Year		2006			2007			2008			Total (%)
No	Causes of crashes	Severity Level			Severity Level			Severity Level			
		F	SI	slI	F	SI	slI	F	SI	slI	
1	Crossing at traffic light & ped. Crossing Time	-	5	-	-	-	-		86	34	1.50
2	Crossing at no traffic light & at ped. crossing place	-	26	21	8	90	104		27	3	3.34
3	Crossing on intersection	-	16	18	12	115	10	3	318	96	7.05
4	Crossing on zebra	23	374	363	70	911	300	93	308	239	32.12
5	Crossing out of zebra	141	199	248	57	150	106	3	272	181	16.26
6	Crossing the road following the vehicle.	-	86	61	12	135	94	5	118	26	6.43
7	Walking on vehicle's lane even if pedestrian walkway is there.	9	95	117	33	103	80	43	254	40	9.27
8	Walking on pedestrian walkway	18	167	132	38	73	40	120	158	209	11.44
9	Walking on the left of road	28	102	75	46	82	51	10	33	65	5.90
10	Walking on right of the road	22	75	31	39	57	20	34	15	6	3.58
11	Walking on center of the road	1	9	5	12	10	8	5	5	-	0.66
12	Working on vehicle	1	-	-	-	-	1	4	1	-	0.08
13	Playing on the road	1	1	-	-	-	-	1	12	2	0.20

14	Standing on the road	9	6	21	8	25	23	3	2	30	1.52
15	Sleeping on the road	7	4	6	7	-	-	1	3	2	0.36
16	Getting on getting off vehicle	-	5	5	-	3	2	4	2	1	0.26
17	Out of road	11	6	3	4	6	-		5	17	0.62
18	Other	37	62	46	43	38	14	9	-	-	2.98
19	Unknown	21	9	3	17	24	8	53	21	15	2.05
	Sum	329	1247	1155	407	1350	861	391	1640	966	100.00
Total				2731			2791			2997	

From this traffic police report and different literature the following causes of pedestrian crashes were identified. Over speeding, pedestrian illegal crossing, absence of enforcement of traffic rule and regulation on pedestrian, absence of median, alcohol impaired driving, age of pedestrians, absence of footpath, alcohol impaired pedestrians, improper functioning headlights and defective tyres, defective brake, steering system problem, inadequate traffic control device, inadequate visibility, driver distraction, aggressive driving, size and weight of vehicles, campuses, and school areas were the identified causes of pedestrian factors. Based on this table 4.8 and other police report causes of pedestrian crash was tabulated as shown in table 4.9.

Table 4.9 Ranking of causes of pedestrian crash pedestrian based on number of crash

Rank	Causes of pedestrian crashes	Number of crash in four years
1	Over speed	132
2	Pedestrian illegal crossing	121
3	aggressive driving	101
4	Driver distraction	95
5	alcohol-impaired driving	18
6	Defective brake, steering system problem	11
7	inadequate traffic control device	10
8	alcohol-impaired pedestrians	9
9	Improper provision of crossing facility	9
10	Absence of footpath	8
11	Lack of driving experience	7
12	improper Functioning headlights and defective tires	6
13	age of pedestrians	4
	Total	531

Source own count from Kirkos sub-city traffic police daily record book

Table 4.8 shown that ranks of crash causes depending on number of pedestrian crashes. Based on this secondary data over speed was first ranked cause with 132 crash in four year at this place. The rank go down to age of pedestrian depending on number of pedestrian crashes.

4.4.2. Analysis of questionnaire Response

In the structured part of the questionnaire, the respondents were asked to rate the degree of contribution of those variables that were drawn from the literature review and that were identified during desk study from secondary data. The analysis of this questionnaire was supportive of the rank provided from secondary data in table 4.8. Furthermore, the respondents were also asked to add other variables which are not specified in the questionnaire and to imply the possible remedies to be taken. The responses were analyzed using the Microsoft Excel package.

The analysis was divided into three groups the pedestrians' point of view, the drivers' point of view and the traffic polices point of view. Therefore pedestrian, drivers and traffic police were asked to rate the frequency of occurrence of this factors at this place.

Then by combining the three groups' response the conclusion were drown. And a correlation test was done between the groups. A ranking system using the Relative Index (RI) method was used to find the most significant factor for each group. The frequency of the causes of pedestrian crashes was identified by using a 5 point Likert scale, namely Never = 1; rarely = 2; Sometimes = 3, Often = 4; and Always = 5. The causes of pedestrian crashes were ranked by comparing their relative index.

From 70 questionnaires distributed to drivers, pedestrian, and traffic police 55 questionnaires were returned with 44 complete answer 9 from driver 13 from pedestrian 22 from traffic police. From those returned questionnaire 11 questionnaires were returned with unfulfilled answer and they were rejected from the analysis 15 questionnaire were not returned back at all. On the other hand to full fill the gap of questionnaires which were not returns and rejected due to incompleteness the study conduct an interview for the pedestrian, police officer and driver.

4.4.3. Sample size

For pedestrian and driver it was difficult to determine the number of population that use that road to determine sample size. Kirkos sub-city was found at the center of AA and a lots of commercial and business center was found in this sub-city; so a lots of pedestrian and driver were come to this place and this make the determination of sample size difficult. Therefore the researcher have used infinite population sample size determination formula to determine number of questionnaire for the two population (pedestrian and driver).

So it was preferable to use the following formulae which is found in most statistics textbooks, especially descriptive statistics dealing with probability. Infinite population where the population is greater than 50,000 this formula is recommended.

$$ss = \frac{z^2(1-p)*p}{c^2} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots equn\ 3.1$$

SS = Sample Size

Z = Z- percent confidence level

P = Percentage of population picking a choice, expressed as decimal

C = Confidence interval, expressed as decimal

Z-values for confidence levels are:

1.645 = 90 % confidence level

1.96 = 95 % "

2.576=99% "

In this research the following value was used

C = -/+5% = 0.05

P = 0.99

Z = 2.576

4.4.3.1. Sample size for pedestrian and driver

$$SS = \frac{2.576^2 * 0.99 * (1-0.99)}{0.05^2} = 20.22 \cong 20$$

4.4.3.2. Sample size for traffic police officers

The number of traffic police currently on duty on the site in Kirkos sub city was 57 so we can use finite population formula.

Pop = 57

$$ss = \frac{z^2(1-p)*p}{c2} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots equn\ 3.2$$ infinite population formula

We can use the previous sample size of infinite population ss= 20

$$\text{New SS} = \frac{SS}{1+\frac{(SS-1)}{pop}} = \frac{20}{1+\frac{(20-1)}{57}} = 30$$

Therefore 30 questionnaire for traffic police 20 questionnaire for pedestrian and 20 questionnaire for driver totally 70 questionnaire was prepare and distributed. The number of questionnaire returned was as shown in table 4.8 bellow.

Table 4.10. Response rate

Group	Number of Questionnaires Distributed	Number of Questionnaires Returned	Response Rate (%)
Pedestrian	20	9	45
Driver	20	13	65
Traffic police	30	22	73.33
Total	70	44	62.85

Source Own calculate from responded questionnaire

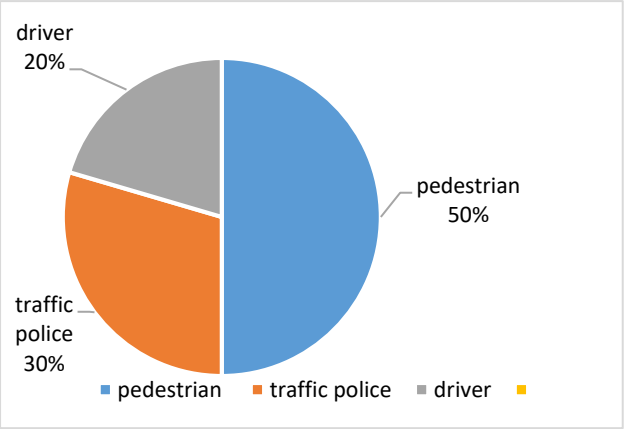


Figure 4.8 respondent proportion (Source Own calculate)

4.4.4. Respondents' Background

Among the 22 responses received from traffic polices 15 (68.18%) of them have 5 to 10 year work experience 2 (9.1%) of them have more than 15 years 5 (22.73%) of them have bellow 5-year experience. In the respect of sex, only 2 (9.1%) traffic police were included and 20 (90.9%) were male. The detail back ground of respondents were as shown in table 4.9 bellow.

Table 4.11. Respondent background (Own calculate from respondent questionnaire)

Description		Pedestrian		Driver		Traffic police	
Sex		No	%	No	%	No	%
	Male	7	77.78	9	69.23	20	90.91
	Female	2	22.22	4	30.77	2	9.09
	Total	9	100	13	100	22	100
Age	>18	0	0	0	0	0	0
	18-30	6	54.54	5	38.46	3	13.64
	30-40	1	11.11	5	38.46	11	50
	40-50	2	22.22	2	15.38	7	31.82
	< 50	1	11.11	1	7.69	1	4.54
	Total	9	100		100	22	100
Service experience	>1 year	-	-	2	15.38	5	22.73
	2-5	-	-	4	30.77	15	68.18
	6-10	-	-	5	38.46	0	0
	< 10	-	-	2	15.38	2	9.1
	Total	-	-			0	0
	Total	-	-	13	100	22	100

4.4.5. Pedestrian Point of View

From Table 4.10 below, it was possible to rank the causes of pedestrian crashes by comparing their RI value. According to pedestrian point of view over speed (RI=0.891), aggressive driving (RI=0.845), absence pedestrian refuge island (RI =0.836), pedestrian illegal crossing (RI=0.809) and absence of enforcement of traffic rule and regulation on pedestrian (RI=0.782) was the highest ranking causes of pedestrian crash crossing the road. Driver distraction (RI=0.382), age of pedestrians (RI=0.327) and Campuses and school areas (RI=0.318), was the least ranked cause of

pedestrian crash as per pedestrian point of view. This is because there is no school and campus on this road segments.

Table 4.12: Frequency of causes of the pedestrian crash from the pedestrian Point of view

Causes of pedestrian crashes	RI	Rank
Over speed	0.891	1
Aggressive driving	0.845	2
the absence of median and pedestrian refuge island	0.836	3
Pedestrian illegal crossing	0.809	4
Absence of enforcement of traffic rule and regulation on pedestrian	0.782	5
Inadequate traffic control device	0.727	6
Absence of footpath	0.709	7
Alcohol-impaired driving	0.700	8
Alcohol-impaired pedestrians	0.573	9
Defective brake and steering system problem	0.545	10
Improper Functioning of headlights and defective tires	0.518	11
Inadequate visibility	0.500	12
Size and weight of vehicles	0.455	13
Driver distraction	0.382	14
Age of pedestrians	0.327	15
Campuses, and school areas	0.318	16

Source Own calculate by using Excel

4.4.6. Drivers' Point of View

From Table: 4.11 below, the highest ranked cause of pedestrian crashes was pedestrian illegal crossing with (RI= 0.764), and the second-ranked was absence of enforcement of traffic rule and regulation on pedestrian not crossing legally with (RI= 0.745) followed by Over speeding and

absence of median and pedestrian refuge island (RI=0.691 & 0.664) respectively. Here also campuses and school area was the least ranked cause of pedestrian crash.

Table 4.13: Frequency of causes of pedestrian crash from driver of view

Causes of pedestrian crashes	RI	Rank
Pedestrian illegal crossing	0.764	1
Absence of enforcement of traffic rule and regulation on pedestrian	0.745	2
Over speeding	0.691	3
the absence of median and pedestrian refuge island	0.664	4
driver distraction	0.645	5
alcohol-impaired driving	0.600	6
inadequate visibility	0.600	7
improper Functioning headlights and defective tires	0.545	8
alcohol-impaired pedestrians	0.518	9
the absence of footpath	0.518	10
defective brake, steering system problem,	0.455	11
inadequate traffic control device	0.382	12
age of pedestrians	0.336	13
aggressive driving	0.327	14
size and weight of vehicles	0.327	15
campuses, and school areas	0.318	16

Source Own calculate

4.4.7. Traffic police point of view

From Table: 4.12 below, the highest ranked cause of pedestrian crashes was over speeding with (RI= 0.818), and the second-ranked was absence of enforcement of traffic rule and regulation on pedestrian not crossing legally with (RI= 0.80) followed by illegal crossing of pedestrian and

alcohol impaired driving (RI=0.764 & 0.750) respectively. Here also campuses, and school area was the least ranked cause of variation orders of (RI= 0.335).

Table 4.14: Frequency of causes of pedestrian crash from Traffic Police Point of view

Causes of pedestrian crashes	RI	Rank
Over speed	0.818	1
absence of enforcement of traffic rule and regulation on pedestrian	0.800	2
Pedestrian illegal crossing	0.764	3
alcohol-impaired driving	0.750	4
aggressive driving	0.718	5
absence of median and pedestrian refuge island	0.700	6
defective brake, steering system problem	0.660	7
improper functioning headlights and defective tyres	0.627	8
alcohol-impaired pedestrians	0.609	9
driver distraction	0.609	10
age of pedestrians	0.600	11
inadequate traffic control device	0.527	12
absence of footpath	0.518	13
inadequate visibility	0.509	14
size and weight of vehicles	0.391	15
campuses, and school areas	0.355	16

Source own calculated by using excel

The Spearman correlation coefficient was calculated using Equation 3.4 and tabulated as shown below in Table 4.15. From the correlation table 4.15, it can be concluded that there is a strong correlation between the attitudes of the respondents in all the three groups. This means that most of the respondents have almost same perception about the causes of pedestrian crashes at this place

Table 4.15: Summary of correlation test on the ranking of causes of variation orders

Respondent	$Rho(\rho_{cal}) = 1 - \frac{6x(\sum d_i^2)}{N x (N^2 - 1)}$	Relation of the Respondents
Pedestrian Vs. Driver	0.971	Strong
Pedestrian Vs. Traffic police	0.983	Strong
Driver Vs. Traffic police	0.986	Strong

Source Own calculated by using Excel

4.4.8. Overall Responses

As sown in Table: 4.16 below, it was possible to rank the causes pedestrian crashes combining the responses of all respondents. The most raked causes of pedestrian crashes by all respondents were over speeding (RI=0.800), Pedestrian illegal crossing (RI=0.779), absence of enforcement of traffic rule and regulation on pedestrian (RI=0.775), the absence of median and pedestrian refuge island (RI=0.732) alcohol-impaired driving (RI=0.681) was the highest ranked causes. Size and weight of vehicles (RI=0.391) and campus and school area (RI=0.33) were the least ranked causes of pedestrian crashes.

Table 4.16: Overall frequency of causes of pedestrian crash

Rank	Causes of pedestrian crashes	RI
1	Over speed	0.800
2	Pedestrian illegal crossing	0.779
3	Absence of enforcement of traffic rule and regulation on pedestrian	0.775
4	the absence of median and pedestrian refuge island	0.732
5	alcohol-impaired driving	0.681
6	age of pedestrians	0.594
7	the absence of footpath	0.582
8	alcohol-impaired pedestrians	0.567
9	improper Functioning headlights and defective tires	0.564
10	defective brake, steering system problem,	0.550
11	inadequate traffic control device	0.545
12	inadequate visibility	0.536
13	driver distraction	0.527
14	aggressive driving	0.476
15	size and weight of vehicles	0.391
16	campuses, and school areas	0.330

Source Own calculated by using Excel

4.5. Discussion of Findings

This section presents the discussion of the study findings from the questionnaires, the desk study, and the interview. The cause of pedestrian crashes, possible remedies of pedestrian crash, reduction measures and recommendations to minimize this crashes were discussed below.

4.5.1. Causes of pedestrian crashes at the study area

From the questionnaires, the desk study and interview, the common causes of pedestrian crashes identified were over speed, illegal pedestrian crossing, the absence of enforcement of traffic rule and regulation on pedestrian breaking the rule, alcohol-impaired driving and absence of proper median and refuge Island were the main causes of the cash at this place. Including the above listed causes a lots of causes of crash were listed in table 4.8 depending on Addis Ababa Kirkos sub-city police report. In addition to police report the causes of pedestrian crashes were ranked in descending order based on their RI value and the most frequent was identified as shown in the table 4.15 as per questionnaire.

As ranked on questionnaires response previously in table 4.15 and from secondary data in table 4.8 it is clear that the first most causes of pedestrian crash at the study area was over speed. One of the causes of this over speeding was the freeway roadway since the upstream traffic was grade separated interchange and strictly prohibited for pedestrian cross there was no traffic interruption. So the vehicle come up with high speed and there was a concrete median separating traffic flow the driver initiated to speed up and it became difficult to the driver to give priority for pedestrian crossing the road at this place.

Illegal pedestrian crossing and absence of penalty on the pedestrian crossing the road illegally was the second and third causes of pedestrian crash respectively according to questionnaire response, and this fact was supported by the interviewees and the observations on the site and during the desk study as shown in table 4.8. As per observation and ordinary interview have showed, the causes of illegal crossing were lack of awareness and pedestrian didn't internalize the rule and regulation of traffic and about their safety. The third cause was the absence of penalty on pedestrian crossing the road illegally. During the interview, there was the question "Is there any problems with implementing penalty on pedestrian breaking the traffic rule in the sub-city? Yes No if yes, what was the problems?" More than 75% of the respondent answer "yes" and the reason they rise was the management problem and lack of human resource to implement the law. But the respondent agreed on the effectiveness of pedestrian penalty. During interview one traffic police said that 72.15% pedestrian crash reduction was recorded since 2006 E.C AA police commission implement this law for one month and no fatality crashes have been recorded for consecutive 10 day. The fourth and fifth-ranked causes of a pedestrian crash were identified as the absence of proper median

and proper refugee island and alcohol-impaired driving respectively at this road segment which was confirmed with the literature review.

4.6. Interviews

These interviews were made face to face between researcher and pedestrian, drivers and police officers who have good willingness to respond the question. The focuses of interview was on their perceptions about causes of pedestrian crash and possible remedial measure to minimize pedestrian crashes.

Table 4.17 Interview result of pedestrian driver and traffic police

Question	Pedestrian response	Driver response	Traffic police officer response
From your experience what are th causes of pedestrian crash crossin the road at this place?	○ Vehicle speed ○ licensing problem ○ experience of driver ○ Unsafe driving behavior ○ Lack awareness of road safety ○ Alcohol impaired driving and chat chewing	○ Pedestrian illegal crossing ○ Alcohol impaired pedestrian ○ Standard of roads and design ○ Traffic control ○ devices ○ Vehicle speed ○ Built up commercial area	○ Over speed ○ Alcohol impaired driving ○ Over confidence driving ○ Pedestrian illegal crossing ○ Pedestrian disability ○ Licensing problem
Do you think available traffic rules and regulations can reduce Pedestrian crash? If No, what could be the solution?	○ Improving licensing rule and regulation ○ Improving traffic management system ○ Improving road design to make the road pedestrian friendly design.	○ More than 65 % of interviewee responds No ○ The solution they forward was providing pedestrian. Punishing legislation	○ But the police officers have different opinion. They have said the rule and regulation is adequate to safeguard pedestrian, but lack of implementation ○ About 25% of them agreed on provision of pedestrian punishment legislation.

Do you have any recommendations and suggestion how to reduction the pedestrian crash in this sub-city? If yes what is your recommendations?	○ separation of pedestrians and vehicles ○ provision of median and pedestrian refugee island ○ speed humps ○ Education and enforcement of law	○ speed humps ○ marked crosswalks ○ Education and enforcement of pedestrian ○ Awareness creation campaign through media and concerned body ○ Providing ped. crossing sign.	○ Push button pedestrian traffic signals ○ speed humps ○ Raised marked crosswalks ○ strict enforcement of traffic law on driver & pedestrian ○ Improving licensing law ○ Separating ped. and vehicle.

4.7. Finding from Interview

From the interview fifteen causes of pedestrian crash in answering the first question, seven remedial measure to answer second question and seven strategies regarding to traffic rule and regulation to minimize pedestrian crash in answering the third question were identified. These variables were merged and checked if they were out of the literatures. But more of them with the same meaning were in the domain of the variables identified from the literatures.

The findings from the interview revealed that over speed, pedestrian illegal crossing, lack awareness of road safety, licensing problem and built up commercial area were the cause pedestrian crashes of this place which was identified by this research.

The interviewee suggested that it is possible to minimize the occurrence pedestrian crash through reducing vehicle speed, providing awareness creation, separating pedestrian and vehicles completely, enforcing pedestrian not to cross illegally by punishment and etc. were the solution.

4.8. Remedial Measures to Minimize Pedestrian Crash

The fourth objective of this research was to suggest possible engineering remedial measures that could made pedestrians safe while they were crossing the road depending on the results finding. To know how to avoid a pedestrian crash both as a driver and a pedestrian, everybody needed to be aware of their responsibilities.

According to the findings from secondary data in table 4.8 and from questionnaire response the first ranked causes of pedestrian crash was over speed, the suggested recommendations by the interviewee were providing speed reduction measure at this place in any way. Slower speeds give

motorists more time to react and could lessen injuries even when crashes did occurred. Traffic calming techniques such as lane narrowing, providing pedestrian refuge islands, and speed humps was the recommended counter measures in reducing pedestrian crashes due to over speed.

Refuge islands located in the medians of 2-way streets allow pedestrians to cross in 2 stages, simplifying the crossing task. This is especially helpful for pedestrians who walk at slower speeds. Refuge islands decrease conflicts, and different literature shown that there were significantly lower pedestrian crash rates on multilane roads with raised medians than on those without such medians.

Curb extensions (extension of the sidewalk toward the roadway in the vicinity of the crosswalk, about the width of a parked vehicle) also can be used to reduce crossing distance. But this remedial measure will bring other types of pedestrian problem because it was the new solution in our country. So it need further investigation but in other developed country it was efficient pedestrian crash reduction measure on multilane road.

Using Traffic signal enhancements such as automatic pedestrian detectors traffic signals to create gaps for pedestrians to cross at this high-speed multi-lane will also increase pedestrian safety.

From the above analysis results of road user at-fault helps to recommend appropriate countermeasures to reduce the severity of pedestrian crashes. For example, since crashes where drivers at fault were found to result in an increased probability of severe pedestrian injuries, and fatality it is recommended to conduct safety awareness and education campaigns targeting drivers on the laws of pedestrian rights-of-way at road cross. Since younger pedestrians of age 18 to 30 were associated with a greater probability of fatality and severe injuries younger population should be one of the main target age groups in the education programs.

Stricter enforcement of speeding and driver compliance with pedestrian right-of-way laws could also improve pedestrian safety. These campaigns should be organized through the coordination of law enforcement officers, safety engineers, and the public to integrate the components of the four E’s: engineering, education, enforcement, and emergency response.

From the result of this research the second causes of pedestrian crash was pedestrian illegal crossing. This occurred while the pedestrian was not in the crosswalk. However, several of these crashes could have been prevented if the pedestrians were walking in the crosswalks. This behavior could be due to the lack of pedestrian education and enforcement. City wide education campaigns on the laws pertaining to pedestrians and the safety benefits of using pedestrian facilities such as

crosswalks and pedestrian refuge islands could improve pedestrian safety. Furthermore, extensive driver education campaigns that focus on driver compliance with pedestrian right-of-way laws and stricter enforcement could prevent the crashes that were due to driver error.

In general the following remedial meseares were recommended by this research to make this street safer for pedestrian:

- Slowing vehicle speed by providing rumple strip, speed hump curb extension and etc.
- Enforcing driver to drive by allowable speed only. In Ethiopia allowable speed in urban and sub-urban was 30Km/hr. but at this place the driver drive beyond this speed.
- Strictly controlling driver who are driving after drinking by using alcohol test apparatus.
- Separating pedestrian from vehicle (Underpass/overpass) for pedestrian especially pedestrian underpass is recommended at this place.
- Providing pedestrian crossing facility properly like raised cross walk at reasonable distance from interchange.
- Increase the level of caution of pedestrian and motorist by putting pedestrian sign.
- Installing security camera that record speed of vehicle and punish driver driving above 30km/hr.

All of this remedial measures were reduction measure except separating pedestrian from vehicle (under pass/ over pass) which is 100% eliminate the pedestrian crash. So the researcher recommends underpass as the first choice to made pedestrian safe. Separation countermeasures reduce the exposure of pedestrians to potential harm both on the roadside and when they are crossing streets. Because in many pedestrian crashes the driver report he/she didn’t see the pedestrian before the accident. So measures were needed to increase the visibility and conspicuity of pedestrians

CHAPTER FIVE

CONCLUSSION AND RECOMMENDATION

5.1. Conclusion

This research focused on the assessment of causes of the pedestrian crash, identifying the place of highest pedestrian crash and based on the result of data analysis to recommend possible remedies to minimize pedestrian crash.

Traffic-related pedestrian crash was a growing public health threat worldwide. Also pedestrian crash was a critical health, economic and social problem in the Ethiopia too. A large number of fatal, severe injury and slight injury pedestrian crashes was recorded in Addis Ababa Kirkos sub city. Hence, this pedestrian safety evaluations was undertaken to identify the most dangerous road section and this high crash place as focusing area of the research to recommend remedial measures. Using different scientific methodology and analysis technique, the study has reached to the following conclusions.

- Getu commercial center to Wello sefer roundabout was identified as high pedestrian crash place in the sub-city. This place was identified from secondary data obtained from AA police commission and Kirkos sub city's police stations for the last four years.
- The awareness of drivers and pedestrian about road traffic rule and regulation was limited and road users did not give attention to pedestrian safety.
- The drivers didn't give a priority for a pedestrian in any road section even when pedestrians were rightfully using road crossings such as zebra crosses.
- Sixteen pedestrian crash causing variables were identified as major contributors from desk study, secondary data and literatures.
- From those identified pedestrian crash causes, based on secondary data and questionnaire over speed was the first ranked causes of crash with 132 total crash and RI 0.8 at this place.
- By comparison, intersections were safer than road segment in this sub-city, which was contrary to the findings usually reported in different literature.
- Crashes where drivers were at fault were more likely to result in fatality and severe injuries compared to the crashes where pedestrian were at fault or both pedestrians and drivers were at fault.

- Young pedestrians of age 18 to 30 years were associated with high probability of fatality and severe injuries than all other pedestrian.

Finally, based on the result of this analysis it would be safe to conclude that over speed, illegal pedestrian crossing, the absence of median and pedestrian refuge island, alcohol impaired driving, and absence of penalty on the pedestrian crossing the road illegally was the most causes of the pedestrian crash at this place.

The recommendation of this study could be used by the respective stakeholders to promote pedestrian road safety. If it will implemented the results of this work could have tremendous impact on the safety of sub-city's society.

5.2. Recommendation

When drivers and pedestrians work together, it can be easy to reduce the incidence of pedestrian crashes. Local authority should also do their part by installing and maintaining pedestrian crossing facilities, enforcing pedestrian crossing the road illegally by different ways like punishing, enforcing decision makers to provide pedestrian punishment legislation and follow up its implementation, providing speed reduction humps and other.

Recommendation for driver

- Drivers are required to yield the right-of-way to pedestrians crossing streets in marked or unmarked crosswalks in any situations even for illegal road crossing pedestrian.
- Driver should drive carefully near streetcar stops car and pass them at reasonable speeds, and always be ready in case of pedestrians make sudden or unexpected movements to cross because the area was business area.
- Furthermore, extensive driver education campaigns that focus on driver compliance with pedestrian right-of-way laws and stricter enforcement could prevent the crashes that were due to driver error.

Recommendation for Pedestrian

Also pedestrians must do their part to avoid vehicle- pedestrian crashes and prevent accidents.

- Pedestrian must be cross only at marked crosswalks and at reasonable vehicle gap.

- Pedestrian must avoid crossing at the blocked visibility or between parked cars. If a parked vehicle is blocking the view of the street, pedestrian must stop at the edge line of the parked vehicle and look at it before entering the street.
- Pedestrian must be sure that drivers see him/her before cross the road. If the driver is stopped, make eye contact before you step into the road.
- Pedestrian should made their culture keeping the traffic rule such as crossing only at allowed cross walk and when the vehicle gap is safe to cross.

All of this recommendation to pedestrian will come up with good result if all concerning body do their part through awareness creation on all road users.

5.2.1. Recommendation for Miscellaneous Bodies

The sub city's police commission should strictly follow the driver and pedestrian breaking the rule and punish them allocating financial and human resources to address the problem and evaluate the impact of these actions.

The designer of road also must give special attention to pedestrian safety. Since this place is commercial area pedestrian volume was relatively high so public safety is a special concern at this place including the possibility of unexpected pedestrian movement. Addis Ababa police commission must re-implement the pedestrian punishment rule on pedestrian crossing the road illegally.

City wide education campaigns on the laws pertaining to pedestrians and the safety benefits of using pedestrian facilities such as crosswalks, and pedestrian refuge islands could improve pedestrian safety. Since younger pedestrians of age 18 to 30 were associated with a greater probability of severe injuries younger population could be one of the main target age groups in the education programs.

5.2.2. Recommendations for Future Research

This research identified some risk factors that were responsible for crashes of pedestrians Addis Ababa kirkos sub city. However, some factors may be yet unidentified due to a shortage of pedestrian related crash data. Such additional research should be conducted because the recommended additional research will enhance our understanding of the risk factors of crashes with pedestrians in Addis Ababa as well as other city of the countries. Thus, a crash data quality study should also be given priority in Addis Ababa police offices, to investigate the underreporting of

crashes, the misclassification of crash severity and the lack of details about crash locations and other detail information. Data storing mechanism was very traditional and must be computerized, most of the data was recorded by hard copy which was very difficult for researchers.

REFERENCES

- Ariotti P., H. B. B. Cybis, and J. L. D. Ribeiro (2006). Influencing Factors in Pedestrian Behavior at Signalized Crossings. Brazilian National Association for Transportation Research and Education Congress ANPET. Vol. 1. p. 174–185.
- Baltes, M. R., and X. Chu (2016). Pedestrian Level of Service for Midblock Street Crossings. Journal of the Transportation Research Board Washington D.C. No. (258)p. 64.
- Brüde, U., & Larsson, J. (2000). Models for predicting accidents at junctions where pedestrians and cyclists are involved. How well do they fit? Accident Analysis and Prevention, 25(5), p. 499-509.
- Damsere-Derry, J., (2010). Pedestrians' injury patterns in Ghana. Accident Analysis & Prevention, 42(4), pp.1080-1088.
- Daniel Molla (2017) Addis Ababa Road Safety Strategy
- Dawit, O. (2016). Road Traffic Accidents and Safety Evaluation Case of Addis Ababa Bole Sub City. Thesis submitted to AAU; pp. 34-82.
- Gårder, P. E (2004). The Impact of Speed and Other Variables on Pedestrian Safety in Maine. Accident Analysis and Prevention. Vol. 36, No. 4. Pp 35
- Getu S. (2015) Investigation of pedestrian crashes on two-way two-lane rural roads in Ethiopia. Accident Analysis and Prevention; No (78): pp. 118.
- Getu S. Washington, Simon, King, Mark J. & Haque, Md (2013) Why are pedestrian crashes so different in developing countries? Transport and the New World City, 2-4 October 2013, QUT Gardens Point, Brisbane, Australia. pp 1-5
- Getu, S. Tullu. Simon Washington, Mark J. King (2013). Characteristics of police-reported road traffic crash in Ethiopia over a six-year period. Australasian Road Safety Research, Policing & Education Conference pp, 35
- Givens Givens Sparks, PLLC,(2013) The Main Causes of Pedestrian Accidents Florida
- Jen L.(2014) Cities safer by design (Guidance and Examples to Promote Traffic Safety through Urban and Street Design. Version (1):p p. 55
- Knoblauch, R. L., M. Nitzburg, and R. F (2001). Seifert. Pedestrian Crosswalk Case Studies: Sacramento, California, Richmond, Virginia, Buffalo, New York, Stillwater and Minnesota. Department of Transportation. Pp.85
- Mara C and Luis A (2010). Evaluation of Pedestrian Safety at Midblock Crossings in Porto

Alegre Brazil. Journal of Transportation Research Board of the National Academies. Washington D.C. No. (2193): pp. 37.

- Max A. Bushell, Bryan W. Poole, Charles V. Zegeer, Daniel A. Rodriguez (2013) UNC Highway Safety Research Center pp.13
- Miranda-Moreno, L. F., Morency, P., & El-Geneidy, A. M. (2011). The link between built environment, pedestrian activity and pedestrian-vehicle collision occurrence at signalized intersections. Accident Analysis and Prevention, 43(5), 1624-1634
- Naci, H., Chisholm. D & Baker, T. D (2009). Distribution of Road Traffic Deaths by Road User Group Injury Prevention p 55-59
- National Center for Safe Routes to School: www.saferoutesinfo.org.
- P. Vedagiri and B. Raghuram, K (2016). Evaluation of Pedestrian–Vehicle Conflict Severity at Unprotected Midblock Crosswalks in India. Journal of the Transportation Research Board, Washington D.C.; No. (258): p. 48
- Priyanka A. (2013) Comprehensive Study to Reduce Pedestrian Crashes in Florida pp 38
- Risser. R, and R. Methorst (2007). Road User Behavior with a Special Focus on Vulnerable Road Users. Technical, Social and Psychological Aspects. p.53
- Sisiopiku, V. P and D. Akin (2003). Pedestrian Behaviors at and Perceptions toward Various Pedestrian Facilities. Transportation Research Part F, Vol. 6, No. 4, p. 249–274.
- Tiwari G., S. (2007) Bangdiwala, A. Saraswat, and S. Gaurav. Pedestrian Risk Exposure at Signalized Intersections. Transportation Research Part F. Vol. 10, No. 2 p. 77–89
- Transportation Policy Committee (2015) Connecting Kentuckiana Regional Planning and Development. Pp 16
- United Nations (2011) United Nations Decade of Action for Road Safety 2011-2020
- World Health Organization WHO (2013). A road safety manual for decision-makers and practitioners
- Richard A. Retting, MS, Susan A. A Review of Evidence-Based Traffic Engineering Measures Designed to Reduce Pedestrian–Motor Vehicle Crashes American Journal of Public Health | September 2003, Vol 93.

AP PE N D I C E S

Appendix A: Questionnaire

Detail of the Researcher

Name: Teshome Asfaw

Course: Master of Science in Civil Engineering (Highway engineering stream)

Mobile: +251-913 929227

E-mail: teshomeasfaw1@gmail.com

Advisor

Prof. Emer T. Quezon (Ph.D.)

This research study titled "safety Evaluation of road crossing pedestrian in Kirkos sub-city is undertaken by Teshome Asfaw at the Jimma University JiT to assess the causes of pedestrian crash crossing the road. Please answer all questions.

For Traffic police Officer

SECTION ONE Personal details Put **X** in the box below

1. *Age in years*

18 – 30 ☐ *30 – 40* ☐ *40 – 50* ☐ *50 above* ☐

2. Sex: *Male.* ☐ *Female* ☐

3. Residence: Kirkos sub-city ☐ Outside Kirkos sub city ☐

4. Working experience in years below five ☐ 5-10 ☐ 10-15 ☐ 15-20 ☐ above 20 ☐

Please indicate your level of agreement with the following questions on a scale 1 to 5.

Never = 1; rarely = 2; Sometimes = 3, Often = 4; and Always = 5

The following are list of causes of pedestrian crash. Based on your experience, indicate how frequently each of this causes are occurred at this place. Please put X in the respective box.

No	Causes of pedestrian crashes	**1**	**2**	**3**	**4**	**5**	Remark
1	Over speeding						
2	alcohol-impaired driving						
3	alcohol-impaired pedestrians						
4	driver distraction						
5	Pedestrian illegal crossing						
6	age of pedestrians						
7	aggressive driving						
8	size and weight of vehicles						
9	defective brake, steering system problem, improper						
10	Functioning headlights and defective tires						
11	the absence of footpath						
12	inadequate visibility						
13	the absence of median						
14	campuses, and school areas						
15	inadequate traffic control device						
16	Absence of traffic rule and regulation						
	If any other causes of pedestrian crashes, please specify						
17							
18							
19							
20							

THANK YOU

Detail of the Researcher

Name: Teshome Asfaw
Course: Master of Science in Civil Engineering (Highway engineering stream)
Mobile: +251-913 929227
E-mail: teshomeasfaw1@gmail.com

Advisor

Prof. Emer T. Quezon (Ph.D.)

This research study titled "Evaluation of road crossing pedestrian safety in Kirkos sub-city is undertaken by Teshome Asfaw at the Jimma University JiT to assess the causes of pedestrian crash crossing the road. Please answer all questions.

For Pedestrian

SECTION ONE Personal details Put **X** in the box below

1. Age in years

Below 18 ☐ *18 – 30* ☐ *30 – 40* ☐ *40 – 50* ☐ *50 above* ☐

2. Sex: *Male.* ☐ *Female* ☐

3. Occupation: *labor* ☐ *Civil servant* ☐ *Businessman/woman* ☐

*Others (specify)*_____

4. Residence: Kirkos sub city ☐ Outside Kirkos sub city ☐

Please indicate your level of agreement with the following questions on a scale 1 to 5.

Never = 1; rarely = 2; Sometimes = 3, Often = 4; and Always = 5

The following are list of causes of pedestrian crash. Based on your experience, indicate how frequently each of this causes are occurred at this place. Please put X in the respective box.

No	Causes of pedestrian crashes	**1**		**2**		**3**	**5**	Remark
1	Over speeding							
2	alcohol-impaired driving							
3	alcohol-impaired pedestrians							
4	driver distraction							
5	Pedestrian illegal crossing							
6	age of pedestrians							
7	aggressive driving							
8	size and weight of vehicles							
9	defective brake, steering system problem, improper							
10	Functioning headlights and defective tires							
11	the absence of footpath							
12	inadequate visibility							
13	the absence of median							
14	campuses, and school areas							
15	inadequate traffic control device							
16	Absence of traffic rule and regulation							
	If any other causes of pedestrian crashes, please Specify							
17								
18								
19								

THANK YOU

Detail of the Researcher

Name: Teshome Asfaw
Course: Master of Science in Civil Engineering (Highway engineering stream)
Mobile: +251-913 929227
E-mail: teshomeasfaw1@gmail.com

Advisor
Prof. Emer T. Quezon (Ph.D.)

This research study titled "Evaluation of road crossing pedestrian safety in Kirkos sub-city is undertaken by Teshome Asfaw at the Jimma University JiT to assess the causes of pedestrian crash crossing the road. Please answer all questions.

For Driver

SECTION ONE Personal details Put **X** in the box below

1. *Age in years*

Below 18 ☐ *18 – 30* ☐ *30 – 40* ☐ *40 – 50* ☐ *50 above* ☐

2. Sex: *Male.* ☐ *Female* ☐

3. Occupation: *civil servant* ☐ *Businessman/woman* ☐

Others (specify) _____

Driving experience (Years) <1 ☐ 2-5 ☐ 5-10 ☐ >10 ☐

Please indicate your level of agreement with the following questions on a scale 1 to 5.

Never = 1; rarely = 2; Sometimes = 3, Often = 4; and Always = 5

The following are list of causes of pedestrian crash. Based on your experience, indicate how frequently each of this causes are occurred at this place. Please put X in the respective box.

No	Causes of pedestrian crashes	**1**	**2**	**3**	**4**	**5**	Remark
1	Over speeding						
2	alcohol-impaired driving						
3	alcohol-impaired pedestrians						
4	driver distraction						
5	Pedestrian illegal crossing						
6	age of pedestrians						
7	aggressive driving						
8	size and weight of vehicles						
9	defective brake, steering system problem, improper						
10	Functioning headlights and defective tires						
11	the absence of footpath						
12	inadequate visibility						
13	the absence of median						
14	campuses, and school areas						
15	inadequate traffic control device						
16	Absence of traffic rule and regulation						
	If any other causes of pedestrian crashes, please Specify						
17							
18							
19							
20							

APPENDIX B: police officers' responses for causes of pedestrian crashes

No	Causes of pedestrian crashes	**1**	**2**	**3**	**4**	**5**	Remark
1	Over speeding	1	2	6	4	9	
2	alcohol-impaired driving	2	2	3	5	10	
3	alcohol impaired pedestrians	4	5	4	4	5	
4	driver distraction	3	3	7	8	1	
5	Pedestrian illegal crossing	2	3	1	7	9	
6	age of pedestrians	5	3	5	5	4	
7	aggressive driving	2	3	4	6	7	
8	size and weight of vehicles	10	5	5	2	0	
9	defective brake, steering system problem, improper	4	2	4	4	6	
10	Functioning headlights and defective tires	5	4	3	3	7	
11	the absence of footpath	7	5	3	4	3	
12	inadequate visibility	7	5	4	3	3	
13	the absence of median	1	5	6	5	7	
14	campuses, and school areas	10	9	2	0	1	
15	inadequate traffic control device	5	5	7	3	2	
16	Absence of traffic rule and regulation	0	2	3	8	9	

APPERNDIX C: Pedestrians' responses for causes of pedestrian crashes

No	Causes of pedestrian crashes	**1**	**2**	**3**	**4**	**5**	Remark
1	Over speed	1	2	1	2	3	
2	Alcohol-impaired driving	1	1	2	3	2	
3	Alcohol impaired pedestrians	3	2	3	0	1	
4	Driver distraction	1	0	2	4	2	
5	Pedestrian illegal crossing	1	2	1	3	2	
6	Age of pedestrians	1	0	5	0	3	
7	Aggressive driving	4	1	3	1	0	
8	Size and weight of vehicles	5	2	1	1	0	
9	Defective brake, steering system problem,	3	3	1	0	2	
10	Improper Functioning of headlights and defective tires	4	2	0	2	1	
11	Absence of footpath	0	0	2	1	6	
12	Inadequate visibility	2	1	2	2	2	
13	Absence of median	0	1	2	3	3	
14	Campuses, and school areas	3	4	2	0	0	
15	Inadequate traffic control device	2	3	1	2	1	
16	Absence of traffic rule and regulation	1	1	1	3	3	

APPERNDIX D: drivers' responses for causes of pedestrian crashes

No	Causes of pedestrian crashes	**1**	**2**	**3**	**4**	**5**
1	Over speeding	3	2	4	3	1
2	alcohol-impaired driving	2	3	4	2	2
3	alcohol-impaired pedestrians	2	2	4	2	3
4	driver distraction	3	2	3	3	2
5	Pedestrian illegal crossing	0	1	2	4	6
6	age of pedestrians	2	2	2	4	3
7	aggressive driving	1	3	4	4	1
8	size and weight of vehicles	4	5	3	2	0
9	defective brake, steering system problem,	1	4	4	1	3
10	improper Functioning headlights and defective tires	3	4	3	0	3
11	absence of footpath	1	4	3	3	2
12	inadequate visibility	0	3	4	3	3
13	absence of median	3	3	3	2	2
14	campuses, and school areas	5	4	3	1	0
15	inadequate traffic control device	4	4	3	2	0
16	Lack of enforcement pedestrian traffic rule and regulation	3	3	4	2	1

Interview Question for Pedestrian.

Question	Pedestrian response	Driver response	Traffic police officer response
From your experience what are the causes of pedestrian crash crossing the road at this place?			
Do you have any recommendations and suggestion about reduction the pedestrian crash in sub-city? If yes what are your recommendations?			
Do you think available traffic rules and regulations can reduce Pedestrian crash? If No, what could be the solution?			