

**DRIVERS' COMPLIANCE WITH ZEBRA CROSSING LAWS IN RWANDA:
Kigali as a case study**

A THESIS

Submitted by

MUKAMANA Rachel (REG NO: PG20135053)

Under the Guidance of

Dr. Nick MARLER

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TECHNOLOGY

SCHOOL OF ENGINEERING

(Nyarugenge Campus)

COLLEGE OF SCIENCE AND TECHNOLOGY

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**DEPARTMENT OF CIVIL ENGINEERING AND ENVIRONMENTAL
TECHNOLOGY
SCHOOL OF ENGINEERING
(Nyarugenge Campus)
COLLEGE OF SCIENCE AND TECHNOLOGY
P.O. Box: 3900 Kigali, Rwanda.**

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A handwritten signature in blue ink, appearing to read 'Nick Marler', with a horizontal line underneath.

SUPERVISOR
Dr.Nick Marler

.....
Head of Dept. of CE & ET
Dr.G.Senthil KUMARAN

*Submitted for the final defense of thesis held at College of Science and Technology on
December 16, 2014.*

DECLARATION

I hereby declare that the thesis entitled “ **Drivers’ compliance with zebra crossing laws in Rwanda: Kigali as a case study** ” submitted for the degree of master of science is my original work and the thesis has not formed the basis for the award of any degree, diploma, associateship, fellowship of similar other titles. It has not been submitted to any other university or institution for the award of any degree or diploma.

Place: Kigali/RWANDA

Signature of the Scholar

Date: March, 2015

Name: MUKAMANA Rachel



**DEPARTMENT OF CIVIL ENGINEERING AND ENVIRONMENTAL
TECHNOLOGY
SCHOOL OF ENGINEERING
(Nyarugenge Campus)
COLLEGE OF SCIENCES AND TECHNOLOGY
P.O. Box: 3900 Kigali, Rwanda.**

BONAFIDE CERTIFICATE

Certified that this thesis titled **“drivers’ compliance with zebra crossing laws in rwanda: Kigali as a case study”** is the bonafide work of MUKAMANA Rachel (REG. No: PG20135053) who carried out the research under my supervision. Certified further that to the best of my knowledge the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion for this or any other candidate.

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A handwritten signature in blue ink, appearing to read 'Nick Marler', written over a horizontal line.

Name of the Supervisor:

Dr. Nick Marler

Academic Designation:

Doctor

ABSTRACT

Existing data related to zebra crossing show that pedestrian safety at zebra crossing sites is strongly influenced by the degree of drivers' knowledge on zebra crossing laws and their compliance with the laws. This research is concerned with the degree to which drivers know the laws and the degree to which they follow them. The interview research was conducted in Nyabugogo and Remera, two main tax parks in Kigali, involving 120 drivers to respond the administered questions. The observation research was conducted at three zebra crossing sites UTC, COGEBANQUE and Nyabugogo market exit; and 263 drivers were observed for their behaviors on zebra crossing sites. The observation was done in one direction and at peak time. Data related to pedestrians accidents on zebra crossings sites in Kigali were also collected from Rwanda National police. The research includes a literature review which includes books, research papers and other previous researches which lead to better understanding of the theories and principles of the compliance on pedestrians crossing. The research findings showed that since 2013, there were 40 accidents at 27 zebra crossing sites where pedestrians were involved while crossing. The findings of this research showed that the level of drivers knowledge on zebra crossing laws is still low (69.5%) and the knowledge of zebra crossing law is 39% in young drivers. Drivers compliance with zebra crossing law is also low (64.7 %), and young drivers are less compliant with the law. The drivers should be trained on existing zebra crossings laws in order to improve their knowledge and compliance with regards to zebra crossing law; and emphasis should be made on young drivers.

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TABLE OF CONTENTS

C E R T I F I C A T E.....	ii
DECLARATION	iii
BONAFIDE CERTIFICATE	iv
ABSTRACT.....	v
ACKNOWLEDGEMENT.....	vi
CHAPTER ONE: INTRODUCTION.....	1
1.1 Background	1
1.2 Problem Statement	1
1.3. Objectives of the study.....	2
1.3.1: General objective.....	2
1.3.2: Specific objectives.....	2
1.4: Research questions.....	3
1.5. Research hypothesizes	3
1.6. Scope of the Study	3
1.7 Thesis outline	4
CHAPTER TWO: LITERATURE REVIEW.....	5
2.1 Introduction.....	5
2.2 Definitions of concepts	5
2.3 Road marking and signs	7
2.3.1 Factors affecting pedestrians while crossing.....	9
2.3.2 Signs location	9
2.4 Pedestrian Crossing Facilities in various countries.....	10
2.4.1 Crossing types	11
2.4.2 Location of pedestrian crossing facilities	13

2.4.3 Zebra crossings	15
2.5 Road safety	16
2.5.1 Road safety data and data collection	16
2.5.2 Road safety inspections	18
2.5.3 Traffic Education Measures	18
2.6 Rwandan laws concerning zebra crossings	19
2.6.1 Rwanda regulations to drivers at zebra crossing	20
2.6.2 Rwanda regulation to pedestrians at zebra crossing.....	20
2.6.3 Driving License in Rwanda	21
2.6.4 Speed limit in agglomeration (city) in Rwanda.....	22
2.7 Compliance with pedestrian crossings outside Rwanda	22
2.7.1 Pedestrian non-compliance at designated crossings.....	23
2.8 Reasons for non-compliance with crossings regulations	25
2.8.1 Three different levels of non-compliance.....	25
2.8.2 Noncompliance depend on pedestrian behavior.....	25
2.9 Drivers Behavior	26
CHAPTER THREE: METHODOLOGY	27
3.1. Problems of pedestrian related to zebra crossing.....	27
3.1.1. Study Area	27
3.1.2. Methodology.....	27
3.2. Level of driver compliance with zebra crossing laws in Kigali.....	28
3.2.1 Study area	28
3.2. 2 Sampling and survey method	34
3.2.3 Progress of survey	36
3.3 Survey interview on driver knowledge of the rules of zebra crossing.....	36

3.3.1 Study area	36
3.3.2. Sampling and survey methods.....	38
3.4 Data analysis	40
CHAPTER FOUR: PRESENTATION OF RESULTS.....	41
4.1 Introduction	41
4.2. Pedestrians accidents at Zebra crossings sites in Kigali	41
4.3 Observed Drivers behavior at Zebra crossing sites.....	42
4.3.1 Drivers behaviors at zebra crossing.....	43
4.3.2 Driver behavior at different locations.....	44
4.3.3. Driver car type and behavior at zebra crossing	45
4.3.4 Driver behavior and number of pedestrian at zebra crossing	46
4.4 . Drivers knowledge on zebra crossing law	46
4.4.1 Description of respondents	47
4.4.2. Driving experience of respondents	48
4. 4.3 Knowledge of drivers on zebra crossing law in Rwanda	49
4. 4.4. Drivers self reported behavior based on interview.....	51
4. 4.5 Response on self-reported driver behavior with ages categories	53
4. 4.6 Responses of drivers on knowledge of law and their self reported behavior on zebra crossing	54
4. 4.7 Response on driving experience and their self reported driver behavior	55
CHAPTER FIVE: ANALYSIS.....	57
5.1 Pedestrian accident in Rwanda (Kigali) at zebra crossing Sites	57
5.2 Drivers' Knowledge on Rwanda Zebra crossing regulations	57
5.3 Observed driver behaviors at zebra crossing sites	59
CHAPTER SIX: DISCUSSION	60

6.1. Number of accident affecting pedestrian at zebra crossing.....	60
6.2. Knowledge on zebra crossing law	61
6.3. Behavior of drivers at zebra crossing.....	62
CHAPTER SEVEN: CONCLUSIONS AND RECOMMENDATIONS	64
7.1. Conclusions	64
7.2. Recommendations	65
REFERENCES.....	67
IX.APPENDICES	71

LIST OF TABLES

Table 1: Relationship of the approach speed to the required visibility	8
Table 2: Crossing Types	11
Table 3: Acceptable Levels of Service for Pedestrians Crossing	14
Table 4: Road users killed in various modes of transport as a proportion (%) of global road traffic deaths, 2010	17
Table 5 Drivers categories according to their responses inspirations.....	47
Table 6 Cross tabulation of driver knowledge on the law and behavior when there is one or more pedestrians started to cross the zebra crossing	54
Table 7 Comparison between Self reported and Observed drivers' Behavior	56
Table 8 Summarized p values and correlation coefficient of survey interview.....	58
Table 9 Summarized correlation coefficients and p values of observed driver behavior at selected zebra crossing sites	59

LIST OF FIGURES

Figure 1: Zebra crossing	20
Figure 3 Surroundings detail of UTC	29
Figure 2 Map Location of UTC	29
Figure 4 Map Location of COGEBANQUE.....	30
Figure 5 Surroundings detail of COGEBANQUE.....	30
Figure 6 Map location of Nyabugogo.....	31
Figure 7 Surroundings details of Nyabugogo	31
Figure 8 UTC zebra crossing site	32
Figure 9 COGEBANQUE zebra crossing site.....	33
Figure 10 Nyabugogo zebra crossing site.....	33
Figure 11 Nyabugogo car park	37
Figure 12 Remera car park.....	38
Figure 13 Number of accidents involved pedestrians at zebra crossing sites in Kigali.....	41
Figure 14 Number of accidents at zebra crossing sites in Kigali per month	42
Figure 15 Drivers behaviors at selected zebra crossing sites	43
Figure 16 Driver behavior at different locations	44
Figure 17 Drivers car types and driver behavior at all 3 zebra crossing sites	45
Figure 18 Driver behavior with number of pedestrian using zebra crossing.....	46
Figure 19 Ages of respondents by category.....	47
Figure 20 Driving experience of respondents since passing test	48
Figure 21: Driver knowledge on zebra crossing law when there is one or more pedestrians started to cross	49
Figure 22 Drivers knowledge on zebra crossing law when there is no one on it but more pedestrians are at the kerb waiting to cross	50
Figure 23 Response on self reported driver behavior on zebra crossing when there is one or more pedestrian on it.....	51
Figure 24: Response on self reported driver behavior at zebra crossing when there is no one on it but more pedestrians are the kerb waiting to cross.....	52
Figure 25 Response on self reported driver behavior with age categories on zebra crossing when there is one or more pedestrian on it	53
Figure 26 Driving experience and self-reported behavior on zebra crossing sites.....	55

LIST OF SYMBOLS AND ABBREVIATIONS

GoR:	Government of Rwanda
HGV:	Heavy good vehicles
HIC:	High-income countries
HR:	Hour
ISBN:	International Standard Book Number
Km/h:	Kilometers per Hour
KN:	Kigali Nyarugenge
LIC:	Low-income countries
LOS:	Level of service
MIC:	Middle-income countries
MN:	Minute
RNP:	Rwanda National Police
RRFB:	Rectangular rapid flash beacon signs
RSS:	Road Safety Strategy
RTDA:	Rwanda Transport Development Agency
Rwf:	Rwanda Franc
SADC:	Southern African Development Community
SECS:	Seconds
SPSS:	Statistical Product and Service Solutions
TMR:	Transport and Main Roads
U.S:	United States

UK : United Kingdom

UTC: Union Trade Centre

CHAPTER ONE: INTRODUCTION

1.1 Background

Walking is a mode which is widely used in Kigali and is recognized to be a sustainable and desirable form of transport [1]. Therefore, it is of key importance that zebra crossings sites were provided and laws were established for road users in order to facilitate the safety of pedestrians while crossing [2].

The law requires drivers in Rwanda to pay special attention when approaching a pedestrian crossing and they are asked to give right of way to pedestrians, and they are asked to slow down in order to give way if necessary [3].

Moreover, many drivers do not stop or slow down for pedestrians in zebra crossing, even when they are legally required to do so [4]. In Rwanda, less is known about drivers' knowledge of zebra crossing law and their behavior at zebra crossing sites, especially in Kigali; which is increasing in number of vehicles and numbers of pedestrian crossing roads. The comprehensive assessment is needed to collect data which is lacking. research was carried out for assessing the number of accidents on zebra crossing where pedestrians were involved, drivers' knowledge of zebra crossing law and their compliance with the law at zebra crossing sites in Kigali. Findings and recommendations of this research offer an opportunity to enhance road safety in Rwanda.

1.2 Problem Statement

The population growth has put pressure on the need to travel, which result on congestion because everyone need to access day to day services, especially in cities of underdevelopment countries [5]. For instance, Kigali population is increasing at an annual rate of between 2.5 and 3.1% [6], thus the increase number of pedestrian working in Kigali city. The most serious problems in city transportation network of these countries of Africa are inadequate facilities and the lack of space for pedestrians and motorcycles which result in road safety problems [7]. The average of 150 persons per month is reported to be involved in accidents, many of which are fatal [6]. The world health organization (WHO) reported that pedestrian fatalities in African country cities account for more than 38% of total road traffic deaths and 59% of them

occurs at zebra crossings [8]. The increase of number of accident at zebra crossing site is mainly due to the illegal behavior of both drivers and pedestrians [9].

For the good safety of pedestrians in Rwanda the government has installed in all road network different zebra crossings to be used by pedestrians, it has also put in place law and regulations regarding the use of zebra crossing sites. They were established to separate pedestrians from motorized traffic, and to slow vehicle speeds to levels low enough to allow pedestrians to cross the roads; thus reduce fatal or serious injuries. However, serious safety problems at zebra crossing sites in Kigali are reported.

Analysis the problem of accident on zebra crossing and assessment of driver behaviour regarding the compliance of zebra crossing laws, under this research, is of great intervention in road safety of Kigali through specific recommendations addressed to decision makers and future research area.

1.3. Objectives of the study

The objectives of the study are divided into general objective and specific objectives.

1.3.1: General objective

The general objective is to analyze the level of driver compliance with zebra crossing laws in Rwanda .

1.3.2: Specific objectives

The specific objectives are:

- 1.To set out the pedestrian accident problem in Rwanda (Kigali) relating to crossing roads.
- 2.To determine drivers' knowledge of zebra crossing law and his behaviors at zebra crossing in Rwanda.
- 3.To test the usefulness of survey tools used in data generation on driver knowledge of their legal obligations on approaching zebra crossings, and of their actual behavior.

1.4: Research questions

In order to meet the above objectives set by this study, the following research questions were answered:

1. Are there problems of pedestrian related to zebra crossing?
2. Are drivers aware and know about the law of zebra crossing in Rwanda?
3. Is the knowledge of drivers applied on the zebra crossing?
4. Is the survey tool able to generate necessary information required to determine knowledge and the compliance of drivers on zebra crossing?

1.5. Research hypothesizes

1. At least a case of accident affecting a pedestrian at zebra crossing exist in Kigali city;
2. The driver awareness of zebra crossing law is low in Kigali city and his/her knowledge is not applied on zebra crossing; and
3. The survey tool is able generate necessary information required to determine knowledge and the compliance of drivers on zebra crossing.

1.6. Scope of the Study

To achieve the objectives of the research, a scoping study was undertaken at the beginning of the study. The scope of this research is limited to an evaluation of driver behavior on zebra crossings zones in Kigali city where three different sites were visited.

The study included the effect of pedestrians' behavior on zebra crossing, driver behavior at the zebra crossing area was observed during peak hours.

Visual assessment were done before choosing the sites, the chosen sites were done according to where information could be obtained. These include the proximity to:

- Roundabout because crossings near a roundabout are marked, the large number of pedestrians prefers to cross there and the speed of motor vehicles entering in or getting out of roundabout is relatively low.
- Have the potential for a large flow of traffic
- Where preferably of pedestrians cross the road

The survey was done in one direction; it concerned the driver who has to stop for pedestrians.

Beyond the scope of this research the discussion were added, resulting in conclusions against each of the objectives and then recommendations for action and for further research work.

1.7 Thesis outline

This thesis report contain seven chapters.

The first chapter introduces the study through a background and a description of the problem. It also summarizes the main objectives.

Chapter two discusses on other studies of compliance with pedestrian crossings outside Rwanda, a review of pedestrian crossing facilities in various countries and the review on road markings (and signs) in general and their purposes, then closes on any research of international standards for pedestrians crossings and particularly Rwanda's standards for markings and signs.

The third chapter describes the study area and methodology used to meet the objectives.

The fourth chapter present the results based on existing data and data from surveys.

The fifth chapter presents the analysis and interpretation of the results presented in chapter four .

The six discuss and compares the results with the findings from the literature review.

The last chapter presents conclusions and recommendations.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter presents the results of the literature review about the concept of zebra crossings. It starts with an overview of the zebra crossing laws in Rwanda then focuses on pedestrians' facilities in others countries. The chapter also discusses about the level of drivers' compliance on pedestrians facilities laws in developing countries. It ends with a concluding section relating the findings from literature review to the situation in Rwanda.

The literature involves reviewing all readily available materials and mainly included: books, journals, regulations, government policies conventions on zebra crossing, governments and other organizations reports, scientific research papers and other previous researches which lead to better understanding of the theories and principles of the compliance on pedestrians crossing facilities.

Acquisition and analysis of available data from Rwanda National police , it would be sufficient to indicate whether there is a particular pedestrian accident problem in Kigali (or Rwanda) and what the problems' characteristics are, depend on the nature (and reliability) of the accident data. Data show that zebra crossings are the location of a particularly high number of accidents/accidents involving pedestrians were searched.

Data from RTDA (Rwanda Transport Development Agency) and also data from direct measurements were consulted. Among the data collected were safety data, behaviors of drivers in study area, vehicle type, number of pedestrians per observation when were necessary.

This research was guided by using mainly literature review on similar research or related documents were consulted during this research.

2.2 Definitions of concepts

Driver means a one that drives, as the operator of a motor vehicle [10]

Zebra crossing is a type of pedestrian crossing used in many places around the world. Its distinguishing feature is alternating dark and light stripes on the road surface, from which it derives its name [2].

A zebra crossing typically gives extra rights of way to pedestrians

Each stripe shall be not less than 2.5 meters and not more than 10 meters in length, and not less than 0.40 meters and not more than 0.60 meter in width [8].

Zebra crossing has advantages and disadvantages. The installation and maintenance is relatively low, and less delays to motorists than signalized crossings. On the other hand, pedestrians often assume all motorists can/or will stop and give way, and this can cause accidents when poorly respected by motorists, especially where pedestrian volumes are low. Zebra crossing requires frequent maintenance to ensure good visibility [5].

Compliance: In general, compliance means conforming to a rule, such as a specification, policy, standard or law.

Regulatory compliance describes the goal that organizations aspire to achieve in their efforts to ensure that they are aware of and take steps to comply with relevant laws and regulations [11]

Pedestrian crossings they are a critical element among the many factors that influence the overall walkability of an environment [9].

Walkability: it is a measure of the level of integration of pedestrian facilities (such as sidewalks, trails and crossings) into the urban environment. It considers the ease in which pedestrians can move through the transportation network enjoyably and safely.

A walkable environment serves to encourage a healthier lifestyle by promoting walking or the use of non-motorized means of transportation [12].

A **pedestrian** : it is any person who is travelling by walking for at least part of his or her journey [11]. In addition to the ordinary form of walking, a pedestrian may be using various modifications and aids to walking such as wheelchairs, motorized scooters, walkers, canes, skateboards, and roller blades. The person may carry items of varying quantities, held in hands, strapped on the back, placed on the head, balanced on shoulders, or pushed/pulled along. A person is also considered a pedestrian when running, jogging, hiking, or when sitting or lying down in the roadway [13].

2.3 Road marking and signs

Pavement markings are an important means of traffic control on streets and roads. In some cases, the pavement markings are used to supplement general traffic regulations, or regulations and warnings given by signs and signals. In other cases, markings can be used without supplement by other devices [13].

The principal advantage of road markings is that they convey guidance or information to the driver without diverting attention from the roadway. In bad weather conditions, this may be of vital importance to road safety [9]. Pavement markings should therefore be given special attention with respect to both application and maintenance [13].

Uniformity in design and application of the markings are important factors. Each marking shall convey the same meaning independent of where it is applied. A solid centre line shall, for example, always mean that no driver is allowed to cross the line in order to overtake [6]` .

A paved road without any markings is difficult for drivers to use in a proper way, especially in darkness and when there is a wide carriageway. As far as road safety is concerned, it is therefore important to apply pavement markings as soon as possible after a new asphalt overlay is done. For the same reason, it is important to maintain the function of the markings by keeping them clean from sand and dirt, and to renew worn markings [13].

The longitudinal markings and the road alignment should always be in harmony with each other. The intention of the road designer must not be cancelled by bad markings. On the other hand, a less good design can be corrected by means of good pavement markings [12].

On dual carriageway roads warning and regulatory signs should be installed in pairs, one on the left-hand and another on the median. The table below relates the approach speed to the required visibility.

Table 1: Relationship of the approach speed to the required visibility

Approach speed(km/h)	Visibility distance to the sign (m)
≤ 60	60
80	80
≥ 100	100-150

Island traffic control devices manual [13]

In Rwanda (driving in the right) the requirement is to place signs on the right side of the road. The warning (danger) signs must be place 150 m to 200 m from the dangerous area. An additional panel should be used to indicate the distance to the dangerous location if it is not practical to place the sign at 150 to 200 m from it [4].

Signs and markings can provide important information to improve road safety by regulating, warn and guiding road users which let people know what to expect and when chances are greater that they will react and behave appropriately [14].

Signs and markings need to be applied in a consistent way, to be placed at logical locations, and be easy to understand and visible[15]. This also means that underlying traffic regulations such as local speed limits need to be established on clear and consistent principles[16].

The visibility of signs and markings needs to be checked regularly to avoid them being hidden by overgrown trees or blurred by sunlight. The use of retro-reflective material is needed to ensure night-time visibility.

Road side signs must be used sparsely. Road users are only able to process a limited amount of information at a time. Too many signs at a particular spot may confuse and distract road users rather than help them. For instance, in UK too many signs may also result in non-compliance and disrespect [15].

2.3.1 Factors affecting pedestrians while crossing

Higher traffic volumes on roadways produce fewer gaps for pedestrians and make it more challenging for pedestrians to make good choices about when to cross. This can lead to pedestrians making riskier choices on when to complete their crossing [17].

In London the transport and main roads (TMR) workbook allocates points to a range of criteria which affect the ease of a pedestrian crossing a road [18]. This includes:

- The delay or Level of Service (LOS) experienced by a pedestrian waiting for a safe gap in a traffic stream
- Pedestrian volumes
- Crash history
- Local traffic conditions and
- Pedestrian connectivity.

2.3.2 Signs location

Signs should be located in a manner that will make them readily visible and easily identifiable from a distance. They should normally be placed on the left-hand side of the carriageway. Direction signs might, however, be placed above the carriageway or on the right hand side. When the visibility is limited because of the road alignment, side obstacles, etc., signs may have to be duplicated on both sides of the carriageway [15].

On divided highways, signs often need to be placed on both sides of the carriageway in order to be visible also to drivers overtaking, or when the traffic situation is such that both lanes are occupied [13].

It is recommended that the lateral clearance to a sign should be at least 1.25 meters. The maximum distance between the edge of the carriageway and the nearest edge of the road sign should never exceed 4.0 meters, or else it may be difficult for the drivers to observe the sign. When a sign is erected on a road with footpaths, the sign should preferably be located at the farthest edge of the footpath [15]. This is for a number of reasons; the most important being that the signpost then would not constitute a danger to pedestrians with impaired vision. The

vertical clearance in such cases should also be adequate to avoid conflict with or injury to pedestrians; minimum clearance should normally be about 2.1metres [13].

Zebra crossing preferably must be located at a two-lane roads with short crossing distances; low traffic speeds; low traffic volumes; consistent pedestrian usage throughout the day; street lighting; and at a two –lane with good visibility of the crossing. It should be also located at left turn slip lanes and roundabouts with high pedestrian usage [18]. Inappropriate location for zebra crossing are on busy multi-lane roads; high-speed roads (>60 km/h); where sight distance is restricted; where there is no street lighting; and where there is inconsistent pedestrian usage [15].

2.4 Pedestrian Crossing Facilities in various countries

Pedestrian crossings allow people to cross the road safely [13]. These crossings are usually marked by white stripes on the road and are also known as zebra crossings but some pedestrian crossings have zigzag lines marked on the road before the crossing [16]. Take extra care when you see a zigzag line on the road as this means you are approaching a crossing which you may not be able to see because of a curve, crest or dip in the road [19]

Pedestrian crossings should be marked at intersections where there is substantial conflict between vehicle and pedestrian movements. Marked crosswalks should also be provided at other appropriate points of pedestrian concentration or where pedestrians would not otherwise recognize the proper place to cross [13].

Pedestrians in a crosswalk have the right-of-way over most vehicles, whether the crosswalk is marked or not [16]. Crosswalks are intended to encourage people to cross only at certain locations.

Some people will cross when and where they want to, regardless of traffic signals, marked crossings, or even their own safety. . For instance, in state of Oklahoma as the person controlling a potentially dangerous machine, it's your job to “play it safe” where pedestrians are concerned and protect them when you see they may be in danger [20].

2.4.1 Crossing types

United Kingdom there exist different types of crossing [21] and they are defined as follow:

Pelican crossings: traffic lights for pedestrians and vehicles; button-operated.

Puffin crossings: pedestrian lights on near side of road; button-operated with curb-side detector.

Toucan crossing: can be defined as the type of crossing designated for pedestrians and cyclists, continuing the bird-name theme, where a waiting pedestrian can stop vehicular traffic by pressing a button and waiting for the pedestrian signal of a red and green man to change to green. Here the green man can be accompanied by a green bicycle.

Table 2: Crossing Types

Name	User	Construction	Advantages	Disadvantages
Zebra crossings	Pedestrians	Simple, white markings and Belisha poles	• Allows pedestrians to cross once vehicles have come to a stop, therefore potentially more responsive and quicker for pedestrians on low trafficked roads. • Relatively low cost of installation and maintenance	• Only allows use by pedestrians • Unsuitable for faster roads • Reliant upon drivers seeing waiting pedestrians and stopping • Can cause traffic congestion when usage is high.
Pelican crossings	Pedestrians	Uses push-button signaling demand for pedestrians,	• Allows pedestrians to force a break in the traffic by pushing a button • Can be part of a	• Can delay traffic in critical areas • Pedestrian aspects are on far side of crossing which may be difficult to see by

		road users are controlled by red amber green lights	linked traffic light system.	partially sighted pedestrians • More expensive to install and maintain signaling than Zebras • The time taken for signals to change in favour of waiting pedestrians may be too long
Puffin Crossing	Pedestrians	Uses push-button and pedestrian detectors for pedestrians, road users are controlled by red amber green lights.	• Is responsive to pedestrians, minimizing red to traffic and cancelling pedestrian demands when they move away or cross early • Can be part of a linked traffic light system • Pedestrian aspects on near side of crossing, which are easier for pedestrians to see.	• Can delay traffic in critical areas • More expensive to install and maintain than zebras • The time taken for signals to change in favour of waiting pedestrians may be too long
Toucan Crossings	Pedestrians and Cyclists	• Same as Puffin but with Signing provision for cyclists on a	• As with Puffin crossings, however cyclists are also permitted to use them on a shared space with	• Same as Puffin Crossings • Large amount of space required for crossing and approaches • Potential for conflict between cyclist and

		shared space with pedestrians.	pedestrians	pedestrian • Lack of flashing phases increases traffic delay
Parallel crossings	Pedestrians and Cyclists	• Segregates cyclist and pedestrians, have parallel but separate signalized crossing provision	• Separates conflicting cyclist and pedestrian movements • Allows for cyclists to cross whilst mounted	• Can cause traffic delays • More space required for separate crossings and approaches • Relatively high expense of installing and maintaining signaling and layout infrastructure

Shared zebra crossing study, London [22]

2.4.2 Location of pedestrian crossing facilities

Crossings are provided as amenities to give access and easier movement to pedestrians [23]. Generally the provision of crossings should be targeted at the needs of those people who experience most difficulty and danger [3]. It should not be assumed that the provision of a crossing alone will necessarily lead to a reduction in road accidents [12].

Pedestrian crossing facilities should be located where:

- Motorists can see a pedestrian move from the footpath or median to the road in sufficient time to stop and where pedestrians can see a vehicle far enough away to safely cross the road before the vehicle arrives [23].

It has been well documented that most pedestrian collisions occur when pedestrians are crossing a road, and most research finds that risk is much higher away from crossing facilities compared with on a crossing [24]. National statistics of UK show that approximately 40% of pedestrian collisions in 2003 in London occurred whilst the pedestrian was crossing the road away from a pedestrian crossing [25] Only 9% of pedestrian collisions occur on a pedestrian crossing and nearly 8% occur within 50m of a crossing [25].

Pedestrian Crossing 'Width' and Length

Under the traffic regulations, the width of a pedestrian crossing is determined by the length of the parallel bars, which have to be at least 2 meters long [25] .

The length of a crossing is the distance between opposite kerbs of the roadway. There are no requirements in the traffic regulations governing the length of a pedestrian crossing [23]. Technical recommendation 11 (TR11) recommends that crossings be no longer than 10 meters where there is no central refuge island [26]. Where refuge islands are used, each side of the crossing should be no longer than 5 meters. The High kerbs can be used to influence cycle and pedestrian route, more space on and around the zebra should reduce conflict with pedestrians [25]. It may be good practice to provide refuges which are large enough to accommodate cyclists

Table 3: Acceptable Levels of Service for Pedestrians Crossing

Average pedestrians delay(sec)	Level of service	Definition	Description	Appropriate Situation
< 5	A	Excellent	Pedestrians able to cross almost immediately on arrival	Local streets Collector Roads
5-10	B	Very good	Most pedestrians able to cross with little delay 95 th percentile delay ± 40 secs	
10-15	C	Satisfactory	Most able to cross with acceptable period 95 th percentile delay ± 60 secs	Minor Arterial Major Arterial
15-20	D	Some concern	Some pedestrians must wait longer than desirable for an acceptable gap 95 th percentile delay ± 80 secs	
20-40	E	Major concern	Most pedestrians must wait longer than desirable for an acceptable gap 95 th percentile delay ± 80 secs	Inappropriate All situations
>40	F	Unsatisfactory	Almost all pedestrians must wait longer than desirable for an acceptable gap 95 th percentile delay ± 80 secs	

Assessment of pedestrian crossings, London [18]

2.4.3 Zebra crossings

Zebra crossings rely on the motorist seeing the pedestrian on the crossing and then slowing down or stopping to allow the pedestrian to cross the road. Traffic regulations require the motorist to give way to pedestrians on the crossing. If a children's guard controlled crossing is in place at the zebra crossing, traffic must wait until all pedestrians have cleared the crossing before continuing [16].

In Vermont, the state of USA, zebra markings are only useful if they are visible at a distance far enough to allow the driver to take safer action and some agencies use zebra marking visibility, among the criteria for deciding the zebra crossing location [26]. Zebra markings visibility depends on roadway geometric design, marking material reflectorization property, weather, and road maintenance level and practice [27].

2.4.3.1 Zebra crossing regulations

Every pedestrian, if he is on the carriageway within the limits of a zebra crossing, which is not for the time being controlled by a constable in uniform or traffic warden, before any part of a vehicle has entered those limits, shall have precedence within those limits over that vehicle and the driver of the vehicle shall accord such precedence to any such pedestrian [22].

No pedestrian shall remain on the carriageway within the limits of "zebra" crossing longer than is necessary for the purpose of passing over the crossing with reasonable dispatch. The driver of a vehicle shall not park, stop his vehicle, or overtake another vehicle within a "zebra" controlled area [2].

2.4.3.2 Some guidelines for the use of the zebra crossings

The pedestrian has the right of way to cross the roadway. A maximum speed of 25 Km/h when approaching the pedestrian priority zebra crossing [27]. Although pedestrians have right of way on pedestrian priority zebra crossings still they should exercise care and caution when using them [28].

2.5 Road safety

2.5.1 Road safety data and data collection

Road safety data are essential for the development of well-founded road safety strategies.

What exactly is the problem? What are the causes? The more we know about road safety developments and about the underlying causes of those developments, the better we will be able to design and implement the appropriate solutions. Efficiency analyses for assuring that the limited resources are used optimally also require sufficient data. This means that we need reliable data in a number of areas: crash statistics, exposure data, safety performance indicators and data from in-depth crash analysis. Whether the data are reliable largely depends on the data collection method that would need to ensure that the data are correct and representative. Furthermore, good documentation of the data collection method is important as is the accessibility of the data [20].

A driver cannot overtake another vehicle at a pedestrian or school crossing. That driver may be stopped or stopping for a pedestrian you cannot see [29].

Table 4: Road users killed in various modes of transport as a proportion (%) of global road traffic deaths, 2010

According to world health organization [7], number of road users killed in various modes of transport is higher in Africa compared to other continents, where there is a high percentage of African pedestrians killed than in other continents of the world [8].

World Health Organization Region	Road users (%)					
		Car occupants	Motorized 2–3 wheelers	Cyclists	Pedestrians	Other/ unspecified
African	LIC	35	11	7	38	9
	MIC	51	4	4	37	4
	ALL	43	7	5	38	7
Americas	MIC	31	16	3	27	23
	HIC	70	13	2	12	3
	ALL	42	15	3	23	17
Eastern Mediterranean	MIC	36	14	3	28	19
	HIC	63	3	2	27	5
	ALL	37	14	3	28	18
European	LIC	32	0	2	26	40
	MIC	52	7	3	32	6
	HIC	49	19	7	19	6
	ALL	50	12	4	27	7
South-East Asia	LIC	25	19	6	34	16
	MIC	15	34	4	11	36
	ALL	15	33	4	12	36
Western Pacific	LIC	12	66	4	12	6
	MIC	22	38	8	24	8
	HIC	33	18	10	33	6
	ALL	23	36	8	25	8
World	LIC	31	15	6	36	12
	MIC	27	25	4	22	22
	HIC	56	16	5	18	5
	ALL	31	23	5	22	19

World health organization [8]

LIC (low-income countries) = US \$1005 or less; MIC (middle-income countries) = US \$1006 to 12 275; and HIC (high-income countries) = US \$12 276 or more

In many countries, crashes involving pedestrians are poorly reported in official road traffic injury statistics. The actual number of pedestrian fatalities and injuries is probably higher than what the official statistics show. Global data on injured pedestrians are not readily available. For this reason, this section presents only data on pedestrian fatalities. It should be noted that the data on pedestrian fatalities represent only a part of the problem. Pedestrian collisions also result in non-fatal injuries, some slight and some serious, and some requiring long-term care and rehabilitation [8].

2.5.2 Road safety inspections

Safety inspection designates a periodic review, by trained experts, of the safety aspect of a road network in operation. It involves visiting the road network. Routine safety inspections are regularly carried out of the road network to identify physical defects in the road infrastructure. As a result, improvements of the road environment can be planned and implemented, using low cost measures whenever possible [15].

2.5.3 Traffic Education Measures

The first main way to influence road user behavior, which is considered in this report, is via road safety education. Education is regarded as a “soft” approach to promoting desirable (from a road safety perspective) road use because, rather than placing external constraints on the individual (as is the case with enforcement and engineering interventions), it relies on persuading people to adopt appropriate behavior [4]. In terms of promoting desirable pedestrian behavior, road safety education interventions can take a number of forms [24]. Information and persuasive messages to promote safe road use can be given via: General publicity campaigns, for example by using televisions, radio, newspapers, magazine adverts, posters, leaflets, formal classroom-based training and formal road-based training; such interventions attempt to raise people's awareness of road safety [30].

In particular, they attempt to promote desirable (“safe”) behavior by: increasing road safety knowledge (e.g. knowledge of the rules and practices described in the Highway Code, and knowledge of what behavior is considered to be safe and unsafe), make road users aware of how unsafe their behavior may be, promoting desirable attitudes (e.g. positive attitudes towards safe road use), providing / teaching people strategies to minimize the risk of being involved in a road traffic collision, and increasing the awareness of the needs of other road users [24].

Engineering treatments may be entirely effective in addressing problems at some pedestrian crossings. In some locations, though, a balance of engineering, education, and enforcement efforts will be the most effective in improving pedestrian safety [31].

2.6 Rwandan laws concerning zebra crossings

Every day, innocent lives of Rwandans suffer major or minor injuries due to accidents which occur in different parts of the country [3]. Despite efforts to curb accidents on Rwandan roads, they continue to claim lives through negligence and sheer lack of observing traffic regulation. Most road accidents are caused by the non-respect of basic traffic regulations by drivers which include; bad maneuvering of motorcyclists, careless driving, over speeding, and violation of road signage [23].

Accidents can be avoided if traffic rules are respected by road users-pedestrians, passengers, car drivers and motorcyclists [1].

It is easy to prevent road accidents if drivers follow the prevailing traffic rules and regulations, Pedestrians are also urged to be vigilant, respect traffic regulations including zebra crossing, and assess the road before crossing [23].

Rwanda transport policy tends to provide modern transport infrastructure and cost effective and quality services, responding to safety and environmental impact, in order to support the economic growth of the country, mobility of people and goods at national and regional level [1]

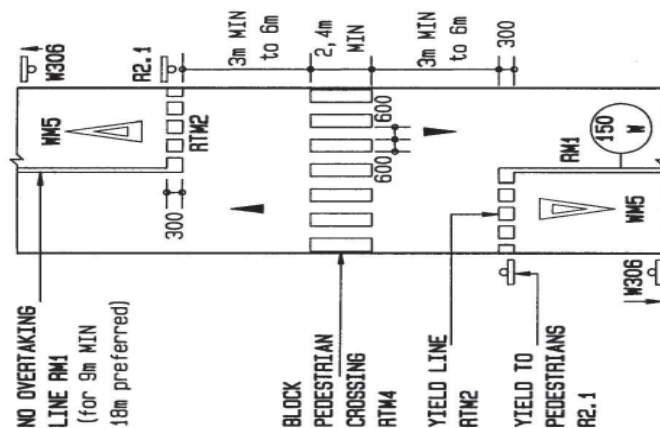
2.6.1 Rwanda regulations to drivers at zebra crossing

When a pedestrian has moved to a passage for pedestrian, at a place where the traffic is not regulated by a qualified agent or by traffic lights, drivers can only come close to this place at moderate speed and cross it only when they can do so without danger for the pedestrian and if need be they must stop to let the pedestrian pass [2].

2.6.2 Rwanda regulation to pedestrians at zebra crossing

Pedestrians must not engage themselves on the roadway in order to cross it before they ensure themselves they can do so without danger for themselves and without hindering the vehicles, and they must use ways set-up at their intention when these exist at less than 50 meters [32]. Persons who push children prams, sick or invalid persons' wheelchairs are submitted, to the pedestrians' rules, the same prevailing for invalid persons who circulate in a vehicle stirred by themselves on the condition of not circulating at a speed superior to that of a pedestrian moving at pace speed [2]. Pedestrians are crossing the roadway or portion of roadway in accordance with the prescribed indications of a traffic signal when such is provided [32].

Block pedestrian crossing markings shall comprise a number of rectangular white painted markings of minimum length 2, 4 m and minimum width 600 mm, spaced 600 mm apart which shall extend across the full width of the roadway or portion of roadway. A length of marking of 3 m is preferred, and this dimension may be further increased if large volumes of pedestrians are present [33].



Source: Road markings SADC , Angola [33].

Figure 1: Zebra crossing

Two parallel continuous lines normally 0.20 meters wide (not less than 0.15 meters and not greater than 0.20 meters wide), drawn across the roadway, and in between, white stripes 0.60 meters wide and 0.60 meters apart as shown in the figure above.

All traffic shall stop at the stop lines as described if there is a pedestrian crossing the road on the pedestrian crossing. No vehicles shall park in such a way that any part of the vehicle is within the lines or within 10 meters on the approach to the crossing [33].

Pedestrian crossings should be marked at intersections where there is substantial conflict between vehicle and pedestrian movements. Marked crosswalks should also be provided at other appropriate points of pedestrian concentration or where pedestrians would not otherwise recognize the proper place to cross.

The protection for the pedestrians that a pedestrian crossing is supposed to provide depends heavily on the drivers' behavior towards pedestrians entering the crossing. Unfortunately, many drivers do not respect the rules to stop when a pedestrian has entered the crossing [32]. Therefore, pedestrian crossings should not be used indiscriminately [28]. An engineering study should be conducted before any installation of pedestrian crossings [33].

2.6.3 Driving License in Rwanda

In Rwanda, nobody can drive an automotive vehicle on the public highway, if he/she is not holding and carrying a National Driving License issued by the National police [32].

The driving license is issued for unlimited validity after the following tests have been satisfactorily passed and a medical certificate issued by a registered doctor [2].

Theory test establishing that the interested person has sufficient knowledge of traffic rules and practical test on the category for which the license is requested. The minimum age for driver is depended on the category (ies) of the vehicle for which it is valid. 15 years for motorcycles when the vehicle does not carry any other person than the driver, and 17 years in other cases.

18 years for drivers of cars of categories A and B and 20 years for drivers of cars in categories C, D, E and F. So, as explained by Rwanda presidential decree N° 85/01 of 02/09/2002, the meanings of these categories are the following:

A. Motorcycles and motor tricycles with or without side-car;

B. Automobile vehicles built for the transport of persons and having in addition to the driver's seat, a maximum eight seats; automobile vehicles affected to the transport of goods and having a 5.000 kgs authorized maximum weight, and motorquadracycles. To vehicles of this category may be coupled a light trailer with one axle.

C. Automobile vehicles affected to the transport of things and having an authorized maximum weight exceeding 5.000kgs to vehicles of this category can be coupled a light trailer.

D. Automobile vehicles built for the transport of persons and having in addition to the driver's seat, more than eight seats.

E. Line of vehicles the hauler of which is included in one of the categories B, C, D for which the driver is habilitated and trailer of which has more than 750 kgs authorized maximum weight.

F. Special machines.

2.6.4 Speed limit in agglomeration (city) in Rwanda

An agglomeration refers to a dense urban area.

“In an agglomeration, maximum speeds of vehicles are established as following:

Motor vehicles serving only for transport of persons with the exception of vehicles of public transport, as well as motor vehicles of a capacity of transport not exceeding one tonne: 60-km/h.

All other vehicles: 40- km/h. The Prefects can prescribe lower speed limits in agglomerations and public ways [32].

2.7 Compliance with pedestrian crossings outside Rwanda

In Oklahoma state, the Driver Compliance Bureau of was created to work with drivers who will not or do not know how to drive in a safe manner [20]. The program is designed to provide self-improvement and safer driving techniques to traffic violators and people involved in collisions.

The City of Boulder (in U.S state of Colorado) has evaluated crosswalk enhancements at uncontrolled crossing locations over the years and has determined that there is a clear relationship between driver compliance

(yielding) and the pedestrian and/or bicycle crossing volume. Data collected at Boulder crosswalks where rectangular rapid flash beacon signs (RRFB) or State Law-Yield signs were installed shows that driver compliance typically increases with higher crossing volumes [34]. It is theorized that the primary reason for this relationship is that drivers tend to ignore enhanced crossing treatments over time at locations where they infrequently see pedestrians crossing [28].

In US State of Nevada drivers must exercise proper caution upon observing a pedestrian on or near a highway, street or road, within or near a school zone or within a marked or unmarked crosswalk. Pedestrians have the right-of-way when crossing at an intersection. Drivers are obligated to yield to pedestrians who are attempting to cross the road [35].

It is illegal for motorists to overtake any vehicle that is slowing down or stopped until the motorist slows down enough to determine why the other vehicle has slowed or stopped.

Drivers are advised to be particularly aware and careful of pedestrians at intersections. And to watch for pedestrians at stop signs, traffic signals and around transit stops.

A crosswalk exists anywhere two streets intersect, even at a “T” intersection. A crosswalk exists even if it is not painted or marked.

When a traffic signal turns green, drivers must yield to persons who are still crossing the street. Pedestrians have the right of way over motorists making a right-hand turn.

If there is a sidewalk, pedestrians should use it. If there is no sidewalk, pedestrians should walk on the side of the road facing the traffic.

Vehicles yielding to a pedestrian should wait until the pedestrian has crossed into the lanes going in the other direction before proceeding.

If a crossing guard is present, motorists must wait until the guard is completely out of the crosswalk before proceeding [35].

2.7.1 Pedestrian non-compliance at designated crossings

Several studies have found that many pedestrian collisions occur due to negligent Behavior by pedestrians (whether intentional or not) [24, 23, 14]. Pedestrians tend to cross the road when it suits them, in terms of convenience and saving time rather than thinking of potential safety

implications [36]. Research conducted in UK in noted that pedestrians are more likely to ignore traffic signs and signals (such as the red man at signalized crossings) than are those in continental Europe [37]. One possible reason for this is that there is no legal requirement in the UK to obey pedestrian signals, whereas in many other European countries (e.g. Germany, Sweden, Netherlands and Belgium). The finding that compared with other European countries, pedestrians in the UK are more likely to ignore signals might also explain, in part, why the UK has a relatively poor safety record (in terms of pedestrian collisions) compared with some other European countries.

The acts of non-compliance that have been found in the literature reviewed relate predominantly to pedestrians who cross against a red man, but also include crossing outside of pedestrian markings (studs) and jumping over pedestrian guard rail. Crossing against a red man at a pelican crossing is seen as far easier to do by pedestrians than, for example, crossing on a dual carriageway or a residential road, despite it being associated with social disapproval [37].

The research suggests that there is a link between crossing behaviors which are seen as easy to perform and having low perceived of risk. The pedestrians should be made more aware of the difficulties and risks associated with crossing the road in potentially dangerous situations which would increase pedestrian safety.

American research shows that, despite jaywalking laws, pedestrians are unlikely to wait for a green light before crossing [38]. The adolescents often fail to obey the traffic signals and/or fail to check that the road is clear. Knowledge of how to use crossings and encouragement to obey the signals is given as part of road safety education and by many parents. However, children may well copy ‘rule-breaking’ adults. Signal control strategies need to be readily understood by children [39]. .

In addition to failing to comply with the signals, pedestrians often cross outside the studs at signal controlled crossings [40]. This is potentially unsafe as it is known that when pedestrians cross the road near to a crossing (within 50 meters), but not actually on the crossing, collision

risk is increased by a factor of four [41]. Drivers anticipate the need to stop for pedestrians at crossings, but not necessarily elsewhere. Except in very low flow conditions, it is probable that pedestrians will only cross diagonally at a signalized junction rather than consecutive arms if there is an all-red phase for traffic. Pedestrians who are cautious or who take a long time to cross the road may be less likely to adopt this crossing behavior than those who are not.

There is some evidence to suggest that installing guard rail at pedestrian crossings does not encourage all pedestrians to cross at the crossing. Pedestrians may get trapped outside guard railings and are forced to climb the railing to reach the footway [42]. A study conducted at Southampton University concluded that there were safety benefits in installing guard rail at pedestrian crossings and junctions, however it also concluded that installing guard rail on links encouraged more risky behavior such as jumping over the railing amongst those pedestrians determined to cross [43].

2.8 Reasons for non-compliance with crossings regulations

2.8.1 Three different levels of non-compliance

The non-compliance is divided into three levels: the degree to which the target group knows of and comprehends the rules; the degree to which the target group is willing to comply either because of economic incentives, positive attitudes arising from a sense of good citizenship, acceptance of policy goals, or pressure from enforcement activities and The degree to which the target group is able to comply with the rules [44].

2.8.2 Noncompliance depend on pedestrian behavior

The US State of Oklahoma gives the following example of the effects of non-compliance. “A teenager steps into the crosswalk (or worse, into the roadway) on a four-lane city street. The driver in the lane nearest her sees her and stops. But the drivers in the next lane don’t see her and don’t know why the first driver stopped. They go ahead at full speed. A pickup driver, several vehicles back in that second lane, reaches the girl’s path just as she steps into view and into danger. If you are the driver in the stopped car, do everything you can to help protect that

girl, such as warning the drivers behind you with a “stop” hand signal or with several taps on your brakes, flashing your brake lights. If you see the car in the lane next to you stop suddenly for no apparent reason, slow down and look out. That driver may be stopped for a pedestrian” [20].

2.9 Drivers Behavior

Large commercial vehicles cannot maneuver like a car or other smaller vehicles. Large commercial vehicles have much larger blind spots than smaller vehicles. Large commercial vehicles take more time and space to slow down or stop. Most crashes between large commercial trucks and other smaller cars are caused by the car drivers [35].

CHAPTER THREE: METHODOLOGY

To achieve the objectives of the research, this chapter outlines the methodology used in order to measure the level of driver compliance with zebra crossing regulations in Kigali.

During research, three surveys were conducted during the research. The first survey was conducted to determine number of pedestrian accidents at zebra crossing. The second survey was conducted in car parks on knowledge of drivers on the rules of zebra crossing, and third survey of driver behavior at specific zebra crossings in Kigali was conducted to determine their compliance with zebra crossing laws.

3.1. Problems of pedestrian related to zebra crossing

Existing data that shows that zebra crossings are the location of a particularly high number of accidents/accidents involving pedestrians were searched. The research intended to answer the question” Are there problems of pedestrian related to zebra crossing? ”.Acquisition and analysis of available and recorded data from government institutions.

3.1.1. Study Area

This survey was conducted at Rwanda national police (RNP) in the department of Traffic which is located at Muhima, in section of accident the informal interview was conducted to ask existing records of roads related accident.

3.1.2. Methodology

The research consisted in reviewing of available accident records data on zebra crossing locations in Kigali City and screen them for time, locations and frequencies. Pedestrian accident cases in zebra crossing were recorded in excel for SPSS analysis (Statistical Product and Service Solutions).

3.2. Level of driver compliance with zebra crossing laws in Kigali

A field visit survey was organized and conducted in pedestrian zebra crossing sites. The purpose of this survey was to measure the behaviors of drivers when approaching zebra crossings. The research intended to answer the question “Is the knowledge of drivers applied on the zebra crossing?”

3.2.1 Study area

The survey was conducted on three signalized zebra crossings sites, where drivers were observed near UTC in the direction from UTC to Main Kigali roundabout, then drivers were observed at crossing which is in front of COGEBANQUE the direction toward Nyabugogo and chez Venant and finally drivers were observed at crossing of the Nyabugogo market exit in the direction toward Kigali centre to Nyabugogo cars park. These sites are located near roundabout and have high potential for large flow of traffic and many pedestrian especially those crossing the road. Each zebra crossings site visited had two-lane cross-sections.

3.2.1.1 UTC zebra crossing

The first zebra crossings site is located near the main Kigali round about, observed vehicles are those from KN 4 Ave to KN 3 Rd. The crossing is used primarily by pedestrians walking to cross from Amy's fast food zone to supermarkets or cultural center zone, around the crossing, there is a green space (See Figure 2 and 3).

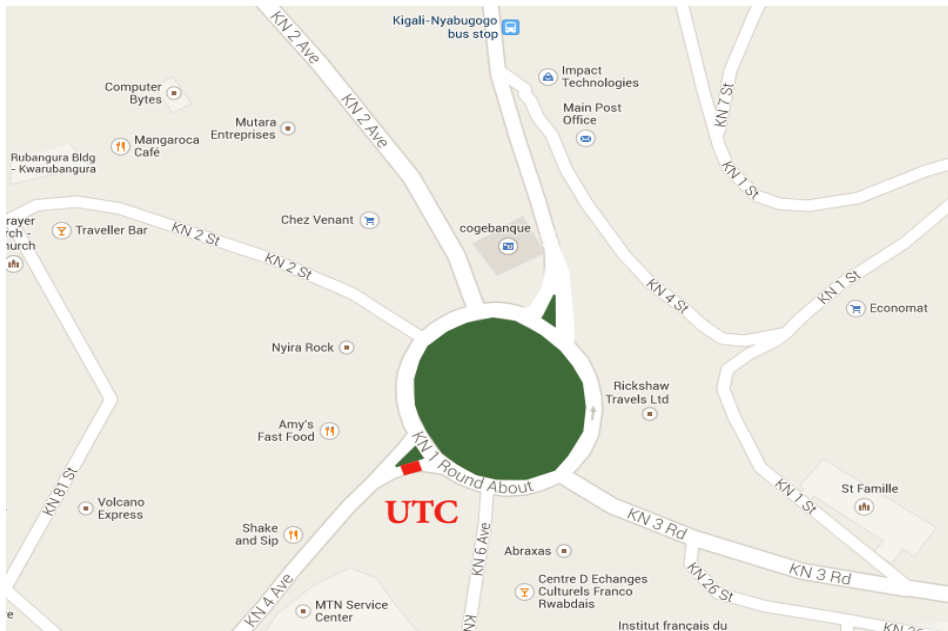


Figure 2 Map Location of UTC



Figure 3 Surroundings detail of UTC

3.2.1.2 COGEBANQUE zebra crossing

It is located near Cogebanque, observed vehicles are those from Nyabugogo bus stop to KN 2 Ave, The crossing is used primarily by pedestrians walking to cross from the zone of shops, bank, business, commercial to church zone or the post office zone. Around the crossing, there is a green space, different services such as shops, bank, business, commercial (See Figure 4 and 5).



Figure 4 Map Location of COGEBANQUE



Figure 5 Surroundings detail of COGEBANQUE

3.2.1.3 Nyabugogo zebra crossing

Nyabugogo zebra crossings is located in front of the exit of Nyabugogo market, the opposite of the crossing there is Muhima primary and Muhima sector observed vehicles are those from Traffic office to Nyabugogo car park, The crossing is used primarily by pedestrians walking to cross from Nyabugogo market to the commercial, residential and business zone (See Figure 6and 7).



Figure 6 Map location of Nyabugogo

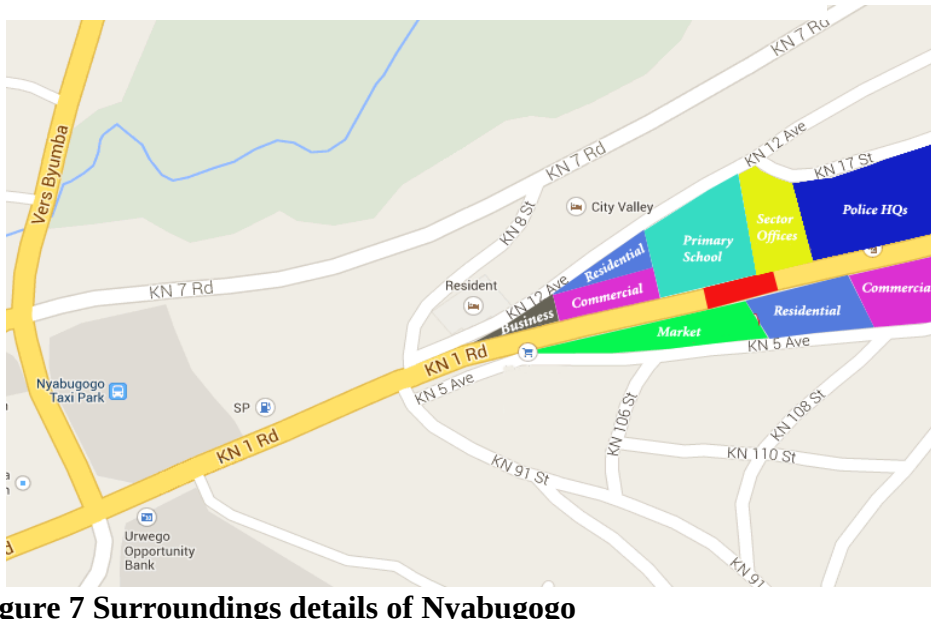


Figure 7 Surroundings details of Nyabugogo

3.2.1.4. Zebra crossing sites width, length

Apart from location and surrounding details at zebra crossing sites used during this research, the width, the length where driver have to accelerate and decelerate have been addressed. Figure 8, 9 and 10 show the zebra crossings width, the length where driver have to accelerate and decelerate at UTC, COGEBANK and Nyabugogo.

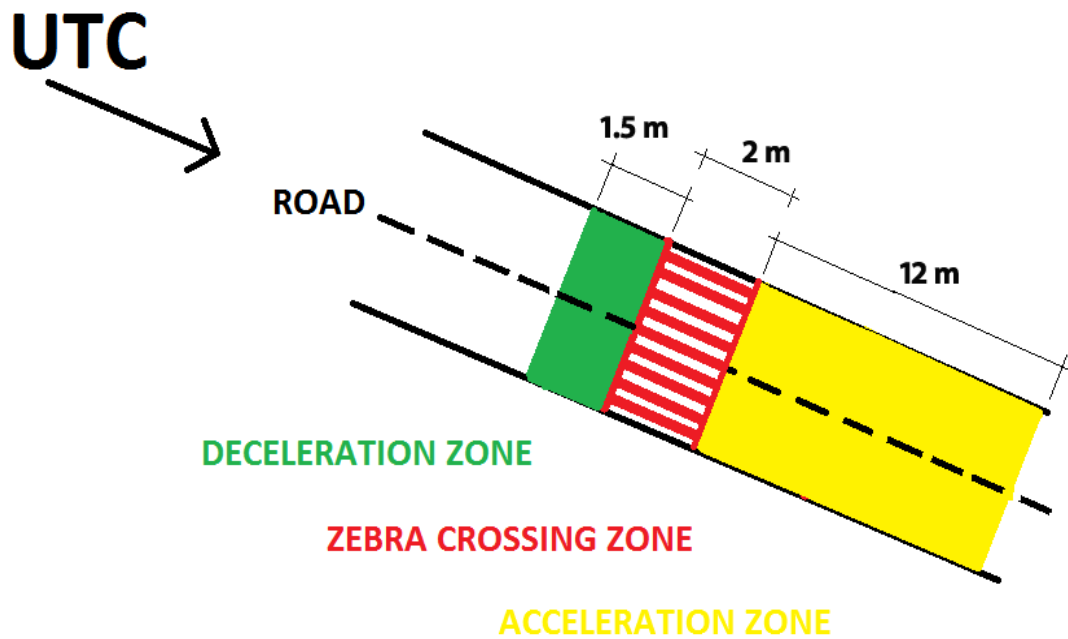


Figure 8 UTC zebra crossing site

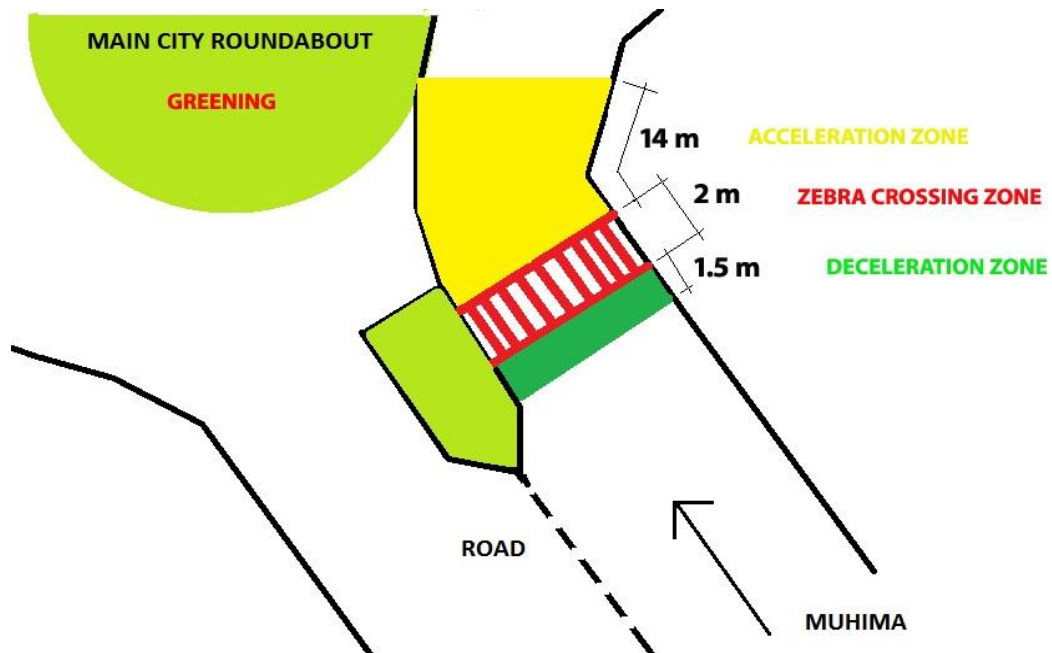


Figure 9 COGEBANQUE zebra crossing site

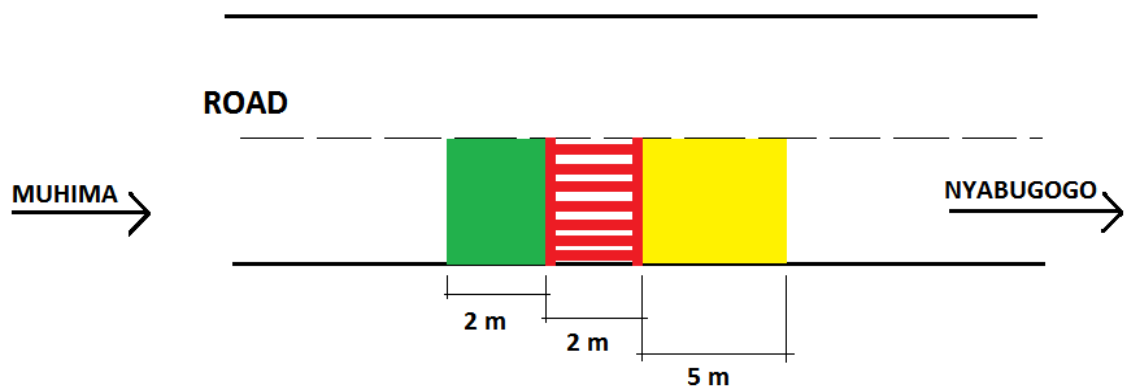


Figure 10 Nyabugogo zebra crossing site

3.2. 2 Sampling and survey method

3.2.2.1. Sampling

Random sampling method was used to found out what vehicle for survey at the zebra crossings, the first vehicle to cross line A was chosen, 60 secs after the previous measured vehicle after that the next vehicle was chosen and measured it and so on. This method was used to reduce possible observer bias in sampling.

A total of 263 drivers were observed at the three crossing sites, 97 drivers were observed at near UTC in the direction from UTC to Main Kigali roundabout, then 82 drivers were observed at crossing which is in front of COGEBANQUE the direction toward Nyabugogo and chez Venant and finally 84 drivers were observed at crossing of the Nyabugogo market exit in the direction toward Kigali centre to Nyabugogo cars park. All those crossings were observed in one direction.

Vehicles were classified into three size groups: small, medium and large. Small vehicles include passenger cars while medium vehicles included pick-ups, minibus, vans and small trucks up to approximately three tons. Large vehicles include trucks above three tons and buses.

3.2.2.2 Survey method

Before conducting a field visits to priority pedestrian zebra crossings, a training on surveying was done and a pilot survey was done. The real field survey was intended to gain personal experience about the crossings and their usage. The method consists of collecting data on delay to vehicle at zebra crossings, the delay depend on whether there are any pedestrians waiting to cross or actually crossing. In order to find out what drivers actually did at zebra crossings, they were observed in peak time (from 5 to 7 PM) on weekdays. Conflicts were measured by observing approaching drivers' action when the pedestrian was on the crosswalk.

To describe the behavior of the drivers at the crossings, three distinct situations were observed and the behavior of each pedestrian was placed into one of these 3 categories. First, pedestrians waited to cross on zebra crossing while none of the approaching vehicles stopped.

Second, vehicles stopped to give way to pedestrians. Third, pedestrians crossed the road in spite of the approaching vehicles, thus forcing drivers to stop.

The method used to measure delay was as follows:

Mark a point A which is a little further away (upstream) of the zebra crossing, At a point before vehicles decelerate on approach to the crossing.

- 1 Mark a point B just downstream of the zebra crossing at a point where all vehicles which have slowed or stopped have ended acceleration and are travelling again at roughly constant speed.
- 2 Distance A to B , it called D meters.
- 3 Measure the travel time of that vehicle or sample of vehicles, over this length D . This time is called T (secs).
- 4 The delay to each measured vehicle is the actual time T minus the free flow time (The free flow time is the time that a vehicle would take if it did not slow down in section D and is travelling at the speed limit on that road..

For each vehicle timed, the pedestrians waiting to cross or actually crossing the zebra have recorded, number of pedestrians has recorded and whether the vehicle was delayed because of vehicles stopped in front of it before it reached the crossing. Vehicles approaching a zebra are dependent only on their own behavior if there is no other vehicles in front of them.

Following from above vehicles approaching the zebra crossing if there is already one or more vehicles in front of it which have already stopped or slowed are affected by these other vehicles as well as by their own behavior.

Pedestrian delay were measured and it was depend on whether pedestrians were crossing or waiting , also whether vehicles arriving at the zebra have stopped in front of them and waiting for pedestrian.

3.2.3 Progress of survey

The survey was done in one day for each site from 5:00 to 7:00 P.M. It was done in November on 26th, 27th and 28th from UTC, COGEBANQUE and in exit of NYABUGOGO market respectively. Those days are working days and at peak time .

Every surveyor were equipped with watch, clipboard, Tape measure, survey forms, pencil, and safety jacket. Researcher as supervisor were at site for each survey to look after other surveyors on safety issues, therefore every surveyor has responsibility to protect himself from any potential dangers and hazards. Some of the precautions was used such as jackets, , the shelter were used to facilitate together the communication easily.

3.3 Survey interview on driver knowledge of the rules of zebra crossing

The driver interview was conducted to address the research question” Are drivers aware and know the law of zebra crossing in Rwanda?” in order to determine the knowledge of drivers on the rules of zebra crossing. It was conducted in two main car parks in Kigali.

3.3.1 Study area

The driver interview on knowledge of the rules of zebra crossing was conducted in the car parks areas which were selected based on the number of traffic uses the parking first one is rich and other one is less rich, those parking are Nyabugogo and Remera car parks. This survey was conducted on 2nd and 3th December 2013 from 12:00 AM to 3:00 pm in Nyabugogo and Remera car parks respectively, that time include a lunch time, this was a good time to get drivers.

3.3.1.1. Nyabugogo car park

Nyabugogo car park is the biggest parking in Rwanda, that accommodates various transport agencies, services, and business operation from both local and regional transport companies that service the wide market and business operations in the heart of Kigali.

Nyabugogo car park facility is divided into a long distance service section and a local Kigali city service section (Figure 11).

The long distance services to and from surrounding towns, rural areas and neighbouring countries (Burundi, Uganda etc.) use the larger northern part of the facility (hatched in red below) with the local taxis using the smaller southern portion of the park (hatched in blue below). A portion of the site (purple hatching below) is utilized as a market in the late afternoon with thousands of shoppers converging on the stalls



Figure 11 Nyabugogo car park

3.3.1.2. Remera car park

Remera car Park is the second big car park in Kigali. The operations at this car park don't seem to be well organized and an increase in day to day operations could cause some problems in terms of the efficiency of the service. Around this car park, there is different service such as bus station, business, restaurant, shop (Figure 12)



Figure 12 Remera car park

3.3.2. Sampling and survey methods

A structured interview questionnaire was elaborated contained simple questions about understanding of driver to zebra crossing, whether drivers understand zebra crossing laws and how they actually behave in practice. The data were recorded using interview survey form was conducted in order to find out the drivers' opinions of the zebra crossings and their perception of what they actually do.

3.3.2. 1. Sampling

A random sampling method was used to interview drivers and a sample of 120 drivers was used in the survey. The survey was done through personal interviews to randomly selected

drivers in car parks, they were considered to represent views of drivers when approaching the crossings.

3.3.2.2 Survey method

Two surveyors were involved in the survey on 2nd December 2013 at Nyabugogo car park, all were started together at the 'middle' of the car park. Surveyor one walked north, surveyor two walked South. Each surveyor walked 20 m in the respective direction. The nearest vehicle in front of each surveyor was the surveyor's first driver interviewed. After finishing the first interview, the surveyor's second vehicle was the nearest fourth vehicle to the first vehicle. The third surveyor's vehicle was the nearest fourth vehicle to the second vehicle. This systematic sampling method is an attempt to minimize any bias that might otherwise occur from a surveyor's personal choice of driver to interview.

Two surveyors were involved in the survey on 3rd December 2013 at Remera car park together at the 'middle' of car park. Surveyor one walked from the middle toward the entry of car park, surveyor two walked from the middle toward the exit of car park, each surveyor walked 5m in the respective direction. The first vehicle that has a driver in it in front of each surveyor is the surveyor's first person interviewed, after finishing the first interview, the surveyor's second vehicle was the fourth from the first, surveyor have to jump three vehicle and the fourth vehicle be the surveyor's vehicle.

3.3.2.2 Progress of the survey

The departure from home was at 11:00 am and arrival at the place of the survey was around 11:30am and directly went to the car parks.

Before starting each survey, as a team composed of two surveyors and researcher, 30 min were taken to discuss again how interview have to be done. The survey was conducted using interview form in which forms were filled all information gathered from a sample of drivers.

The first survey form has taken longer to fill, and then the next ones were quite easy. Generally interview were conducted between 3 and 5 minutes. A surveyor was interviewed 30 drivers.

The surveyors introduced themselves, then explained a research on driver compliance with zebra crossings laws in Rwanda, and that data would be used for that research only. In case driver refused to respond or terminate the interview, a surveyor left politely the driver and select another one. At the end of each interview, thanking remarks were addressed to drivers “Thank you to accept to be interviewed; your accurate information will serve as a tool to analyze the level of driver compliance of zebra crossings laws and will help to improve road safety in our country”.

3.4 Data analysis

This part explains how the data collected were analyzed for drawing conclusions. Data analysis is the process of systematically applying statistical and/or logical techniques to describe and illustrate, condense and recap, and evaluate data. Data collected were recorded in survey forms (appendix 1), entered in excel sheet and then analyzed using SPSS (version 17.0) to get a single data file. Pearson’s correlation coefficient (r), a statistical measure of the strength of a linear relationship between paired data, was used for some variables to test if there is a relationship between them. The positive correlation was considered as values greater than zero, and weak correlation was considered as r values below 0.4, while the strong correlation was considered as r values greater than 0.5 [45].

CHAPTER FOUR: PRESENTATION OF RESULTS

4.1 Introduction

In this chapter, the results obtained from three different surveys are presented in three section. The first one represent results of pedestrian accidents at zebra crossing, the second one present results on knowledge of drivers on zebra crossing law in Rwanda and the third section shows the results on drivers behaviors at zebra crossing.

4.2. Pedestrians accidents at Zebra crossings sites in Kigali

To indicate the scale of the road safety problems of zebra crossings in Kigali, government data showed that during 2013, there were 40 accidents where pedestrians were involved in accident while crossing, those 40 accidents were occurred in 27 sites (Figure 13). More accidents were occurred at Kinamba and Nyabugogo zebra crossings sites (Figure 14).

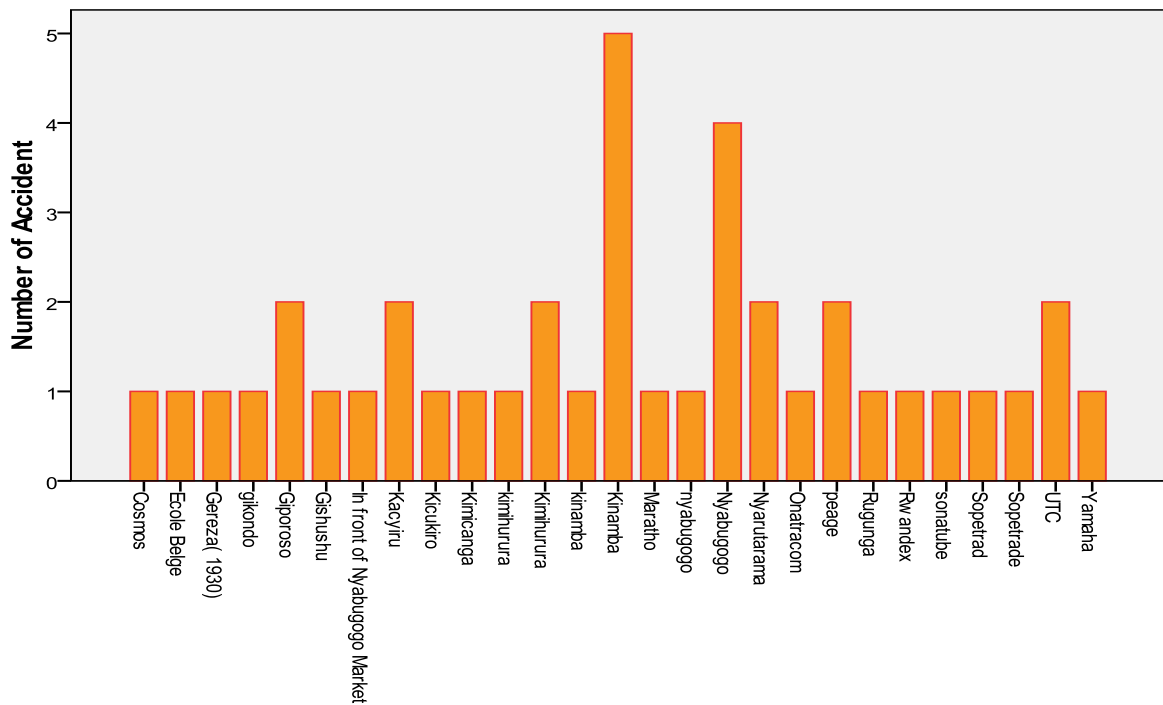


Figure 13 Number of accidents involved pedestrians at zebra crossing sites in Kigali

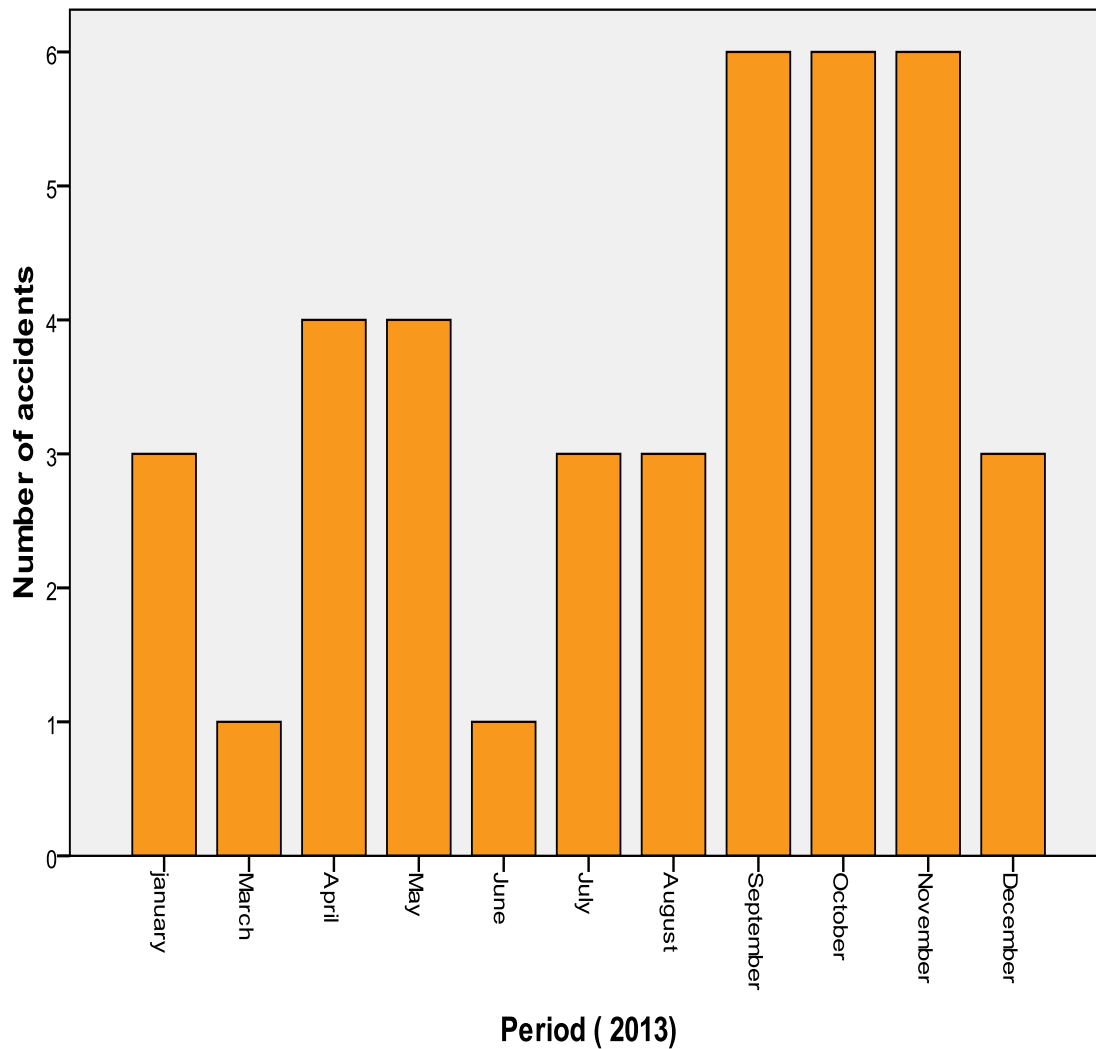


Figure 14 Number of accidents at zebra crossing sites in Kigali per month

4.3 Observed Drivers behavior at Zebra crossing sites

The observed behaviors of drivers at three zebra crossings sites were: to stop or slow down when approaching zebra crossing and there is one or more pedestrians wait or starting to cross to stop until pedestrian(s) reach the kerb and to keep driving with no reaction about pedestrians.

4.3.1 Drivers behaviors at zebra crossing

Within a total of 263 observed drivers at zebra crossing, 35.7% of them did not stop or slow down for pedestrians, pedestrians waited on the kerb while the approaching vehicles did not stop or slow down. The total number of drivers who stopped and allow pedestrian to cross were 64.3%. Among them 4.2 % of drivers were forced by pedestrians to stop while crossed halfway and 9.5% of drivers stop or slow down because of vehicles stopped in front of them before they reached the crossing (Figure 15).

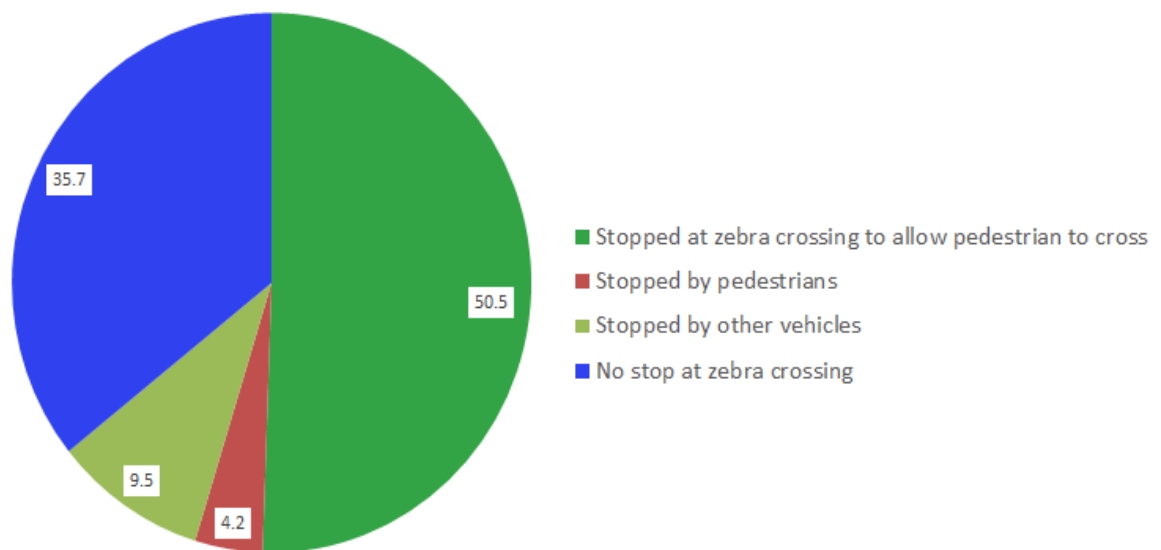


Figure 15 Drivers behaviors at selected zebra crossing sites

4.3.2 Driver behavior at different locations

COGEBANQUE, Nyabugogo market and UTC zebra crossing sites 82, 84 and 97 drivers were observed for their behavior respectively. Drivers at COGEBANQUE zebra crossing site did not allow pedestrian to cross at 74.4% while drivers at UTC allowed pedestrian to cross at 86.6%. (Figure 16).

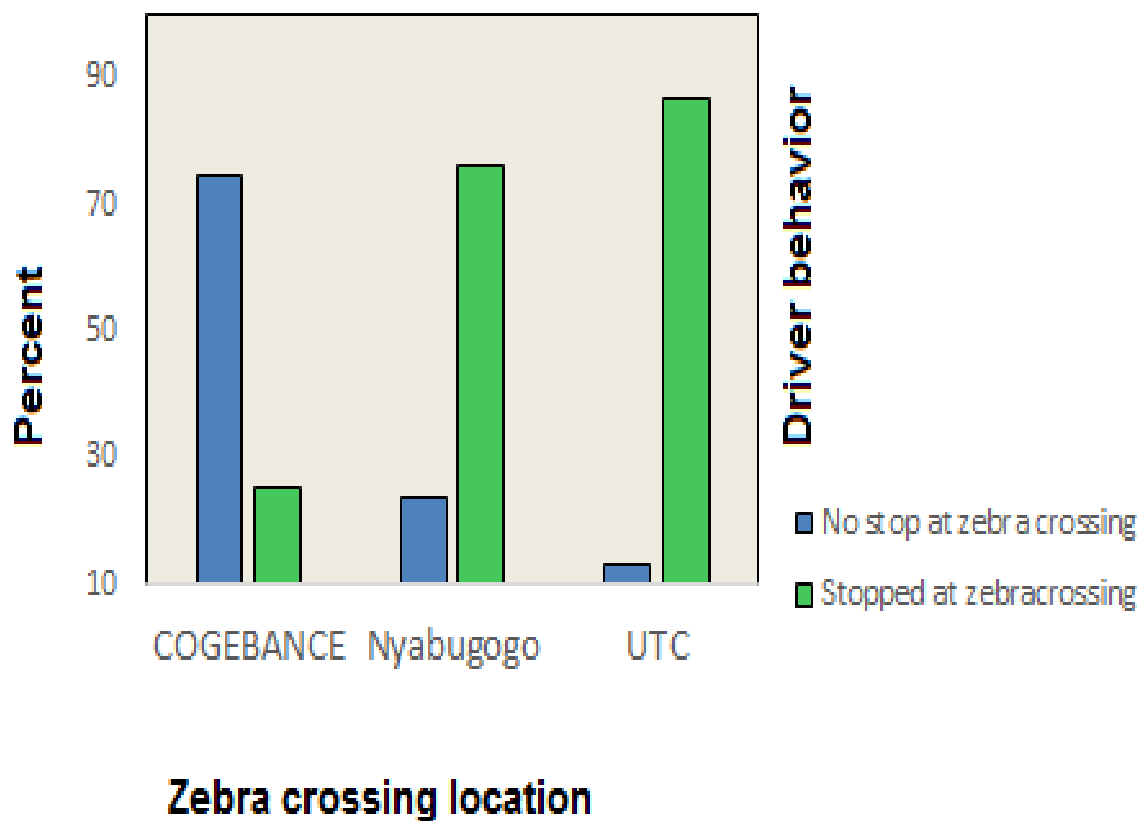


Figure 16 Driver behavior at different locations

4.3.3. Driver car type and behavior at zebra crossing

Within a total of 263 observed drivers, 125 had small vehicles, 107 medium and 31 heavy vehicles. Drivers of medium vehicles stopped for pedestrian at 74.9% while drivers with small and heavy vehicles stopped at 64 % and 63% respectively (Figure 17).

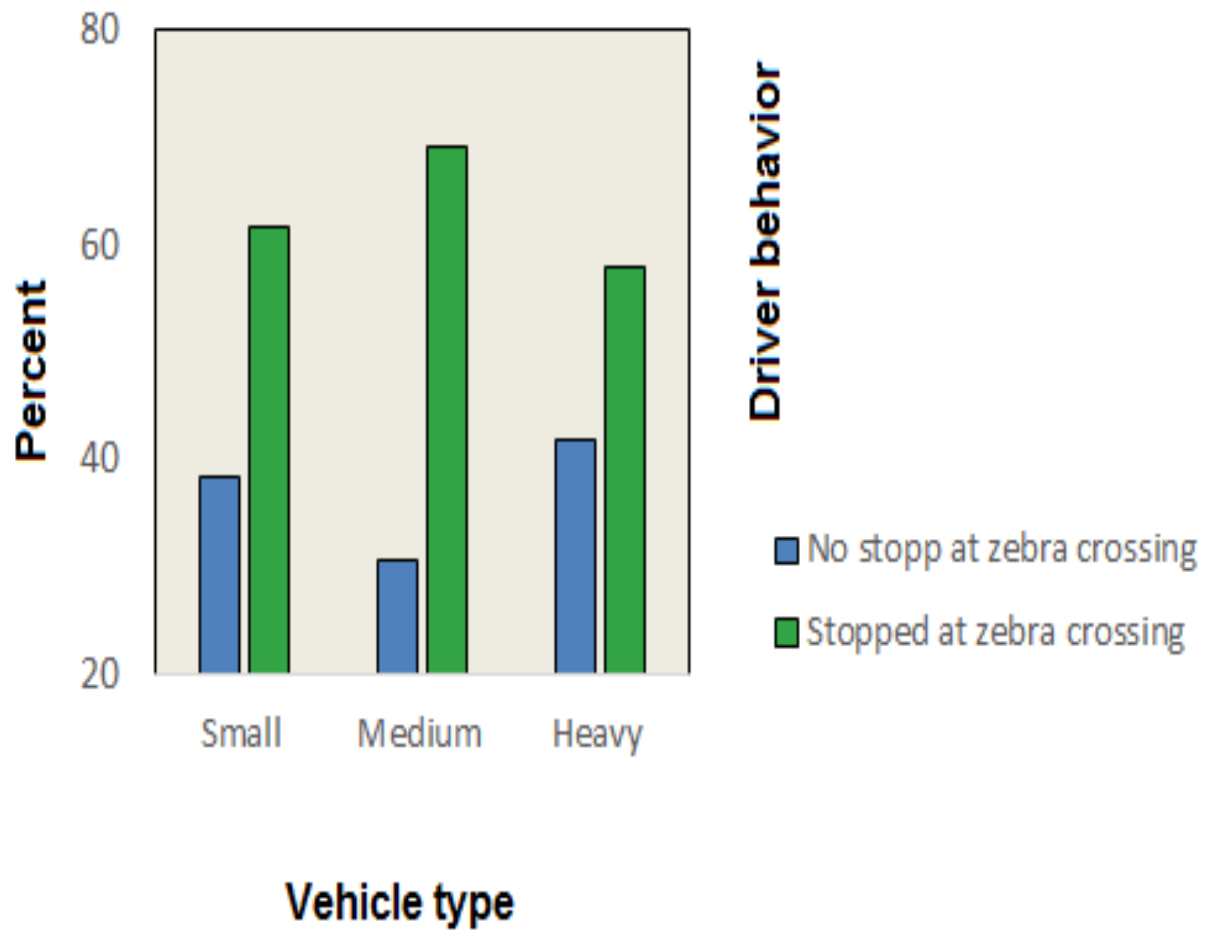
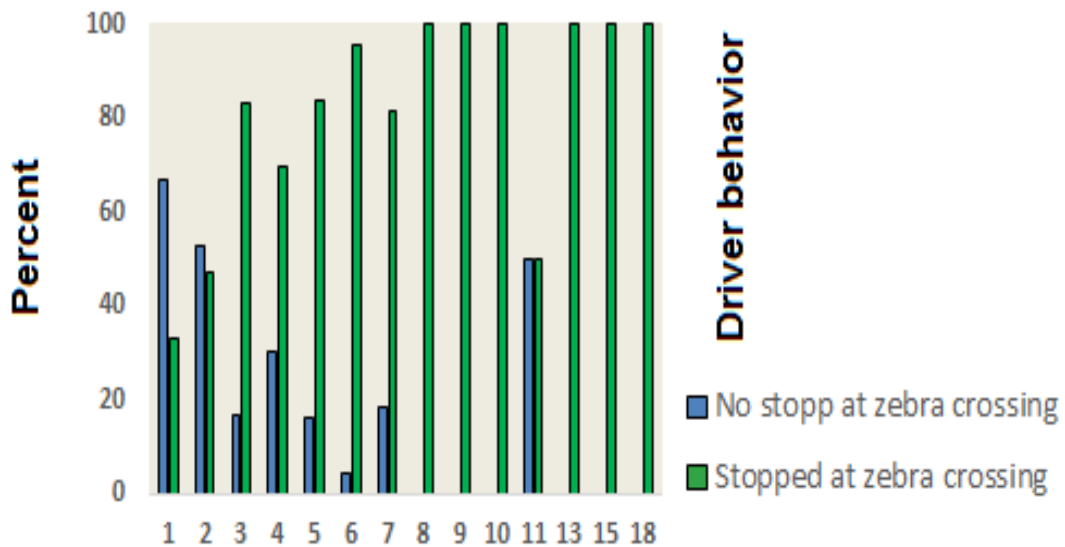


Figure 17 Drivers car types and driver behavior at all 3 zebra crossing sites

4.3.4 Driver behavior and number of pedestrian at zebra crossing

This research found that the number of pedestrians using zebra crossing varied from 1 to 18 pedestrians . With one pedestrian at zebra crossing, drivers did not stop at the zebra crossing at 67.2% while above 8 pedestrians using zebra crossing increased number of stopped drivers at 100% (Figure 18).



Number of pedestrians using the zebra crossing

Figure 18 Driver behavior with number of pedestrian using zebra crossing

4.4 . Drivers knowledge on zebra crossing law

Rwanda presidential decree n° 85/01 of 02/09/2002[4] regulating general traffic police and road traffic the “article 27” in this decree states that a driver must stop if there is one or more persons waiting to cross or on the crossing itself. The driver may not drive on until all peds have reached the far kerb’[4].

4.4.1 Description of respondents

All respondents of interview survey were 100% males. Out of 120 respondents, 36 of them drove buses, 61 drove min bus, 23 drove cars. Their ages were classified into three categories (young, mature and old) the ages on these categories varied from 18 to less than 35 years, 35 to less than 55 years and above 55 years respectively. The youth category represented 45.85 % and old category were 9.2 % (Figure 19). Drivers at 60% responded questions on zebra crossing law using their knowledge on it and other 40 % used intuition or experience to respond questions (Table 5) .

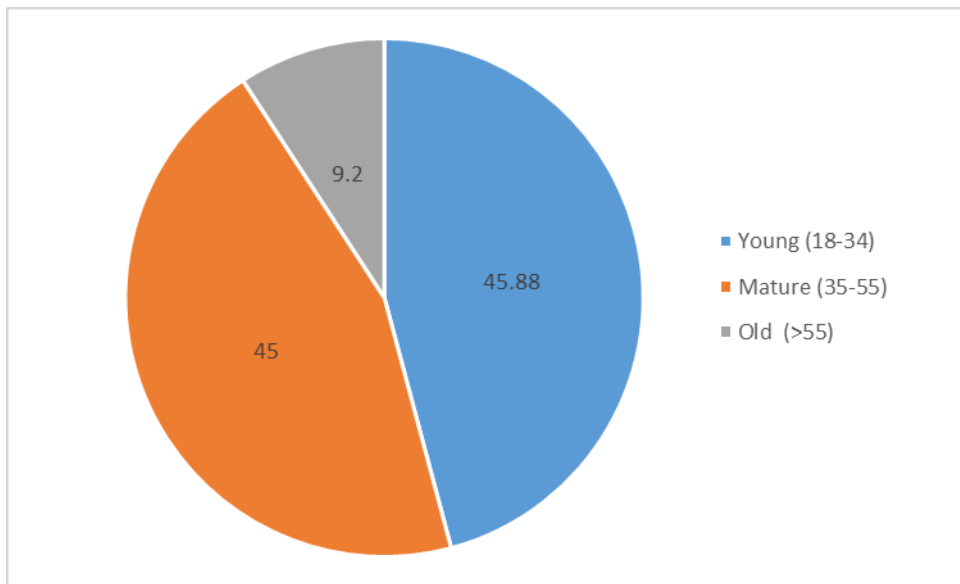


Figure 19 Ages of respondents by category

Table 5 Drivers categories according to their responses inspirations

	Frequency	Percent
Zebra crossing law	72	60.0
Experience or intuition	48	40.0
Total	120	100.0

4.4.2. Driving experience of respondents

Driving experience of respondents were categorized according to their experience in driving. Four categories were established: no experienced; less experienced; experienced; and more experienced. The ages on these categories varied from 0 to less than 3 years, 3 to less than 6 years, 6 to less than 9 years and above 9 years respectively. The percentage in driving experience was 48.3%, 18.3%, 16.7% and 16.7% for no experienced, less experienced, experienced and more experienced respectively (Figure 20).

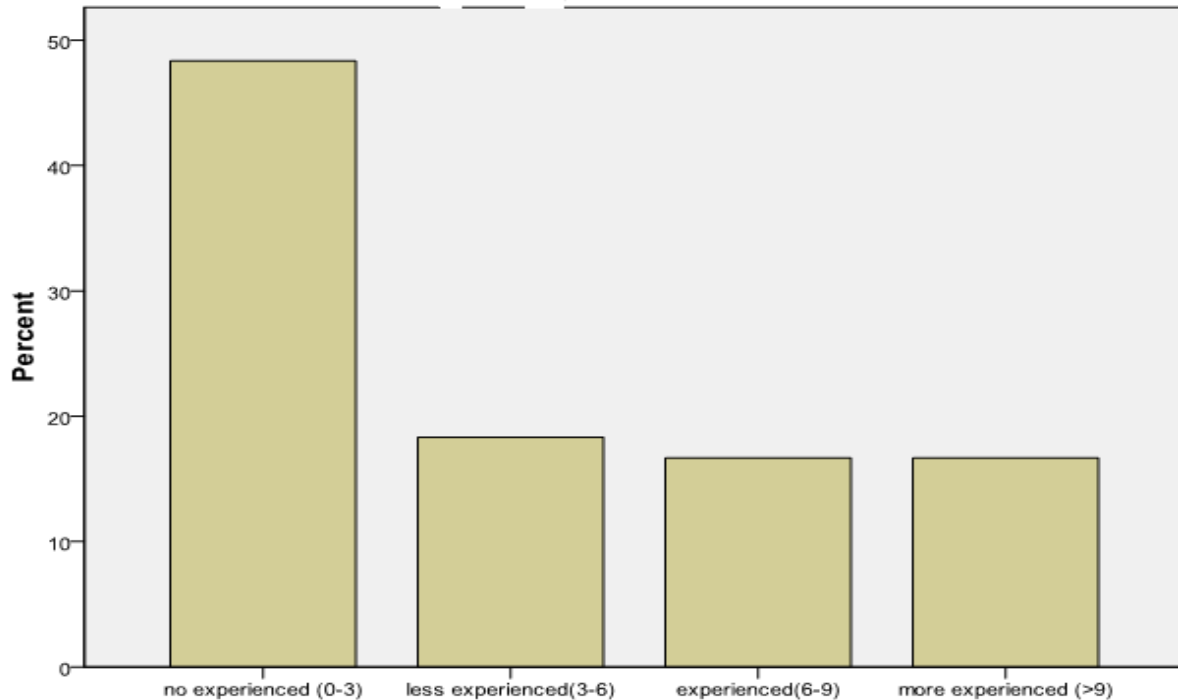
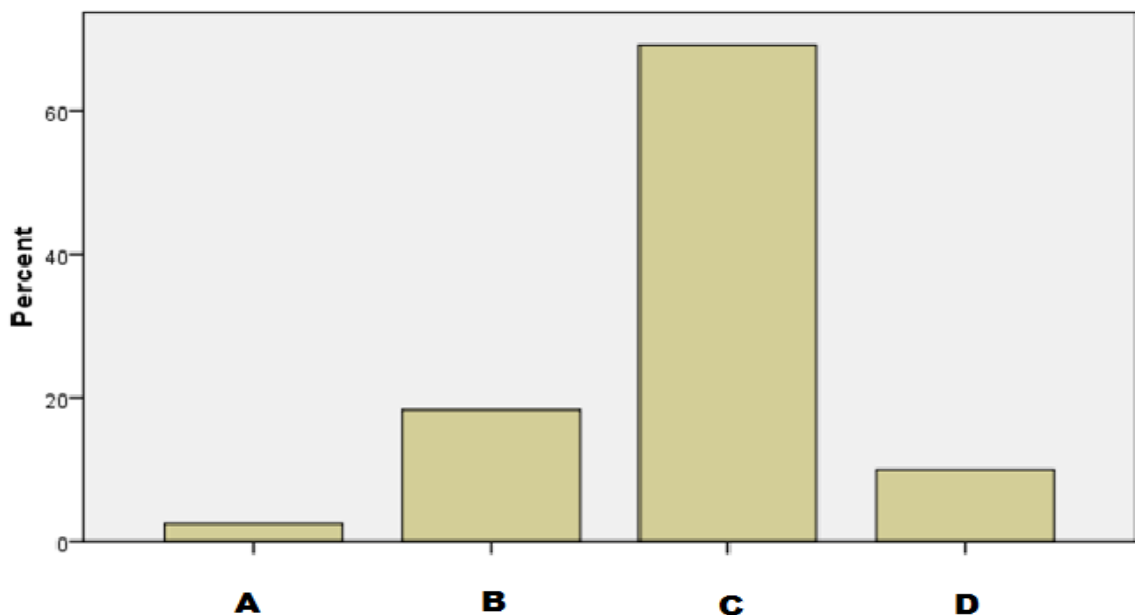


Figure 20 Driving experience of respondents since passing test

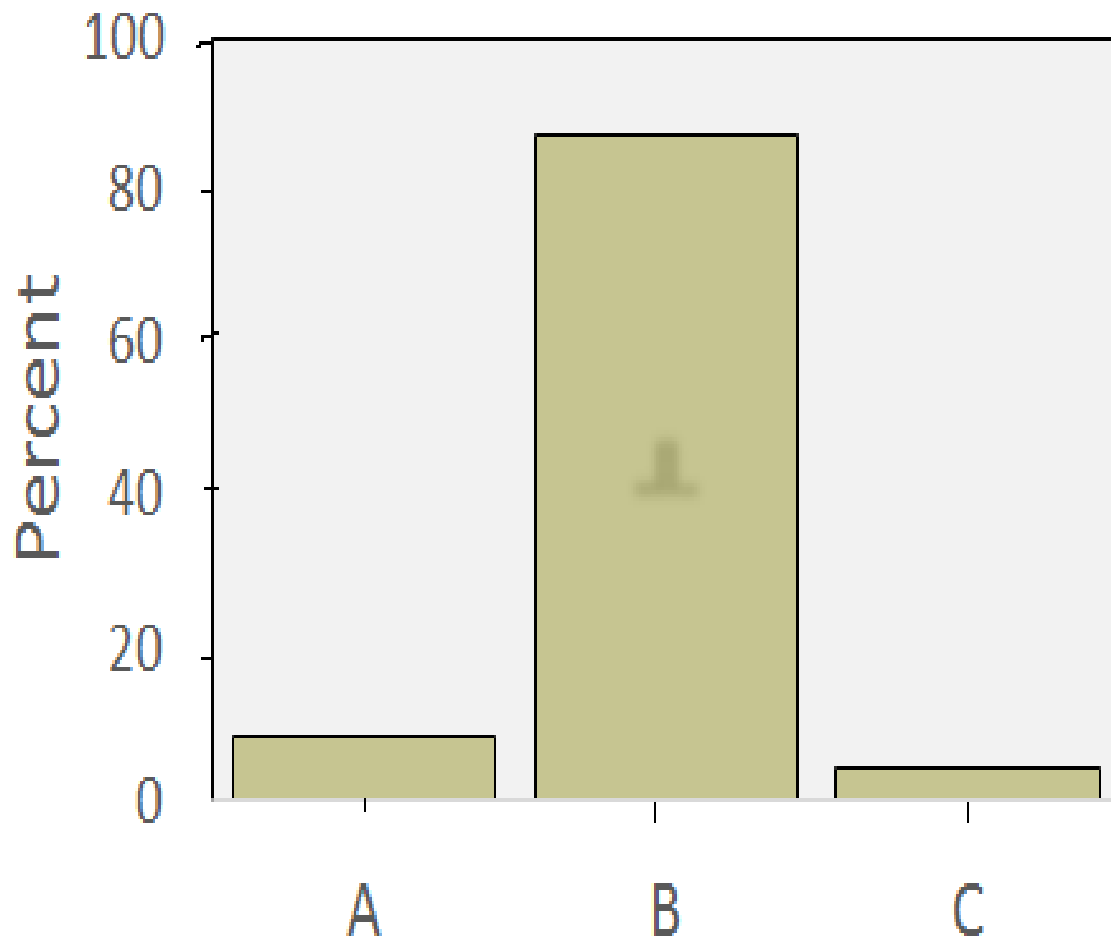
4.4.3 Knowledge of drivers on zebra crossing law in Rwanda

The percentage of drivers who responded that the law requires to “slow down or stop, starting again when there is a space for you to do so, even if he/she/they have not yet reached the other kerb” was 69.2 (Figure 21). About 2.5 % and 18.3% of drivers responded that zebra crossings law mean nothing to them. when pedestrians started or waiting to cross. When asked what the zebra crossing law requires them to do when is no one on it but more pedestrians are at the kerb waiting to cross, 87% drivers responded that the law requires to slow down or stop to allow them to cross, starting again when there is a space for you to do so, even if he/she/ they have not yet reached the other kerb (Figure 22).



A: Nothing, keep driving, **B:** Steer in front of, or behind, or between the pedestrian(s), **C:** Slow down or stop, starting again when there is a space for you to do so, even if he/she/they have not yet reached the other kerb, **D:** Stop and do not start again until the pedestrian/last pedestrian has reached the other kerb

Figure 21: Driver knowledge on zebra crossing law when there is one or more pedestrians started to cross

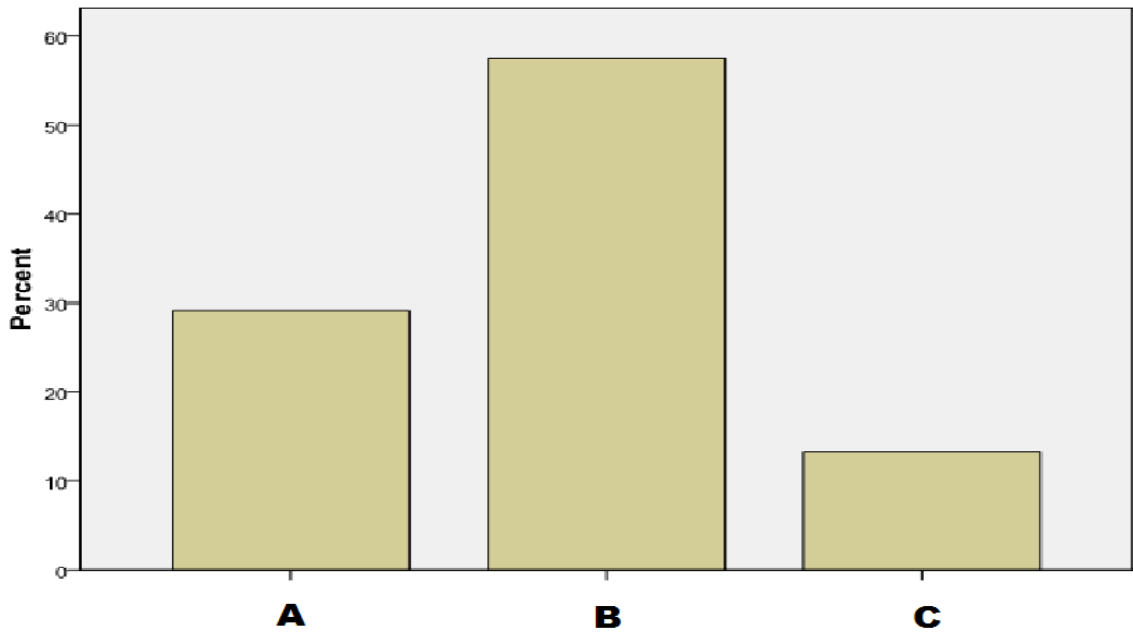


A:Nothing, keep driving , **B:** Slow down or stop to allow them to cross, starting again when there is a space for you to do so, even if he/she/ they have not yet reached the other kerb , **C:** Stop and do not start again until the pedestrian/last pedestrian has reached the other kerb

Figure 22 Drivers knowledge on zebra crossing law when there is no one on it but more pedestrians are at the kerb waiting to cross

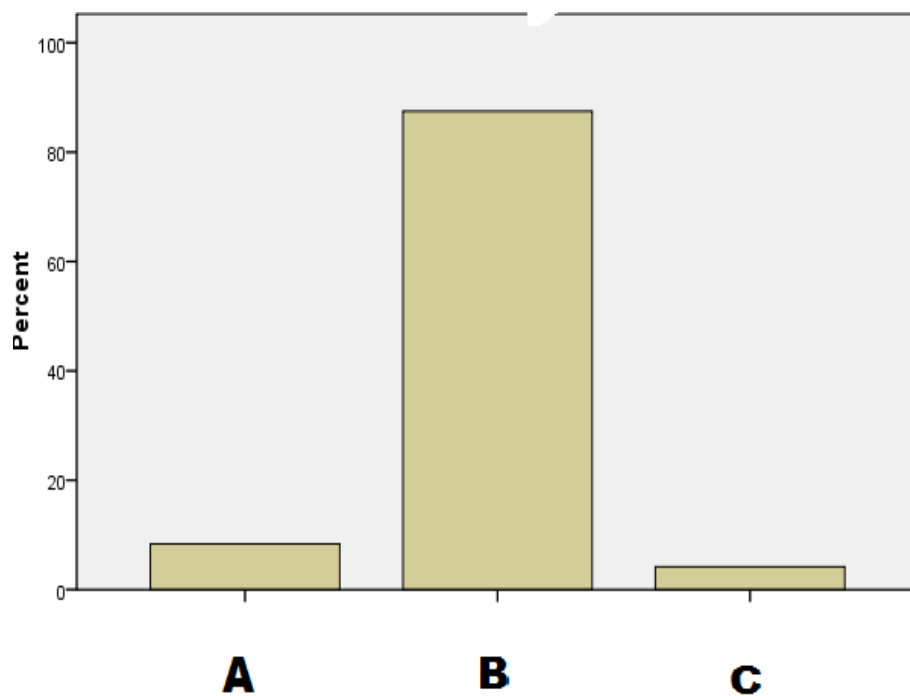
4. 4.4. Drivers self reported behavior based on interview

In different ways, questions solicited information about driver's behavior in a self reported manner. One question asked respondents what they do when approach a zebra crossing and there are pedestrians started or waiting to cross. When asked whether they would slow down for pedestrians started to cross, 57.5% of drivers answered positively, and 29.2% answered negatively. When there are pedestrians waiting to cross, 89.2% of drivers answered that they would slow down their vehicle to give the right of way to pedestrians at crossings (Figure 23 and 24)



A: Nothing , B: Slow down or stop to allow them to cross, starting again when there is a space for you to do so, even if he/she/they have not yet reached the other kerb , C: Stop and do not start again until the pedestrian/last pedestrian has reached the other kerb

Figure 23 Response on self reported driver behavior on zebra crossing when there is one or more pedestrian on it

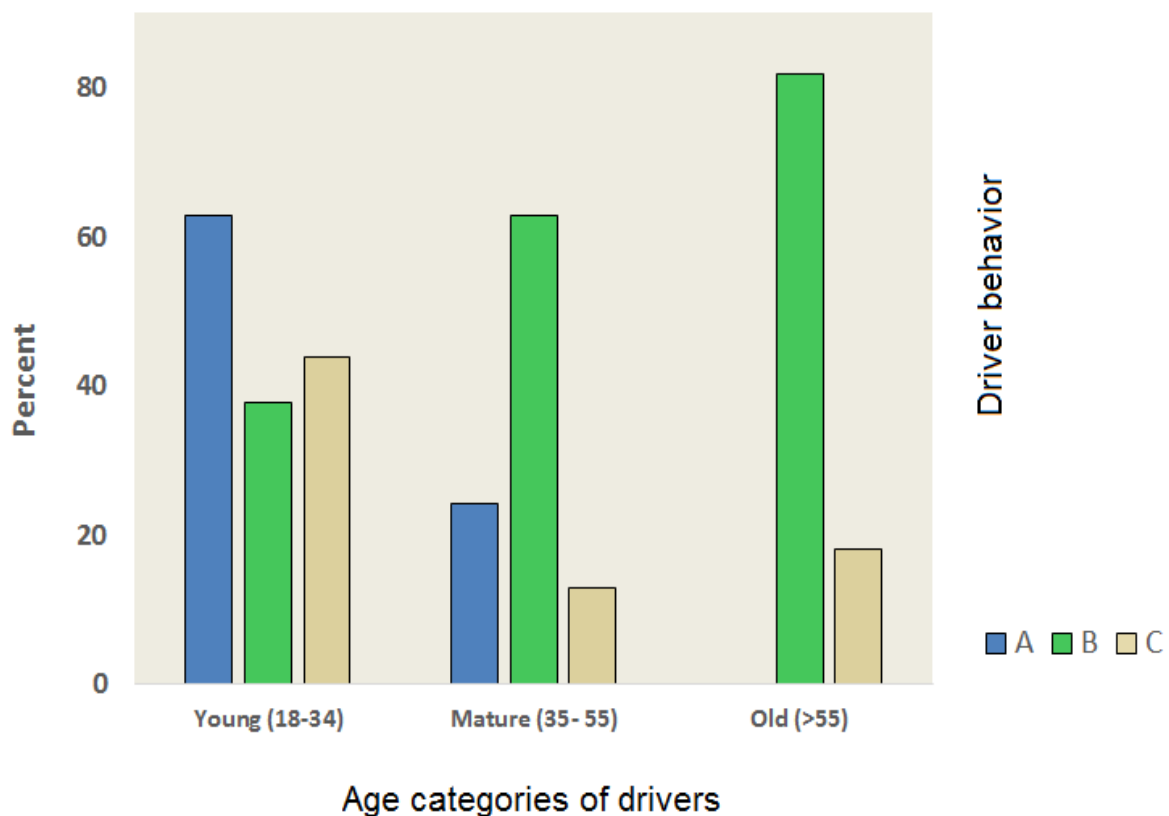


A: Nothing , B: Slow down or stop to allow them to cross, starting again when there is a space for you to do so, even if he/she/they have not yet reached the other kerb , C: Stop and do not start again until the pedestrian/last pedestrian has reached the other kerb

Figure 24: Response on self reported driver behavior at zebra crossing when there is no one on it but more pedestrians are the kerb waiting to cross

4. 4.5 Response on self-reported driver behavior with ages categories

With ages categories, when asked drivers what they do when approaching zebra crossing and there is no one or more pedestrians on it but one or more pedestrians are at the kerb waiting to cross , 81.8% of old drivers answered that they would slow down or stop and starting again when there is a space to do , while in young category 62.9 % of them responded that they keep driving (Figure 25).



A: Nothing , B: Slow down or stop to allow them to cross, starting again when there is a space for you to do so, even if he/she/they have not yet reached the other kerb , C: Stop and do not start again until the pedestrian/last pedestrian has reached the other kerb

Figure 25 Response on self reported driver behavior with age categories on zebra crossing when there is one or more pedestrian on it

4. 4.6 Responses of drivers on knowledge of law and their self reported behavior on zebra crossing

The drivers were asked a question on what the zebra crossing law requires them to do, and what they do in practices when they approach a zebra crossing and there is no one on it but one or more pedestrian are at the kerb waiting to cross. Eighty percent (80%) answered that the law require nothing and they do not stop for pedestrians, 29.5 % answered that the law require to slow down or stop to allow pedestrians to cross but they keep driving, and 56.1% answered that the law require to slow down or stop to allow pedestrians to cross and they allow them to cross at zebra crossing (Table 6).

Table 6 Cross tabulation of driver knowledge on the law and behavior when there is one or more pedestrians started to cross the zebra crossing

	Driver behavior (%)			
	A	B	C	Total
Knowledge				
A	8 (80)	0 (0)	2 (20)	10 (100)
B	31 (29.5)	59 (56.1)	15 (14.3)	105 (100)
C	4 (80)	0 (0)	1 (20)	5 (100)
Total	43 (35.8)	59 (49.5)	18 (15)	120 (100)

A: Nothing , **B:** Slow down or stop to allow them to cross, starting again when there is a space for you to do so, even if he/she/they have not yet reached the other kerb, **C:** Stop and do not start again until the pedestrian/last pedestrian has reached the other kerb.

4. 4.7 Response on driving experience and their self reported driver behavior

According to driving experience, the response of drivers on their behavior when they approach a zebra crossing and there is one or more pedestrians on it varied between respondents categories. The drivers in no experienced category and more experienced responded that they don't stop at zebra crossing at 37.7 % and 30% respectively. The drivers in experienced categories responded that they allow pedestrians to cross at 85.8 % (Figure 26).



A: Nothing , **B:** Slow down or stop to allow them to cross, starting again when there is a space for you to do so, even if he/she/they have not yet reached the other kerb, **C:** Stop and do not start again until the pedestrian/last pedestrian has reached the other kerb

Figure 26 Driving experience and self-reported behavior on zebra crossing sites

Self Reporting Bias

Observed drivers and the reporting drivers were not the same ones. The observed included (presumably) all types of driver and all types of vehicle while ‘reported’ were males only. Observed drivers’ behaviors at zebra crossings sites was lower than reported rates in the interview, i.e slow down or stop for pedestrians 64.2% vs to 69% (Table 7). Such a difference could be attributed by self reporting bias in the interview survey .The trends related to self reporting were noted (Table 7):

Table 7 Comparison between Self reported and Observed drivers’ Behavior

Driver Requirement	Self Reported Behavior (%)	Observed Driver Behavior (%)
Stopping	28.3	8.7
Slow down or stop	69.2	64.3
Keep driving	2.5	27

CHAPTER FIVE: ANALYSIS

This chapter starts by analyze the data on pedestrians accidents at zebra crossing sites in Kigali, the relevancy of data collected in answering the research questions and the accuracy of the approach used and then the results obtained from the selected observations sites. As presented under sections of chapter four, are analyzed statistically to obtain the meanings

5.1 Pedestrian accident in Rwanda (Kigali) at zebra crossing Sites

Finding showed that there is at least a case of accident affecting a pedestrian at zebra crossing in Kigali. An average of two accidents occurred on zebra crossing every month and more than six accidents at zebra crossing affecting pedestrian occurred in September, October and November (Figure 13). Results showed that at least two or more accidents occurs every month on every zebra crossing considered in this research (Figure 14).

5.2 Drivers' Knowledge on Rwanda Zebra crossing regulations

There was a significant difference in driving experience and age of correspondents ($p < 0.01$) (Table 8). The proportion of old was significantly lower than the proportion of young and mature. Old respondents was 9.2 % while young and mature were 45 % and 45.83% respectively (Figure 19). The proportion of drivers who reported to understand that zebra crossing law when there is one or more pedestrians on it is 'stopping' until all pedestrians reached the kerb was lower than for those who understand it to slowing down or stop and starting again when there is a space to do, i.e 10% and 69.2% respectively (Figure 21). This pattern was consistent in both cases, also when there is no one on it but one or more pedestrian are waiting to cross, i.e 4.4% and 87.5% respectively.

To determine drivers' knowledge on zebra crossing law, their responses were correlated with their age, driving experience and their behavior at zebra crossing (Table 8). There was a significant difference in knowledge of zebra crossing law among drivers ($p < 0.05$) and the knowledge on zebra crossing law was correlated with driving experience and age with correlation coefficients (r) of .255 and .281 respectively (Table 8). The old drivers answered

that they know zebra crossing law at 81.8% and this percentage was higher than of young and mature drivers whose zebra crossing law knowledge was at 39% and 62.9 % respectively (Figure 25).

The driver knowledge of zebra crossing law was highly correlated with their self reported behavior ($r=.686$). The knowledge on zebra crossing law was at 69.2 % (Figure 21), but drivers who self reported to apply the knowledge in practice was at 57%.

Table 8 Summarized p values and correlation coefficient of survey interview

	Correlation coefficient	P values
Knowledge on law and driving experience	.255**	.000
Knowledge on zebra crossing law and age	.281**	.002
Driving experience *age	.312**	.001
Knowledge on law zebra crossing law and self-reported behavior at zebra crossing law	.686**	.000
Self reported behavior and age	.99***	.0000
Self reported behavior and driving experience	.78**	.000

* Correlation is significant at the 0.05 level

** Correlation is significant at the 0.01 level

*** Correlation is highly significant at the 0.01 level

Details of this test may be found in appendix 9

5.3 Observed driver behaviors at zebra crossing sites

There was a significant difference in driver behavior at zebra crossing ($P < 0.05$) (Table 9). The drivers who stopped at zebra crossing to allow pedestrians to stop were 64.7 % and higher than the drivers who did not stop (Figure 15). The zebra crossing location and driver behavior were highly correlated ($r = 0.87$) (Table 9). High percentage (76.2%) of drivers at NYABUGOGO market sites were stopped for pedestrians and high percentage (74.4%) of drivers at COGEBANQUE did not stop for pedestrians (Figure 16),

The vehicle type and driver behavior were also positively correlated and the correlation was weak ($r = 0.09$) (Table 9). The drivers with small vehicles stopped for pedestrian at crossing than larger vehicles (Figure 17). The number of pedestrians at zebra crossing also positively influenced driver behavior ($r = 0.39$). Above 8 pedestrians at zebra crossing, drivers stopped and allowed them to cross at 100% (Figure 18).

Table 9 Summarized correlation coefficients and p values of observed driver behavior at selected zebra crossing sites

Factors	Correlation coefficient
Number of pedestrian * behavior	.39**
Vehicle type *behavior	.09*
Location and behavior	0.87***

* Correlation is significant at the 0.05 level

** Correlation is significant at the 0.01 level

*** Correlation is highly significant at 0.01 level

CHAPTER SIX: DISCUSSION

This chapter discusses the results found from the data summaries and analyses in the previous two chapters.

6.1. Number of accident affecting pedestrian at zebra crossing

On 27 zebra crossing sites concerned by this research at least one accident occurred on each site every month (Figure 14). The existing cases of accidents at zebra crossings that affect pedestrians in Kigali shows that road safety in Kigali is still problematic. The causes of accident might be high speed of drivers who failed to stop and knocked pedestrian who were crossing.

According to Ministry of transport and works [8], high speed of drivers is a crucial parameter that may create hazards to the pedestrians on zebra crossing instead of safety [13]. Green shield research [15] showed that accident on zebra crossing is due to speed of drivers coupled with the lack of law awareness by pedestrians on zebra crossing.

Both young drivers and pedestrians, especially youth might also be responsible of accidents at zebra crossings in Kigali city, because are known to violate and ignore traffic rules. Rwanda has more than 80% of youth and most of them settle in Kigali seeking jobs, working or studying.

For instance, nearly 80% of adolescents drivers interviewed during this research, reported never or hardly ever checking to make sure the traffic had completely stopped before crossing at a pedestrian crossing, and 20% reported them fairly often or very often getting partway across the road and having to run the rest of the way.

The presence of respondents, about 2.5 % and 8.3% for drivers who understand that zebra crossings law to mean nothing to the driver when pedestrians started or waiting to cross, is a matter of concern. Driver have to decide to give way or not depending on driver time.

For the question asked respondents if their behaviors at zebra crossing depend on zebra crossing laws or their driving experience. 40 % answered that their behaviors depend on their experience and 60% answered that their behaviors depend on zebra crossing laws in Rwanda as shown in Table 6

During observations at zebra crossing sites, 4.2 % have stopped drivers in the middle of the lane, which would be cause of accident if drivers did not stop (Figure 15). This shows that pedestrians crossed without checking their security on the road. Both cases may lead to accidents which affect pedestrians at crossing sites. Further study on pedestrian knowledge and compliance with zebra crossing law should be conducted to assess a relationship between driver and pedestrian towards minimum to zero accident at zebra crossing sites.

This was in line with research of George [39] who showed that adolescents often fail to obey the traffic signals and/or fail to check that the road is clear.

6.2. Knowledge on zebra crossing law

According to Rwanda presidential decree n° 85/01 of 02/09/2002 [4] regulating general traffic police and road traffic the "article 27" in this decree states that when a pedestrian has moved to a passage for pedestrian, at a place where the traffic is not regulated by a qualified agent or by traffic lights, drivers can only come close to this place at moderate speed and cross it only when they can do so without danger for the pedestrian and if need be they must stop to let the pedestrian pass.

The total drivers who responded during interview were 120 and 91 % of them were young and mature. Old drivers who responded were 9% (Figure 19) The percentage of drivers who responded that they know zebra crossing law was 69. Only 37.1% young drivers responded that they know zebra crossing law (Figure 24). The data and analysis shows that young drivers have a poor knowledge of the zebra crossing law. The finds shows that driver knowledge of law is positively correlated with driver behavior on zebra crossing sites. This implies that improvement of driver knowledge on the law can improve his/her behavior at the crossing site. Capacity building of drivers on zebra crossing regulations can increase driver compliance with the law. Research conducted in Botwana has shown that the knowledge of road safety influence the number of accidents in roads. The existing cases of accident at zebra crossing

shows that the knowledge of law by both drivers and pedestrian is still low. The research showed that with improved knowledge, the number of accident reduces in case when the pedestrians are also aware about the road safety laws [14].

6.3. Behavior of drivers at zebra crossing

The drivers who slowed down and stopped at zebra crossing to allow pedestrian to cross were 64.3 % (Figure 15). From site observations, some of drivers stopped or slowed down when approaching zebra crossing not only for a reason of giving a way to pedestrians, but some of them were forced by pedestrians to stop and others stopped or slowed down because of others vehicles stopped in front of them before they reached the zebra crossing. The percentage of compliant drivers with zebra crossing law were 50.5% (Figure 15).

The experienced drivers who know the law were more complaints to zebra crossing because with longer experience, they have learned from the past the driving environment, and therefore they have become safer drivers. On the other hand, a decrease in percentage of compliance of law at zebra crossing was due to the increased number of no experienced drivers who were mostly young and with low knowledge of zebra crossing law_ (Figure 25). Young drivers especially teen drivers, on the other, they don't only lack sufficient knowledge and driving experience but they are also known for their high risk taking behavior that may degrade road safety.

The results of this research are in line with Neuman [44] that showed that low compliance on road safety regulations in young driver is due to their low knowledge in road safety and high risk taking decisions.

Some few of more experienced drivers ignored application of law on zebra crossing because of their experience (Figure 26). This was due to the low monitoring of road safety regulations in Rwanda which characterized Rwanda in last 20 years, who would punish the drivers not complying with the Road safety law.

.Madaniyo [5] reported that larger vehicles may require longer braking distances to slow down than small vehicles. Greenshield study noted that the vehicle and the driver of the vehicle shall accord precedence within the limits of a zebra crossing to any pedestrian [22].

The location of zebra crossing have affected driver compliance law. For instance, drivers in places with congestion like UTC stopped not giving a way to pedestrians, but for traffic jam. High percentage (74.4%) of drivers at COGEBANQUE did not stopped for pedestrians, a research found that the reason of that is the slop of road at this site which influenced drivers to slowing down, drivers moved at low speed before reaching zebra crossing for that raison it's difficult for pedestrians waiting at the kerb to make sure if a driver let him/her to cross and pedestrian take measures to cross when there is no vehicle .

The heavy vehicle using sharp slopped zebra crossing reduced the driver compliance with the zebra crossing law. Heavy vehicles are harder to slow and stop down at zebra crossing than small and medium vehicles(Figure17). These vehicles uses higher speed than others in congested loads which make them harder to stop at zebra crossing in Kigali. Most of them are heavy good vehicles distributing foods in Kigali. Their speed should be monitored and or should use no congested and "*poids lourds* loads".

CHAPTER SEVEN: CONCLUSIONS AND RECOMMENDATIONS

This study had mainly sought to set out the pedestrian accident problem in Rwanda (Kigali) relating to crossing roads, to determine driver knowledge and compliance of zebra crossing regulations in Rwanda, and to test if the use of an interview survey can generate information on driver knowledge of their legal obligations on approaching zebra crossings, and of their actual behavior, particularly where it can be used to help guide policy. National police records was used to set out the pedestrian accident problem in Rwanda. In two tax parks(Nyabugogo and Remera), 120 males drivers were systematically sampled and interviewed to determine driver knowledge and compliance of zebra crossing regulations in Rwanda, and 263 drivers were observed at three zebra crossing sites (UTC, COGEBANK and Nyabugogo).

It should be noted that this work was based on limited samples which are not necessarily representative of the driver population in Rwanda, and conclusions and recommendations should be viewed in this light.

7.1. Conclusions

There is a serious problem of accident on zebra crossing in Kigali city, where two accidents per month occur at every zebra crossing in Kigali. The number of accidents affecting pedestrians on zebra crossing sites in Kigali city is high. Findings of the research shows that the drivers lack knowledge on zebra crossing law, particularly young drivers. The driver's compliance with zebra crossing law is low, particularly in young drivers. The experienced drivers who know zebra crossing law are more complaints to zebra crossing and they are safer drivers. On the other hand, a decrease in percentage of compliance of law at zebra crossing is due to the increased number of drivers lacking the knowledge of zebra crossing law. Heavy vehicle using sharp sloped zebra crossing reduced the driver compliance with the zebra crossing law. The findings shows that heavy vehicles are harder to slow and stop down at zebra crossing than small and medium vehicles. Interestingly, the tool used to generate information necessary to assess the driver knowledge and compliance with regards to zebra crossing, has collated accurate information, on which the above conclusion was drawn.

7.2. Recommendations

The problematic accident at zebra crossing sites in Kigali city, low knowledge and compliance of zebra crossing law lead to Failure to achieve the objectives of the Rwanda zebra crossing Laws. In order to minimize accidents affecting pedestrian at zebra crossing in Kigali, the research recommended followings:

1. An immediate intervention should be established to monitor road safety regulations violation at zebra crossing sites where pedestrian are much more affected especially in Kinamba and Nyabugogo crossing sites;
2. The government should also improve public transport and encourage its use to ease the congestion of traffic that often results in pedestrians and drivers at logger heads about who has the right to use the road; and
3. Increase the driver and pedestrian knowledge on zebra crossing law and their compliance

Improve road safety in Rwanda, the government should improve the knowledge of zebra crossing law as follows:

1. The road safety should train drivers on zebra crossing law, particularly focusing on young drivers;
2. The government should strengthen road safety campaigns in order to increase the knowledge of pedestrians on zebra crossing law;
3. This efforts to strengthen road safety should not only involve government but should be multisectorial.

Furthermore, the compliance with zebra crossing law should be improved as follows:

1. Drivers and pedestrians who violate pedestrian crossing rules should be made to pay a stern fine and be recorded on safe road records,
2. The speed of heavy good vehicles distributing foods in Kigali should be monitored and or should use no congested "*poids lourds* loads" ,

3. Government of Rwanda should establish the road signs to indicate the location of zebra crossing ahead, and indicate allowed speed before reaching zebra crossing site.

Last but not least, a deep study should be conducted at zebra crossing sites in order to assess compared effect of drivers and pedestrian awareness of zebra crossing law on reduction of accidents at zebra crossing sites in Kigali. The research should be conducted in the whole country to assess the awareness of zebra crossing the law Rwanda

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IX.APPENDICES

APPENDIX 1: FIELD SURVEY FORM ON ZEBRA CROSSING SITES

Surveyor names:

SITE NAME :						
Date :			Time			
			From:		To :	
Direction towards		Width(m)			Baseline Length (m)	
Clock Time Hh mn sec	Vehicle Type	Time reach A	Time reach B	Number of pedestrians started or waiting to cross	Time taken Secs	Delay in sec Calculate later

APPENDIX 2: INTERVIEW FORM IN ENGLISH

Interview survey of drivers' knowledge of zebra crossing rules and of their behaviors at zebra crossings

This interview form has been developed to assist my thesis study in Transportation Engineering and economics(TEE) in better understanding the level of driver compliance with zebra crossing regulations in Rwanda.

The outcome of this survey will therefore help this study to identify what are the factors influence no compliance on zebra crossings regulations in Kigali and provide suggestions for possible ways to improve its performance.

You are therefore kindly requested to provide the responses based on your understanding and knowledge on these different regulations of the zebra crossings in Rwanda. Any information provided by you will be assessed confidentially with no name being recorded and no individual being identified in the course of the survey or during the analysis.

Kind regard,

MUKAMANA Rachel

KIST

MSc student

Surveyor name(s)

Approx time of this batch of interviews: from: am/pm to: am/pm

date: location of interviews:

1. This is the driver of a truck/delivery van/pickup/car/bus/minibus or similar vehicle/motorcycle (tick one only)

2. Male/female

3. How long since you passed your driving test? Years

4. How old are you ? years

5. Are you a professional driver? Y / N

6. When you approach a zebra crossing and there is one or more pedestrians on it, which one of the following does the law require you to do?

Nothing ☐

Steer in front of, or behind, or between the pedestrian(s) ☐

Slow down or stop, starting again when there is a space for you to do so, even if he/she/they have not yet reached the other kerb? ☐

Stop and do not start again until the pedestrian/last pedestrian has reached the other kerb? ☐

7. When you approach a zebra crossing and there is no-one on it but one or more pedestrians are at the kerb waiting to cross, which one of the following does the law require you to do?

Nothing, keep driving ☐

Slow down or stop to allow them to cross, starting again when there is a space for you to do so, even if he/she/ they have not yet reached the other kerb? ☐

Stop and do not start again until the pedestrian/last pedestrian has reached the other kerb? ☐

8. Your responses to the last 2 questions are based on:

zebra crossing rules in Rwanda ☐ experience/intuition ☐

9. In practice, what do you actually do when you approach a zebra crossing and there are pedestrian(s) on it? If your behavior varies, tick more than one box.

keep driving and steer in front of, or behind, or between the pedestrian(s) to avoid hitting them

☐ ☐

slow down or stop, starting again when there is a space to do so, even if he/she/they have not yet reached the other kerb ☐ ☐

stop and do not start again until the pedestrian/last pedestrian has reached the other kerb ☐ ☐

10. In practice what do you actually do when you approach a zebra crossing and there is no-one on it but one or more pedestrians are at the kerb waiting to cross? If your behavior varies, tick more than one box.

keep driving ☐ ☐

Slow down or stop to allow them to cross, starting again when there is a space for you to do so, even if he/she/they they have not yet reached the other kerb ☐ ☐

Stop to let them cross and do not start again until the pedestrian/last pedestrian has reached the other kerb? ☐ ☐

That is the end of my questions. Thank you for your help

APPENDIX 3: PEDESTRIANS AT UTC ZEBRA CROSSING



APPENDIX 4: PEDESTRIANS AT COGEBANQUE ZEBRA CROSSING



APPENDIX 5: PEDESTRIANS AT NYABUGOGO MARKET ZEBRA CROSSING



APPENDIX 6: TABLES ON KNOWLEDGE AND BEHAVIORS OF DRIVERS

1 Drivers behaviors

		Frequency	Percent
Valid	No stop on zebra crossing	94	35.7
	Stopped on zebra-crossing	169	64.3
	Total	263	100.0

1 Vehicle type * Driver behavior _ Cross tabulation

			Driver behavior_		Total
			No stop on zebra crossing	Stopped on zebra-crossing	
Vehicle type	Small vehicle	Count	48	77	125
		% within Vehicle type	38.4%	61.6%	100.0%
		% within travel time	51.1%	45.6%	47.5%
	Medium vehicle	Count	33	74	107
		% within Vehicle_type	30.8%	69.2%	100.0%
		% within travel_time	35.1%	43.8%	40.7%
	Heavy vehicle	Count	13	18	31
		% within	41.9%	58.1%	100.0%

Total	Vehicle_ type			
	% within travel	13.8%	10.7%	11.8%
	_time			
	Count	94	169	263
	% within Vehicle	35.7%	64.3%	100.0%
	_type			
	% within travel	100.0%	100.0%	100.0%
	_time			

3 .Location * Driver behavior _ Cross tabulation

			Driver behavior _		Total
			No stop on zebra crossing	Stopped on zebra-crossing	
Location	COGEBANQUE	Count	61 _a	21 _b	82
		% within	74.4%	25.6%	100.0%
		Location			
	Nyabugogo market	% within travel_time	64.9%	12.4%	31.2%
		Count	20 _a	64 _b	84
		% within	23.8%	76.2%	100.0%
		Location			
	UTC	% within travel_time	21.3%	37.9%	31.9%
		Count	13 _a	84 _b	97
		% within	13.4%	86.6%	100.0%
		Location			
		% within travel_time	13.8%	49.7%	36.9%

Total	Count	94	169	263
	% within Location	35.7%	64.3%	100.0%
	% within travel time	100.0%	100.0%	100.0%

a : cell with counts less of expected values , b: cell having higher than expected values

4 Number of pedestrians_ * drivers behaviors_ Cross tabulation

			Drivers behaviors		Total
			No stop on zebra crossing	Stopped on zebra-crossing	
Number of pedestrians_ 1.00	Count		43 _a	21 _b	64
	% within Number of pedestrians_		67.2%	32.8%	100.0%
	% within travel time		45.7%	12.4%	24.3%
2.00	Count		28 _a	25 _b	53
	% within Number_of_pedestrians_		52.8%	47.2%	100.0%
	% within travel time		29.8%	14.8%	20.2%
3.00	Count		6 _a	30 _b	36
	% within Number_of_pedestrians_		16.7%	83.3%	100.0%
	% within travel time		6.4%	17.8%	13.7%
4.00	Count		9 _a	21 _a	30
	% within Number_of_pedestrians_		30.0%	70.0%	100.0%

	% within travel time	9.6%	12.4%	11.4%
5.00	Count	4 _a	21 _b	25
	% within	16.0%	84.0%	100.0%
	Number_of_pedestrians_			
	% within travel time	4.3%	12.4%	9.5%
6.00	Count	1 _a	24 _b	25
	% within	4.0%	96.0%	100.0%
	Number_of_pedestrians_			
	% within travel time	1.1%	14.2%	9.5%
7.00	Count	2 _a	9 _a	11
	% within	18.2%	81.8%	100.0%
	Number_of_pedestrians_			
	% within travel time	2.1%	5.3%	4.2%
8.00	Count	0 _a	5 _a	5
	% within	0.0%	100.0%	100.0%
	Number_of_pedestrians_			
	% within travel time	0.0%	3.0%	1.9%
9.00	Count	0 _a	4 _a	4
	% within	0.0%	100.0%	100.0%
	Number_of_pedestrians_			
	% within travel time	0.0%	2.4%	1.5%
10.00	Count	0 _a	3 _a	3
	% within	0.0%	100.0%	100.0%
	Number_of_pedestrians_			
	% within travel time	0.0%	1.8%	1.1%
11.00	Count	1 _a	1 _a	2
	% within	50.0%	50.0%	100.0%
	Number_of_pedestrians_			
	% within travel time	1.1%	.6%	.8%
13.00	Count	0 _a	3 _a	3

Total	15.00	% within Number_of_pedestrians_	0.0%	100.0%	100.0%
		% within travel time	0.0%	1.8%	1.1%
		Count	0 _a	1 _a	1
		% within Number_of_pedestrians_	0.0%	100.0%	100.0%
	18.00	% within travel time	0.0%	.6%	.4%
		Count	0 _a	1 _a	1
		% within Number_of_pedestrians_	0.0%	100.0%	100.0%
		% within travel time	0.0%	.6%	.4%
	Total	Count	94	169	263
		% within Number_of_pedestrians_	35.7%	64.3%	100.0%
		% within travel time	100.0%	100.0%	100.0%

5 Driving experience of respondents

		Frequency	Percent
Valid	no experienced (0-3)	58	48.3
	less experienced(3-6)	22	18.3
	experienced(6-9)	20	16.7
	more experienced (>9)	20	16.7
	Total	120	100.0

6. Vehicle type

		Frequency	Percent
Valid	Bus	36	30.0
	Car	23	19.2
	Min bus	61	50.8
	Total	120	100.0

APPENDIX 7. Tables on drivers Knowledge on zebra crossing laws/regulations

1. When you approach a zebra crossing and there is one or more pedestrians on it , which one of the following does the law require you to do?

		Frequency	Percent
Valid	Nothing	3	2.5
	steer in front of or behind or between the pedestrian(s)	22	18.3
	slow down or stop , starting again when there is a space to do so,	83	69.2
	stop and do not start again until the pedestrian has reached the other kerb	12	10.0
	Total	120	100.0

2. When you approach a zebra crossing and there is no one on it but one or more pedestrian are the kerb waiting to cross which one of the following does the law require you to do?

		Frequency	Percent
Valid	nothing	10	8.3
	slow down or stop to allow them to cross, starting again when there is a space for you to do so	105	87.5
	stop and do not start again until the pedestrian has reached the other kerb	5	4.2
	Total	120	100.0

3. Your response to the last two questions are based on the following

		Frequency	Percent
Valid	Zebra crossing law in Rwanda	72	60.0
	experience/ intuition	48	40.0
	Total	120	100.0

APPENDIX 8. Response on Drivers Behaviors

1. In practice, what do you actually do when you approach a zebra crossing and there is one or more pedestrians on it?, if your behavior vary tick more than one box

		Frequency	Percent
Valid	Nothing	35	29.2
	slow down or stop , starting again when there is a space to do so	69	57.5
	stop and do not start again until the pedestrian has reached the other kerb	16	13.3
	Total	120	100.0

2. In practice , what do you actually do when you approach a zebra crossing and there is no one or more pedestrians on it but one or more pedestrian are at the kerb waiting to cross ?, if your behavior vary tick more than one box

		Frequency	Percent
Valid	nothing	43	35.8
	slow down or stop to allow them to cross, starting again when there is a space for you to do so	59	49.2

stop and do not start again until the pedestrian has reached the other kerb	18	15.0
Total	120	100.0

3. Ages * In practice , what do you actually do when you approach a zebra crossing and there is no one or more pedestrians on it ?, if your behavior vary tick more than one box Cross tabulation

			In practice , what do you actually do when you approach a zebra crossing and there is no one or more pedestrians on it ?, if your behavior vary tick more than one box			
				slow down or stop , starting again when there is a space to do so,	stop and do not start again until the pedestrian has reached the other kerb	
Ages	Young(18-35)	Count	22	26	7	55

	% within In practice , what do you actually do when you approach a zebra crossing and there is one or more pedestrians on it ?, if your behavior vary tick more than one box	62.9%	37.7%	43.8%	45.8%
	% of Total	18.3%	21.7%	5.8%	45.8%
mature (35-55)	Count	13	34	7	54
	% within In practice , what do you actually do when you approach a zebra crossing and there is one or more pedestrians on it ?, if your behavior vary tick more than one box	37.1%	49.3%	43.8%	45.0%
	% of Total	10.8%	28.3%	5.8%	45.0%
Old(>55)	Count	0	9	2	11

Total	% within In practice , what do you actually do when you approach a zebra crossing and there is one or more pedestrians on it ?, if your behavior vary tick more than one box	0.0%	13.0%	12.5%	9.2%
	% of Total	0.0%	7.5%	1.7%	9.2%
	Count	35	69	16	120
	% within In practice , what do you actually do when you approach a zebra crossing and there is one or more pedestrians on it ?, if your behavior vary tick more than one box	100.0%	100.0%	100.0%	100.0%
	% of Total	29.2%	57.5%	13.3%	100.0%

4. When you approach a zebra crossing and there is no one on it but one or more pedestrian are the kerb waiting to cross which one of the following does the law require you to do? * In practice , what do you actually do when you approach a zebra crossing and there is no one or more pedestrians on it but one or more pedestrian are at the kerb waiting to cross ?, if your behavior vary tick more than one box Cross tabulation

	In practice , what do you actually do when you approach a zebra crossing and there is no one or more pedestrians on it but one or more pedestrian are at the kerb waiting to cross ?, if your behavior vary tick more than one box			
	nothing	slow down or stop to allow them to cross, starting again when there is a space for you to do so to do	stop and do not start again until the pedestrian has reached the other kerb	Total
when you nothing approach a zebra crossing and there is no one on it but one or	8	0	2	10
slow down or stop to allow them to cross,	31	59	15	105

more pedestrian starting again are the kerb when there is a waiting to cross space for you to which one of the do following does the law require stop and do not you to do? start again until the pedestrian has reached the other kerb	4	0	1	5
Total	43	59	18	120

5. Driving experience * In practice , what do you actually do when you approach a zebra crossing and there is one or more pedestrians on it ?, if your behavior vary tick more than one box Cross-tabulation

Count

In practice , what do you actually do when you approach a zebra crossing and there is one or more pedestrians on it ?, if your behavior vary tick more than one box			Total
Nothing	slow down or stop , starting again when there is a space to do so,	stop and do not start again until the pedestrian has reached the other kerb	

Driving experience	no experienced (0-3)	22	31	5	58
	less experienced(3-6)	6	10	6	22
	experienced(6-9)	1	17	2	20
	more experienced (>9)	6	11	3	20
Total		35	69	16	120

APPENDIX 9. Statistical Test

1. Ages and driving experience

Correlations

		Ages	Driving experience
Ages	Pearson Correlation	1	.312 ^{**}
	Sig. (2-tailed)		.001
	N	120	120
Driving experience	Pearson Correlation	.312 ^{**}	1
	Sig. (2-tailed)	.001	
	N	120	

^{**}. Correlation is significant at the 0.01 level (2-tailed).

2. Law and Behavior

Correlations

		When you approach a zebra crossing and there is one or more pedestrians on it, which one of the following does the law require you to do ?	In practice , what do you actually do when you approach a zebra crossing and there is one or more pedestrians on it ?, if your behavior vary tick more than one box
When you approach a zebra crossing and there is one or more pedestrians on it , which one of the following does the law require you to do?	Pearson Correlation Sig. (2-tailed) N	1 120	.686** .000 120
In practice , what do you actually do when you approach a zebra crossing and there is one or more pedestrians on it ?, if your behavior vary tick more than one box	Pearson Correlation Sig. (2-tailed) N	.686** .000 120	1 120

** . Correlation is significant at the 0.01 level (2-tailed).

3. Behavior and law

Correlations

		In practice , what do you actually do when you approach a zebra crossing and there is one or more pedestrian s on it ?, if your behavior vary tick more than one box	Driving experien e	when you approach a zebra crossing and there is no one on it but one or more pedestria n are the kerb waiting to cross which one of the following does the law require you to do?	In practice , what do you actually do when you approach a zebra crossing and there is no one or more pedestrian s on it but one or more pedestrian are at the kerb waiting to cross ?, if your behavior vary tick more than one box	When you approach a zebra crossing and there is one or more pedestrian s on it , which one of the following does the law require you to do?	Ages
In practice , what do you	Pearson Correlatio n	1	.141	.308**	.600**	.686**	.205*

actually do when you approach a zebra crossing and there is one or more pedestrian s on it ?, if your behavior vary tick more than one box	Sig. (2- tailed)		.123	.001	.000	.000	.025
	N	120	120	120	120	120	120
Driving experience	Pearson Correlation	.141	1	.188*	.154	.255**	.312*
	N	120	120	120	120	120	120
when you approach a zebra crossing and there	Sig. (2- tailed)	.123		.040	.094	.005	.001
	N	120	120	120	120	120	120
	Pearson Correlation	.308**	.188*	1	.068	.641**	.117
	Sig. (2- tailed)	.001	.040		.459	.000	.205

is no one on it but one or more pedestrian are the kerb waiting to cross which one of the following does the low require you to do?	N	120	120	120	120	120	120
In practice , what do you actually do when you	Pearson Correlatio n Sig. (2- tailed)	.600** .000	.154 .094	.068 .459	1	.458** .000	.073 .430

approach a zebra crossing and there is no one or more pedestrian s on it but one or more pedestrian are at the kerb waiting to cross ?, if your behavior vary tick more than one box	N	120	120	120	120	120	120
When you approach a zebra crossing and there	Pearson Correlation	.686**	.255**	.641**	.458**	1	.281*
	Sig. (2-tailed)	.000	.005	.000	.000		.002

is one or more pedestrian s on it , which one of the following does the law require you to do?	N	120	120	120	120	120	120
Ages	Pearson Correlation	.205*	.312**	.117	.073	.281**	1
	Sig. (2- tailed)	.025	.001	.205	.430	.002	
	N	120	120	120	120	120	120

**. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed).

4 Ages and law

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	12.841 ^a	6	.046
Likelihood Ratio	14.746	6	.022
Linear-by-Linear Association	9.383	1	.002
N of Valid Cases	120		

a. 5 cells (41.7%) have expected count less than 5. The minimum expected count is .28.

5 Ages and behavior

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	8.528 ^a	4	.074
Likelihood Ratio	11.440	4	.022
Linear-by-Linear Association	5.006	1	.025
N of Valid Cases	120		

a. 2 cells (22.2%) have expected count less than 5. The minimum expected count is 1.47.

APPENDIX 10: Training and Pilot Survey

Training

Training of surveyors were done from 8:00 to 12:00 at KIST on the 30th September.

The details and purpose of the survey were given, survey and the interview forms were explained in detail. Surveyors were trained on different two types of surveys, survey forms and the procedures to fill in the forms. The same group of surveyors were maintained for the whole period of surveys in order to avoid any loss of time to train new surveyors and to maintain their flow of understanding about the surveyors.

On this date detailed descriptions of the surveys were given out, and each survey task was described and practised later.

Pilot Survey

In a real survey, pilot surveys would be done to test the survey method and to help train the surveyors. It is important that all surveyors read fully the instructions for each survey, and for each task within that survey, and have the opportunity to ask questions before the survey day.

The pilot survey was conducted at predefined locations on the 1st and 2nd of October/2013 .

The concept of surveys was new to surveyors therefore the extra effort was taken to explain the survey. It was not difficult to find driver to interview, the driver in Kigali was very interested in the study and the time took to answer the questions.

Field survey was planned to carried out during peak hours either from 6 A.M or 5 P.M ,during pilot survey it was found that at 6 A.M the flow of pedestrians at zebra crossing was low which could affect the data that is why the survey were carried out at 5 P.M to enable more data to be collected.

Cross table of Knowledge and behavior of Drivers

	Drivers behavior (%)			
Driving experience	A	B	C	Total
no experienced (0-3)	22 (37.9)	31 (53.4)	5 (8.6)	58 (100)
Less experienced	6 (27.2)	10 (45.4)	6 (27.2)	22 (100)
experienced(6-9)	1 (5)	17 (85)	2 (10)	20 (100)
more experienced (>9)	6 (30)	11 (55)	3 (15)	20 (100)
Total	35 (100)	69 (100)	16 (100)	