ADDIS ABABA UNIVERSITY
ADDIS ABABA INSTITUTE OF TECHNOLOGY
SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING

ASSESSMENT OF MOTORCYCLE CRASHES IN SOUTH OMO ZONE, ETHIOPIA

A THESIS SUBMITTED TO ADDIS ABABA UNIVERSITY SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING IN PARTIAL FULFILLMENT OF THE REQUIREMENT FOR THE DEGREE OF MASTERS OF SCIENCE IN ROAD AND TRANSPORT ENGINEERING

BY
TEGEGN MOTA DADEBO

ADVISOR
Dr. GETU SEGNI TULU

DECEMBER, 2019

ADDIS ABABA, ETHIOPIA

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DECLARATION

I, the undersigned, declare that this thesis entitled "Assessment of Motorcycle Crashes in South Omo Zone, Ethiopia" has been carried out by me under the supervision of my research Advisor Dr. Getu Segni Tulu and has not been presented as a thesis for a degree in any other university. All sources of materials used for this thesis have been duly acknowledged.

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Date: December, 2019

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ABBREVIATIONS AND ACRONYMS

ANOVA: Analysis of Variance

BAC: Blood Alcohol Concentration

CI: Confidence Interval

CSA: Central Statistical Authority

g/dl: gram per deciliter

GDP: Gross Domestic Product

Km: Kilometer

Kph: Kilo Meter per hour

MCC: Motorcycle Crashes

NGO: Non-Governmental Organization

OR: Odd Ratio

MPH: Mile per Hour

NHTSA: National Highway Traffic Safety Administration

RTC: Road Traffic Crash

RTA: Road Traffic Accident

RTDD: Road and Transport Development Department

RTI: Road Traffic Injury

SOZTPO: South Omo Zone Traffic Police Office

SPSS: Statistical Package for the Social Science

UK: United Kingdom

USA: United States of America

WHO: World Health Organization

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ABSTRACT

Road traffic crashes have a significant impact on social, economic and public health sectors in Ethiopia. Globally, close to 1.35 million peoples die from road traffic crashes each year. Of these, on average,28% of road traffic death accounted for two and three-wheelers worldwide. These figures indicate that two and three-wheelers death occurs more than a quarter of all road traffic crashes. In South Omo, motorcycles are often used for personal and commercial transport and gradually leads to different crashes, which deserves more attention. The main objective of this study is to assess the magnitude and factors associated with motorcycle crashes in the south Omo zone, Ethiopia. Both primary and secondary data sources were used. Four-year police-reported crash data included reports from (January 2014 to December 2017) about motorcycle crashes was conducted from records of four police stations of south Omo zone and standard questionnaire were require an in-depth understanding of the problems. First, descriptive statistics were used by using frequency distribution and percentages. Multinomial logistic regression model and one-way analysis of variance (ANOVA) were done using SPSS software which was used to analyses secondary and primary data respectively. The results indicate that a total of two hundred six motorcycle crashes have been registered in four police stations throughout the studied are from (January 2014 to December 2017). Among these,36(17.5%) was fatal,88(42.7%) were serious injuries,52(25.2%) were slight injuries and 30(14.6%) were caused by property damages. The gender proportion of motorcycle crashes were happened by male riders only. The result of multinomial logistic regression model reveals that, severity of motorcycle crash increase with riders age of below 18 and between 31-50;low education level(5 to 8); insufficient riding experience(over 2 to 5); owners of motorcycle; long service year of motorcycle(over 5 to 10) and motorcycle with sudden mechanical problems are the main determinant factors for the occurrence of motorcycle crashes. Almost, the highest number of motorcycles are legally registered. But, some of them are unregistered and the impact would be the severity of the crash which might be worst. In addition, the result from the participants or motorcycle riders in this study respond shows that, of the total,37.9% of motorcycle riders are not wearing safety helmets. Moreover, the main factors that contribute to the occurrence of motorcycle crashes are human factors 266(68.6%), Vehicular (motorcycle) factor 36(9.3%), environmental factor 44(11.3%) and the other like enforcement of legislation and regulation 42(10.8%) are other factors to the occurrence of motorcycle crashes.

Based on the study, among others, the most important factors for motorcycle crashes were failure to give priority for pedestrians, careless riding, over speeding and violating traffic rules. Besides, loss of control of motorcycle and collision while overtaking other road users were the other most risk factors. Generally, the problem was steadily increasing in the study area over this period of time and needs critical remedial measurements. Though, the concerned policymakers may need to consider those mentioned factors; ensuring that motorcycle riders obey traffic rules, making sure that the riders are properly training before riding and enforcing the speed limit appear to be the most critical parts of necessary measurements.

Key Words: Motorcycle, Crashes, Magnitude, Risk factors, South Omo Zone, Ethiopia

1. INTRODUCTION

1.1. General Background

Road traffic crashes have a significant impact on social, economic and public health sectors in Ethiopia. Globally, close to 1.35 million people died due to road traffic crashes each year which is increased 10% million compared with the previous year means that nearly 3700 people are killed on the world's roads every single day. The data from world health organization report shows that low and middle-income countries bear the greatest burden of road traffic fatalities and injuries, which is ranked as the eighth leading cause of death for people of all age groups. Moreover, the report further stated that, in southeast Asia and the western pacific, the majority of deaths are among riders of motorized two and three-wheelers which represent 43% and 36% of all death respectively (WHO, 2018).As a result, World health organization is collaborated to reduce the number of mortality rates from traffic crash by half in the year 2020 of all road traffic deaths (WHO, 2018).

Globally, almost 1.25 million peoples die each year means that more than 3,400 peoples are killed on the road every single day, and about 20 to 50 million people injured as a result of road traffic crashes. However, the majority of 90% occur in low and middle-income countries which have 82% of the world population and 54% of the world's registered motorized vehicles. This fact suggests that the road traffic death rate in those countries had twice compared with high-income countries (WHO, 2015). Even though, the report further revealed that almost 286,000 (23%) of all road death in 2013 is in motorcycles which are mostly in developing countries. Moreover, the report further stated that 34% of the world motorcycle fatality occurs in South East Asian and Western Pacific regions.

According to the world health organization (2013) road safety report, the African region has the highest mortality rate in 2010, which has an average of 24.1 per 100,000 motor vehicle crashes. However, it has only 2% of the world's vehicles and contributes 16% to global death. Almost, 33.7 and 31.9 death per 100,000 per year occurs in Nigeria and South Africa which has the highest fatality rates respectively in Africa. Out of these figures, motorcycle fatality accounts for only 7% of total death (WHO, 2015). Nowadays, as a whole road traffic death becomes an embryonic major public health alarm and hinders the economic and social development of the country and affects thousands of lives, resulting in severe injuries (Tariku, et al., 2017). Worldwide, road traffic injury projections indicated that it will become the fifth leading cause of death by 2030 unless there is a new commitment to prevention (WHO, 2013). Even though the number of motorcycle crashes increased from time to time and more emphasis needs to be given to make motorcycle safety for safe roads and also the interventions are needed carefully specially for low and middle-income countries, like Ethiopia.

In developing countries; quickly increasing motorization is overtaking the development of transportation infrastructure as well as fatalities and injuries due to road traffic crashes are also raising. Even at that,

Ethiopia is one of the low-income countries with low motorization ownership but high predominant road traffic injuries which is categorized in this region. Indeed, according to the recent study conducted in Ethiopia, reported that overall incidence rate in motor vehicle crashes and related fatalities is still very alarming and needs more attention to reduce such scenarios (Teferi et al., 2014). Additionally, the report (WHO, 2006) in Africa announced that the death from road traffic injuries is 40% greater than other low- and middle-income countries and 50% greater than the average of the world deaths. As a result, the problem is likely to be more severe in a motorcycle than other motor vehicles and it needs more fights to defend for road safety (Enos, 2010).

Motorcycle crashes are on the rise and at such a fearing and disturbing rate. In fact, several pieces of evidence from many studies show that most of the motorcycle crashes occur due to motorcycle rider error (Allen, Rice, Senserrick et al., 2017; Heydari et al., 2016; & Bambach et al., 2012;). Moreover, all studies have reported that unsafe behavior resulting from rider error is one of the major causes of the motorcycle crash. Compared to other motor vehicle drivers, motorcycle riders are often considered more vulnerable because of their lack of protection in the event of a crash. Hence, motorcycle riders are often associated with high fatality and injury risks. Therefore, understanding and improving rider behavior are one important way of increasing motorcycle safety and needs greater effort.

In low and middle-income countries, motorcycles are the main convenient means of transportation used for daily phenomena. This comes in line with increasing crashes with other motor vehicles due to their small physical bodies. According to the latest world health organization (WHO) data published in 2017, road traffic death in Ethiopia is reached almost 27,140 (4.27%) of total death including motorcyclists and the age-adjusted death rate is 36.36 per 100,000 of population. Unfortunately, these ranks, Ethiopia number 22 (twenty-two) in the world. The report further shows that Ethiopia is among the worst in traffic safety unless the government needs to take action to address road safety. However, this requires a contribution from multiple sectors such as transport, police, health, education and actions that address the safety of roads, vehicles and as well as road users and so on (WHO, 2017). Therefore, to reduce this problem effectively, it is important to identify the main contributing risk factors that affect motorcycles crashes by reviewing the studies done in other countries and identifying the different gaps.

Motorcyclists are the main road users of any prospering and growing economy in their daily life. However, growing concerns related to motorcycle crashes have increased from time to time owing to the potential level of injury severity and economic impact. Spacious et al., 2016, a study in Tanzania shown that motorcycles were the leading cause of road traffic crashes, which accounts for 53.4% of total road traffic injuries. Even though, the increase in population size, motor vehicle particularly motorcycles and also infrastructure with the economic growth and increase in the size of the city demands, a transport

service supply in line with the increase in the mobility need of the people. However, motorcycle injuries have become an undesirable cause of this urbanization and motorization. Moreover, the study testified that motorcycle fatality increases with increasing motorization and urbanization in early levels of growth (Law et al., 2009).

To date, only little is known about motorcycle crash, which strikes gradually enormous human lives, especially in low- and middle-income countries. However, the motorcycle fleet in Ethiopia is increasing in number with results in deaths and injuries from time to time if compared with crashes from the other motorized vehicle groups, especially in the south Omo zone. Recent studies on road traffic crash in Ethiopia shown, there is an escalation of motorcycle crashes (e.g. Wolayta and Arbaminch cities). However, till now no study is conducted, particularly on motorcycles crashes. Furthermore, the problem is increasing from time to time and goes through a tremendous loss of human life and needs intimate collaboration and immediate response with stakeholders on the issue. This study focuses on three main factors contributing to motorcycle crashes such as human, vehicle (motorcycle) and environmental factors. A recent study conducted on road traffic crashes reported that almost 40% and 31.2% of road traffic injury on both Arbaminch and wolayta city respectively, were in motorcycles (Direslgne et al., 2017 & Haile Michael et al., 2015). However, this is only the magnitude but not means that risk factors are identified for the issue but more study is needed to identify those factors that contribute to motorcycle crashes. Therefore, the intention of this study is mainly concentrating on assessing the magnitude and main risk factors associated with motorcycle crashes and possible countermeasures to reduce motorcycle crashes related to the high involvement of motorcycles in the south omo zone, Ethiopia. The findings should be essential for the evidence-based interventions for policy-making decisions to reverse the dangerous motorcycle crash trend and to improve motorcycle safety in the study area as well as other cities in Ethiopia.

1.2. Statement of the problem

Worldwide, close to 28% of the total road traffic crash occurs among motorized two and three-wheelers. Out of this figure; the African region accounts alone 9% of the total share of crashes (WHO, 2018). However, few studies conducted in Ethiopia on road traffic crashes show that the problem is serious and suggested that the government needs to give due attention to motorcycle safety. For instance, a study was done at Arbaminch general hospital, 45 (40%) out of 112 road traffic injuries resulted from motorcycle crashes (Direslgne et al., 2017).In addition to these, the study conducted on Bahir Dar, Amhara, Ethiopia among 524 road traffic injuries, 108 (20.6%) and wolayta zone, SNNPR of Ethiopia among 240 road traffic injuries, 75 (31.2%) were due to motorcycle crashes respectively (Asaye & Haile Michael et al., 2015).

According to the south omo zone road and transport development department (2017) report, the total number of only registered (motorcycles which have number plate only) within four years (from 2014 to 2017) is almost 3,045 and increased in 13.6% between four years. However, in this report crashes due to unregistered motorcycles were reported. Indeed, this figure is excluding the motorcycles which have not number plates. In the same way, the death and injury of motorcycle-related crashes have also increased in the popularity of motorcycling during the same period. Besides, due to rapid motorization and urbanization, most of the rural and urban communities have used this mode of transport for a daily activity without due training. (Yideg, 2015) study in Gedeo zone, Ethiopia announced that due to poor controlling system both in giving license for the riders and enforcing traffic regulation, most of the motorcyclist had been resulted from highest rate of crashes compared with other vehicles and these report further witnessed that the numerous number of motorcycles on the road are without having number plates. Moreover, the study revealed that those who ride without a number plate had the highest probability to be involved in the crashes.

In connection with all the above facts, there has been an increase in the number of motorcycles over the last four years in the South Omo zone. And this has obviously come in hand with an increase in motorcycle injuries and fatalities from time to time, and nothing has been done about this worst issue. As a researcher, I recommended that the government could be aware of this issue so that something can be done in the nearest future. The trend is expected to continue if no preventive measures are done to reduce these serious issues.

1.3. Research questions

The study focuses on the following research questions to achieve the study.

1. What is the magnitude of motorcycle crashes in the south omo zone?
2. What are the major risk factors affecting the motorcycle crashes in the south omo zone?
3. What possible countermeasure can be applied to reduce the problems of motorcycle crashes (MCCs) in the study area?

1.4. The objective of the study

This study is expected to address the following general and specific objectives.

1.4.1. General Objectives

The main objective of this study aims to assess the magnitude and main risk factors affecting motorcycle crashes in the South Omo zone, Ethiopia and also try to fill the research gaps by providing possible countermeasures to reduce the problems.

1.4.2. Specific Objectives

The specific objectives of the study are:

- To assess, the magnitude of motorcycle crashes in the south omo zone.
- To identify major risk factors affecting the motorcycle crashes in the south omo zone.
- To propose possible countermeasures to the problems of motorcycle crashes in the study areas.

1.5. Scope of the Study

The scope of the study was limited to the south omo zone which is seven hundred fifty (750 Km) from Addis Ababa (the capital city of Ethiopia) and five hundred thirty (530 Km) from Hawassa (main region of southern nation's nationalities and people's region) of Ethiopia. Besides, the study focuses on four main police station reports, particularly in motorcycle crashes by considering the highest number of motorcycle populations around the study areas.

1.6. Significance of the study

Previously, no studies conducted to assess motorcycle safety in the south omo zone, Ethiopia. So, the finding of this study is immensely important in different scenarios. However, it may serve as a benchmark for the stakeholders to develop evidence-based interventions in order to overpower the impact of motorcycle crashes in the country. Therefore, this study will contribute important inputs regarding the magnitude and main risk factors affecting motorcycle crashes in the south omo zone. Moreover, this study will recommend the possible countermeasures to policymakers and other stakeholders in order to decrease death and injuries resulting from motorcycles crashes. In the end, this study may also help as a baseline data for further studies on the motorcycle's crashes in south omo zone and reference for other cities in Ethiopia.

1.7. Organization of the Study

The study is been classified into five main chapters. Chapter one gives an introduction to the study and contains the background of the study, statement of the problem, research questions, objectives of the study (general and specific objectives), Scope of the study, the significance of the study, and limitation of the research. Chapter two reviews kinds of literature on motorcycle safety and possible countermeasure to reduce the problems. In chapter three, the method used to conduct the research is described and details of the method of the research works have been stipulated. Chapter four presents the findings on data analysis and discussion. Finally, based on analysis discussions, the research comes up with a general conclusion and recommendations of the study are stated in chapter five.

1.8. Limitation of the Study

During the preparation of this report, the researcher faced so many challenges such as the absence of sufficient information related to motorcycles crashes in terms of their number, type, distribution, traffic flow, and other related factors, which made this study difficult. Also, the available data is more general including vehicles other than motorcycles; and also, some data is not fully registered in the daily record checklist document of each police station. In addition to this, a lack of some very useful data was another problem. For example, the records in the police stations said nothing about helmet and rider's alcohol and drug use. Improper handlings of data were strongly seen in those police traffic stations. The study has to rely on data from the archives of the traffic police, which are bulky and uneconomical in terms of time and resources. In addition, the study was limited by the unwillingness of some of the respondents to give information about motorcycles due to doubt of some nature. Besides, shortage of times, insufficient finance, absence of recent information and limited cooperation of the government offices were the main problems that, the researcher had to face during the survey and data collection phase. These limitations were solved in order to render the study successful. The purpose of the study was explained briefly to the respondents which were only academic and assured them about the confidential treatment of their information.

2. LITERATURE REVIEW

2.1. Introduction

This chapter provides a detailed literature review on related background studies. And also, it gives literature `based on available published research notes and journal papers on the magnitude of motorcycle crashes and major risk factors mainly contributing to the motorcycle crashes and also provides possible countermeasures in the study areas.

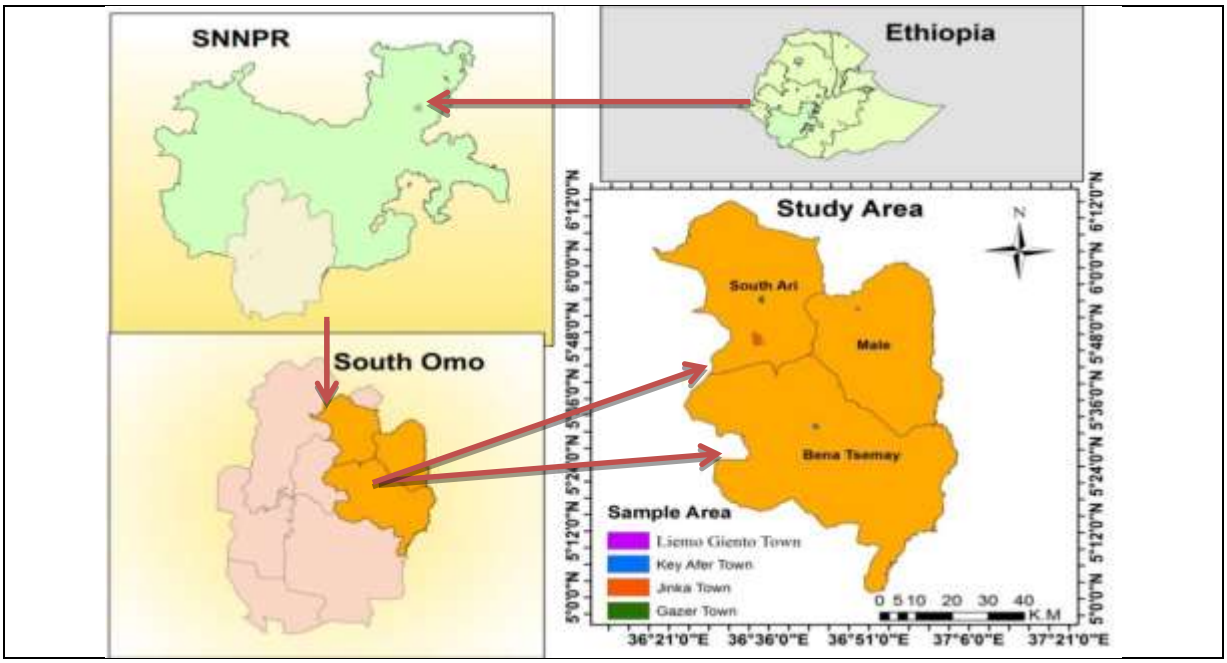

Figure 2.1: Road map of the study area
Source**:** Google map

2.2. Concept of motorcycle crashes

A road traffic crash is defined as any vehicle crash occurring on a public highway. It includes collision between vehicles and animals, vehicles and pedestrians or vehicles and other fixed obstacles including single-vehicle crashes, which is involved a single-vehicle without including other road users are also included (Safe Car Guide & Tesema et, al., 2004). However, in 2013, the World health organization (WHO) reported that approximately fifty (50%) of all death occurs all over the world is due to Vulnerable road users especially in a motorcyclist is accounted (23%) of all death. Moreover, there is an increasing trend of motorcyclist death and injuries throughout the world over the past four years. As a result, they are at high risk of severe head injury, which is the main cause of death. Even at that, the reason behind the issue, is most of the motorcyclists are not using safety equipment like wearing a helmet (Shehzad et al., 2017 & Nunn, 2011).

Motorcyclists share traffic space equally with other road users, especially in those developing countries. However, these make them as highly represented in the fatal crash because they are physically small and

not seen by other vehicles in addition to this, use a small space to overtake. As a result, the number of motorcycle injuries is increased in a number of countries in recent years (Who, 2015 & Naci et al., 2009). However, Human errors, road environment, and vehicle (motorcycle) factors are reported by the traffic police as the main causes of road crashes. Consequently, countries need to take more action in order to reduce the problem and to make roads safe for all users.

2.3. Overview of trends in motorcycle crashes

According to recent data from world health organization (WHO) reports on road traffic crashes in 2017, the cost of most countries is almost 3% of GDP (gross domestic product). However, it has a great effect on all country's economy especially a developing country, like Ethiopia.

Motorcycle crash as well as other motor vehicle crashes, has negative effects on the economy and human life both in developed and developing countries. For instance, in 2015, the organization for economic co-operation and development made a comprehensive report in Great Britain tried to identify the intimacy between economy and road causality. And, attested that the economy and road causality have direct relationships besides the main fact behind is that, as the economy of a certain country increases, in the same way, traffic volume increase so does. As a result, if the volume of traffic is high, the causality is also too high. In addition, the study carried out in Mekelle city, northern Ethiopia reported that road traffic crash affects not only south economy but also it is a human security threat in developing countries which could cause fatality, disability, and illness (Micheal, 2017). Therefore, identifying the challenge of road traffic crashes in the economy and human security will need to take due attention by the governments and other stakeholders. Hence, also identifying risk factors that affect to come up with those issues is very essential and need more effort.

According to the National Transport and Safety Authority (2014) report, the total number of motorcycle fatalities is increased from the year 2005 to 2014 which accounts for 44 (forty-four) to 394(three hundred ninety-four) respectively. A recent study conducted in Cambodia, which is located in Southeast Asian country found that overall road traffic fatality is increased by 23% from 2007 to 2011 which accounts for 1,545 to 1,905 deaths occurred. However, among the dead in 2011, 88% were occurred in vulnerable road user like motorcyclist (66%), pedestrian (13%) and family/passenger vehicle account (9%). out of total death, from five years period motorcyclist fatalities increased by 30% (Roehler et al., 2015). The study was done on urban referral hospitals in Kigali, Rwanda; found that about (62.84%) out of 269 (two hundred sixty-nine) of all road traffic injuries, motorcyclists take the first rank which is accounted for 30.86% (Ingabire et al., 2015). As a result, motorcycle crashes are challenging hazards in many low and middle-income countries because they are used for different means of transportation but in the developed world, it is different i.e. for recreational purposes only (Who, 2015).

However, an increasing number of published studies on road traffic injuries and fatalities show that the RTA problem gets more and more attention by governments, NGOs, academics and the international community more broadly. Moreover, the fatalities in motorcycles have continued to increase for the past years in both the United States and Great Britain shows an upward trend. However, in most of these years; In Great Britain, the rate of increasing motorcyclist Causalities and fatalities has been higher than the rate of other vulnerable road user groups. This fact is shown in the following (chart 2.1).

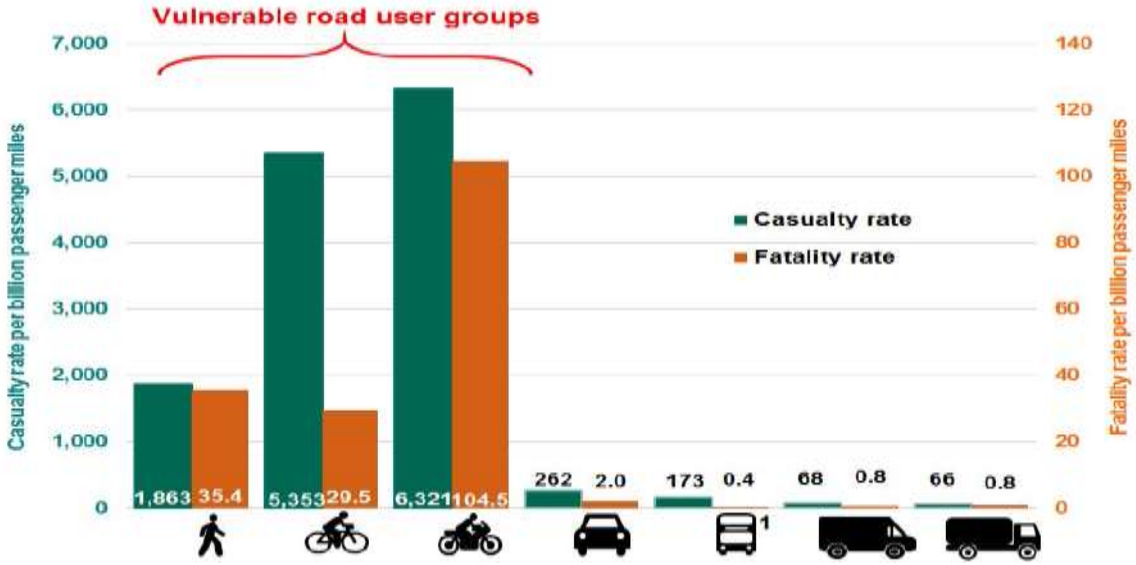

Chart 2.1: Causalities and fatalities rates by road user type

Source: Annual Report, Road Causalities in Road User Group, Great Britain, 2016

The number of motorcycles from time to time is increasing in both developing and developed countries even at that, motorcycle crashes are increased more in developing countries (Haworth, 2012).In addition, data collected for the global status reports for road safety in 2015 shows that between 2010 and 2013 there was a 27% growth in the number of motorized two-wheelers globally. Further, the report has shown that the economic cost of road crashes and injuries is estimated to be one percent (1%) of gross domestic product (GDP) in low-income countries like Ethiopia. However, to reduce this serious growing issue more attention is needed carefully by understanding the challenging risk factors.

For instance, understanding the death of motorcycle crashes by different road users for example drivers, cyclists, motorcycle rider including two and three-wheelers and also other road users is essential. However, from the previous world health organization report, Cambodia is one of the low-income countries like Ethiopia which has total registered motorized vehicles 2,457,569 in 2013. Out of these figures, motorized two and three-wheeler accounts 2,068,937 (84.2%) and other motorized vehicles account for only 388,632 (15.8%). Even at that motorized two and three-wheeler accounts 71% of all road crash deaths (WHO, 2013). Moreover, this fact emphasizes that motorcycle injury is a very serious issue,

especially in a developing country. Hence, more focus will be needed for motorcycle safety. The following figure shows the explained idea in the above (Figure 2.2).

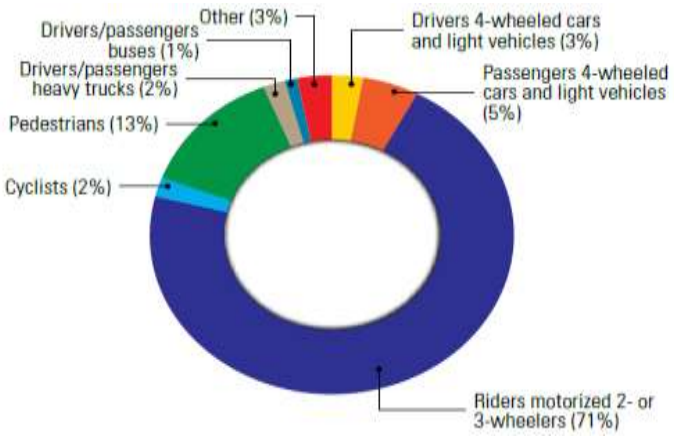

Figure 2.2: Percent of death by road user category
Source: Annual report, death by road users in Cambodia, (WHO, 2013).

Most studies show that motorcycle crash has occurred with other motor vehicles. The reason is that due to their small physical body; they haven't seen by other vehicle drivers. As a result, they are risky due to lack of protection during the crash. More recent study shown that road crashes caused by motorcyclist accounted for 23.23% of all road traffic crashes were due to the collisions between motorcycle versus another motor vehicle, the reason behind the problem is that riders were not wearing safety helmet at event of crash and these trends, the majority of riders to head injury (Eric et al., 2018). In addition to these, another recent study result shows that 73% of all crashes involved with motorcycle-vehicle (Sanyang et al., 2017).

As have seen from the following figure, the recent study result revealed that compared to other causes of motorcycle injuries; motorcycle-vehicle was the commonest one and accounted for 45% of all motorcycle injuries (Ingabire et al., 2015). This study could be addressed those problems according to our context so does.

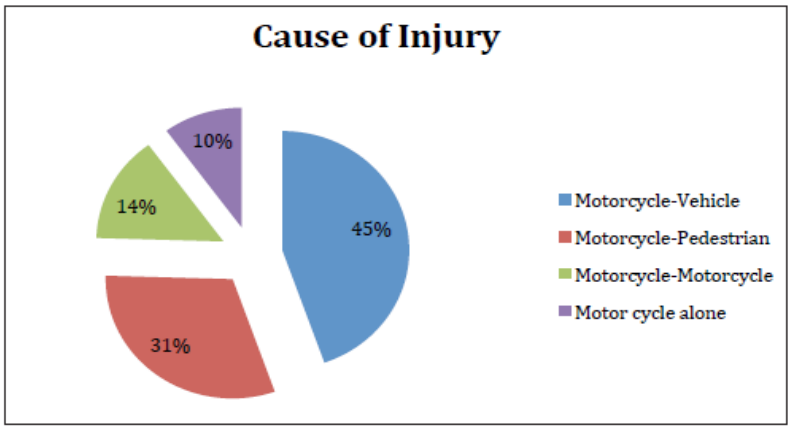

Figure 2.3: Cause of injuries in motorcycles with other road users
Source: Kigali teaching University hospital emergency Report, Rwanda; From Original Article (Ingabire, et al., 2015).

2.4. Major factors contributing to the motorcycle crashes

Road traffic crashes are formed by a complex combination of different factors but not attributed to any single factor. However, the study carried out in Kenya on motorcycle safety, the finding had revealed that the regular occurrence of motorcycle crashes is happened due to poor training skills, lack of riding experience, not wearing safety helmet regularly, un-implementation of traffic laws and also nature of the roads. However, these all fact place motorcyclists at risk of road traffic injuries (Silvester, 2014).

Most of the time motor vehicle crashes are formed by the combination of the following three components. These are classified into three road system components as Human, the vehicle (motorcycle) and the road environments factors.

Moreover, according to the Ethiopia steps survey (2015) on the road traffic accident facts report, show the Human factor contributes (80%), the vehicle factor (8%), the road environment factors (3%) and other factor accounts (9%). However, a very recent study carried out in motorcycle traffic injuries in Iran and the world, the result shows that human factors account for 58.82%, Vehicle factors account for 22.05% and environmental factors account for 17.64%. Further, the figure revealed that the human factor takes the first rank for the occurrence of road traffic crashes for either motorcycle or other motor vehicles (Mazaheri et al., 2018).

The following figure shows how those three components interacted with each other (figure 2.4).

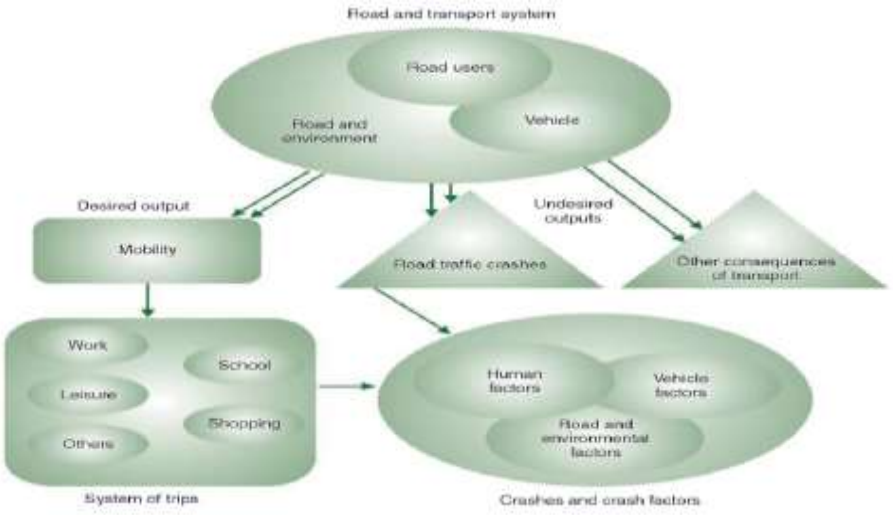

Figure 2.4: Three components of road and transport approach system
Source: Transportation planning and road safety, New Delhi; India, 2005

According to the study conducted in Hunan, China and Iran reported that enforcement of speed limit, advertising of helmet wearing, road lighting system and the conspicuity of motorcycle riders are the main contributing risk factors for motorcycle crashes (Fangrong et al., 2016). A similar study reported that rider age, rider alcohol, and drug use, and speed were contributors to both head and neck injuries (Erhardt et al., 2016).

However, the recent study conducted on India tried to explain factors that contribute to the motorcycle crashes and focused only on-road factors but not considered in other factors like human and vehicular (motorcycle) factors and also the methodology that the researcher used is not explained briefly (Naqvi et al., 2017). Most of the studies conducted in other countries used questionnaire-based methods. Consequently, this study was considered different factors from those to identify the issues efficiently.

2.4.1.Human Factors

Human factors contribute the largest share in the occurrence of road traffic crashes. However, in developing countries, almost 70 to 80 % of all traffic crashes are due to human factors (WHO, 2013). These factors are for instance age, alcohol, and other drug use, experience, training of riders, speed and helmet which are explained in detail in the following section. As a result, a human factor plays a key role in road traffic crashes.

The study conducted in Southeast Iran results shows that out of 2,156 (90%) of all road crashes, the human factor was a main contributing factor which is reported by police (Rad et al., 2016). The reason behind that is, due to losing control of motorcycles and disregarding traffic laws. A similar study conducted In Iran concluded that having no riding license and not wearing safety helmets are the two main influential factors that increase the fatality risk of motorcycle crashes (Tavakoli et al., 2016). These studies emphasized that most of the motorcycle crashes happen due to human factors. Hence, a deep understanding of those factors may reduce motorcycle crashes which are also our country's challenge and needs great effort to come up with solutions.

2.4.1.1. Age of motorcycle riders

Age is the main factor responsible for the occurrence of motorcycle crashes. However, most studies investigated that increasing age will increase the chance of crash while other studies show that the low age, decrease the chance of crashes. Even at that, the idea that researchers found is controversial, it is better to consider the recent fact conducted on this Environment which is convinced more of us.

Indeed, the recent study found that increasing age and long experience in motorcycle use are the two main contributing human factors being involved in the severity of motorcycle crashes. However, an increase in age will increase the chance of severe crashes in motorcyclists. Indeed, they cannot easily observe the hazards on the road them as aged and experienced (Apidechkul & Flavio et al., 2017). Moreover, Similar findings have been reported earlier (Schneider & Savolainen, 2011). Although, another recent study conducted in western Africa especially in the Gambia, found that out of 254 (94%) of motorcycle crashes were occurred among males and more than 71% of crashes were involved above the age of 25 years (Sanyang et al., 2017). Furthermore, this can be partly be explained by their greater exposure to traffic crashes as a rider/driver and as frequent travelers in motorcycles as well as other motor vehicles for daily activities. Even though, Ethiopia is not focused on this issue whether increasing age and experience,

increase the probability of motorcycle crash or not. Therefore, this idea must focus on the time of this study.

2.4.1.2. Alcohol and other drugs

Alcohol and other drugs have been found to be major risk factors in all types of motorcycle crashes as well as other motor vehicles. The study shows that increasing the consumption of alcohol and drug use, increases the chance of death or serious injury (Kudebong et al., 2011). Another study which was conducted in Nairobi, Kenya has shown that an increase in drug or other substances by 1% increases crash by 14.8% why because it won't be able to balance while riding and likely to cause crashes.

Ethiopian federal police commission sets national drink driving laws for both general and young drivers. In the year 2012/2013, data from federal police commission show that BAC (Blood alcohol content) limit for the general population and young drivers is less than or equal to 0.08g/dl. However, the total number of road traffic death account of 4%. Moreover, making a comparison is difficult because legal BAC limits and enforcements vary so much from country to country.

Even though, Ethiopia, which is a low-income country, which has insufficient resources and economy to cover those all needs for road safety. Moreover, this fact shows that using alcohol has a negative impact (WHO, 2015).

Educating, people about the impact of alcohol and drug use is not only enough to reduce those issues but also police enforcement on the road is more important with the attentive following of riders (Smith, 2013).

2.4.1.3. In-experience and rider training

Riding a motorcycle requires sufficient experience and due training before riding on public roads. The same is true for other motor vehicles. Moreover, the studies have ensured that riders who have taken rider training courses are better equipped to cope with riding emergencies and less likely to be involved in a crash. In addition, According to the study on the risk of motorcycle injuries in Umea University on public health, results show that, 69% of motorcycle riders themselves were the caused by crashes is due to the lack of knowledge or poor riding skills about motorcycles and concluded that those who have taken formal training courses are better equipped their vehicle (motorcycle) and less likely to be involved in a crashes (Nyagwuyi, 2012). Moreover, the author further found that 75.6% of riders have poor riding techniques leading to loss of control of the motorcycles and 72% were collision while overtaking other road users were the main risk factors for motorcycle crashes.

Motorcycle rider training could be an important way of reducing the number of crashes and the severity of injuries. It is better to share the experience from developed countries to developing countries for the sake of road safety. Even at that, the study found that an increase in the level of riding training will reduce the crash by 5.1% and also an increase in the level of experience by 1% (Kudebong et al., 2011). And further concluded that proper helmet use, continuous mass education, and law enforcement are the main measures

to reduce motorcycle crashes. Even though, lack of these measures is seen today in our country, Ethiopia due to low enforcement of the law.

The recent study conducted on motorcycle safety (2016), shown that those who have taken rider training courses are less likely to be involved in a motorcycle crash. Another study has shown that a 1% increase in the level of education will reduce the 5.03% motorcycle crash (Chepngetich, 2016). This tells that if there were riders advanced education, they are expected to grasp sufficient knowledge and skills which guide them in their daily circumstances. The report further emphasized that riders should be encouraged to embrace the art of having more education since it will equip them in their riding and also managing their time and other resources.

The following figure shows that one of the main risk factors for motorcyclist which is poor driving techniques which suggest what effect of the poor driving technique is in motorcycle safety (Figure 2.5).

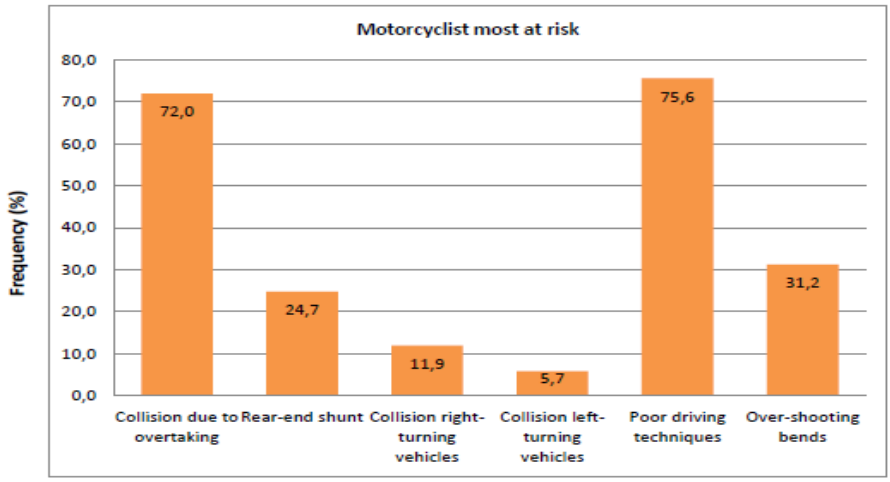

Figure 2.5: Motorcyclist main risk factors

Source: Unpublished master's thesis report, Umea University, 2012

2.4.1.4. Excessive Speed

Respecting traffic rules and regulations is mandatory for the common traffic safeties for all road users both in developing and developed a world. However, most riders and drivers violate these rules and regulations by driving above the posted speed limits and leads to deaths and injuries.

Speeding is a measure cause of both motorcycles as well as motor vehicle crashes. According to the study conducted on (Chepngetich, 2016) result show that a 1% increase in the speed will increase the road crashes by 20.4%. This embraces us that when the riders are using the above-permitted speed, the likelihood of getting a crash is very high. A more recent study reported that increasing the speed of 80-89mph (mile per hour) increases the death risk by 13% and also increases the speed of 80-90 mph makes the chance of death by 27%. This simply indicates that increasing the speed by 1 mph doubles the death risk (Rice et al., 2017). Moreover, another study revealed that speeding is the main contributing risk factor for crashes involving all road users, especially in motorcyclist it is seen highest and accounted for 77%.

This study further reported that most of the risk factors strongly related to vulnerable road users (Sanyang et al., 2017). Even if, the speed limit in our nation is provided for both urban and rural areas, enforcement of the law regarding speed is not enormous. However, developed countries like the Netherland, the United States of America and so on are using those technology instruments like fixed speed cameras or radar can be highly effective to reduce road crashes (Ribeiro, 2011). Even at that our country Ethiopia has due to insufficient resources and economy to import those instruments which are aforementioned for each city in our country is more difficult. However, strict enforcement regarding the law is still needed.

Riding above the speed limit is the main cause of death and being responsible for up to 40% of all road death in many countries (WHO, 2013). However, changing road user behavior is one of the best ways to reduce road traffic crashes. Moreover, implementing and sustained enforcement of the law is adequate to change road user behaviors by informing awareness of the public to understand the reason behind the law (WHO, 2015).

2.4.1.5. Licensing of motorcycle riders

Riding license is a certificate to ride any motor vehicle freely on the public road that shows somebody has the skill of riding i.e. issued only to those that have been certified by approved riding schools. According to the Traffic safety facts 2015 motorcycle data, the national Highway traffic safety and Administration (2016), reported that motorcycle rider without a valid riding license has a chance of a 27% to the fatal crash. Moreover, the study on (Simba, 2015) found that almost 84.2% of motorcycle riders death on road was due to lack of formal training or valid motorcycle riding license. The study on (Nyagwuyi, 2012) found that almost 69% motorcycle rider crash occurs due to lack of poor riding skills and 75.6% has poor riding techniques and further concluded that most of the motorcycle riders have insufficient knowledge about traffic safety. This results from them to the high involvement of crashes due to a careless driving style. The figure below shows these facts (Figure 2.6).

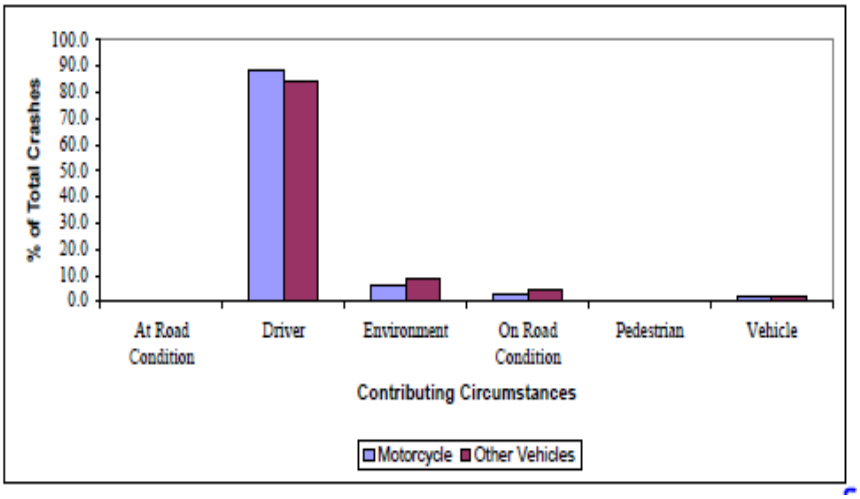

Figure 2.6: Contributing factors of motorcycle crashes
Source: College of Engineering; University of Bangladesh; MSc. Thesis report, 2007

The recent study in Northern Laos found that most of road traffic injuries occurred among younger male and vulnerable road users, especially in motorcyclists is accounted 76.5% and the study further revealed that road traffic injuries disproportionally affects young male road users especially motorcyclists in almost 85.5% has no riding license (Slesak et al., 2015). Moreover, most of the time riding a license is given by without formal training for instance by relatives, friends and so on. Observation from my own experience from my study area is that so many motorcycle riders have no riding license and also motorcyclists are riding unregistered motorcycles because there is no plate number at the back of their motorcycles.

Further preventive actions need to target and strict law enforcement needs the highest place to reduce those who haven't ridden licenses and expanding numerous traffic police through the field to control those to check violation in order to reduce problems. Lack of valid licensing of riders leads to the worst case of motorcycle crashes and injuries because of insufficient knowledge and skill about riding. Therefore, more effective enforcement of licensing motorcyclists could serve as a preventive to unsafe practices and measures to reduce crashes.

2.4.1.6. Helmet use

The helmet is one of the most factors used for the safety of motorcyclists. However, of all vulnerable road users, motorcyclists are involved at high risk in road crashes compared with other vehicles, particularly in head injuries and death. Rather, to reduce death and head injuries resulting from motorcycle crashes, frequently using a helmet is the only key method. Moreover, the recent study has shown that not simply wearing a safety helmet, but also the improper wearing style of helmet is significantly increasing the head injury of motorcycle riders (Fangrong et al., 2016).

The study found that using helmet regularly decreases the risk of head injuries which is the major cause of deaths, and proposes that educating local motorcyclists responds to the problems. Further, the report suggests that laws governing the use of helmets be enforced and must give due attention by the government and other stakeholders in order to reduce road crashes and thereby safe use of roads (Jackie et al., 2015). Although, the recent study in Cambodia shows that almost 80% of motorcycle fatalities are reported due to not wearing motorcycle helmet at the time of crashes and emphasized that Cambodia has an extreme motorcycle death rate among south East Asian countries (Roehler et al., 2015).

In most of the African countries like Ethiopia, there is no comprehensive helmet law is provided which is shown in the red color shown (Figure 2.7).

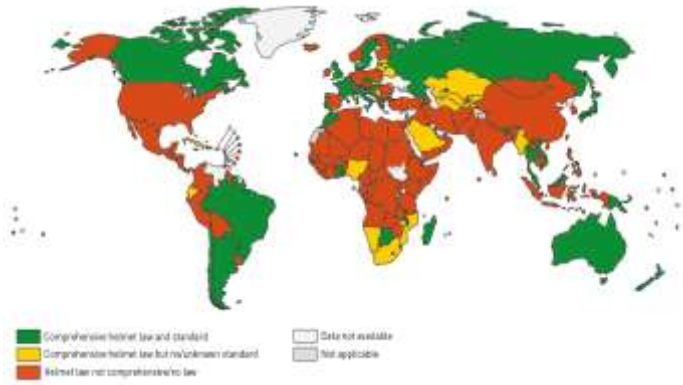

Figure 2.7: Motorcycle helmet laws and helmet standards by country
Source: World Health Organization (WHO, 2015)

A recent study conducted in Brazil found that regular wearing of safety helmet reduced the chance of suffering severity and fatal injuries by 9% (Flavio et al., 2017). In fact, the absence of safety helmets was also found to significantly increase the injury severity of motorcycle riders with the probability of fatalities approximately 21% & 45% higher than those wearing helmets at non-intersections and intersection, respectively (Fangrong et al., 2016). And, connected with these facts, the probability of fatalities and severe injuries increased by about 26% when crashes occurred at the intersection with signals. This shows that not wearing a safety helmet at intersection increases the probability of fatalities.

A study carried out in southwestern Nigeria found that wearing safety helmet frequently protects head injury of 75% from motorcycle crashes. Moreover, the study notified that wearing safety helmet consistently and law enforcement are not sufficiently reducing the crash but educating the community about the far use of the safety helmet is crucial means. This could be encouraged worldwide for rider safety for all road users.

Various studies done worldwide have shown that wearing a safety helmet decreases the severity of the head injury as well as the mortality rate in motorcycle crashes (WHO, 2015; Liu et al., 2009), but little has been done so far to explore the injury pattern sustained by motorcyclists.

In Ethiopia, a mandatory helmet law for riders and passengers was repealed in 2012/2013, whereas laws required a safety helmet to be fastened is not provided especially for most developing countries. Moreover, hither to most of the motorcyclists not wear a safety helmet, particularly in the study area. In recent years helmet wearing is mandatory in Ethiopia but the law is not a lot respected in the country, it was seen that most of the motorcyclists are not wearing safety helmets in their traveling time just they keep their helmet on the up of motorcycle body and simply they ride with a bare head. This is what the motorcycle riders cannot give due attention to their safety as well as other road user's safety. There is some limitation regarding helmet wearing. Indeed, this indicated that there were weak enforcement and lack of supervision by the authority.

2.4.2.Vehicle (Motorcycle) factors

For a safe system approach using a safe vehicle is one of the key ways to reduce the possibility of road traffic injury. However, increasing motorcycle safety is one of the five pillars of schedules of the world Health Organization global plan for a decade of action for road safety 2011-2020.

The world health organization reported that one of the best ways of maintaining motorcycles during its service year is essential for safe driving; for instance, brake failure, tire damage, light condition, and other mechanical defects. Further emphasized that, if there is a problem with the aforementioned lists, it is simple to involved in road traffic crashes (WHO, 2013). As a result, developing countries like Ethiopia most of the vehicles are mostly used and cause injuries. The study carried out in Nigeria, on western Africa country found that wrong overtaking, bad roads, sudden mechanical defects, over speeding and alcoholic intake are causal factors that increase the rate of motorcycle crashes (Ayinla et al., 2012). Even if, human factors are more occur in road crashes, vehicle factors have needed far study to come up with road user safety.

2.4.3.Environmental Factors

Another contributing factor that leads to a road traffic crash is an environmental factor like narrow and damaged roads, traffic crowdedness, poor lighting and the rapidly growing number of used motor vehicles. One of the responsibilities of government is to make the road safe for all road users. Due to the breakdown of the loss of control in crashes, it is identified that the majority (77%) occurred on straight road sections rather than on curves (23%) (Senserick et al., 2017). Another study revealed that unsafe road conditions like inadequate traffic signs, narrow roads width and mechanical defects of the motorcycle were the main factors contributing to crashes (Rad et al., 2016). Providing a safe road is a government responsibility with some contribution to the community around the area. This is not only meant by capital but also by sharing core ideas to the stakeholders for what to do best is needed carefully.

The study on (Kamruzzaman et al., 2013) shows that roadway locations where the lesser level of road traffic injury severity shows that, the place is more enforced by traffic police whereas a high level of road traffic injury severity shows that no traffic enforcement or traffic controls for instance traffic signal. This emphasized that for reducing road traffic injuries, placing traffic police at the place where the concentrated number of traffic is existing.

The study in Nigeria reported that most of the motorcycle crashes occur during the rainy season the reason behind that is, there are filled potholes with water and also a slippery surface of the roads. These show that if the weather condition is not good, the more motorcycles involved in the crash as well as other vehicles, especially during the rainy season. As most of the studies show that most of the Ethiopian road is not good for vehicles freely to transport from, so that more involvement of motorcycle crashes happens but in developed countries, here are continuous efforts to meet the safety standards of road situations

through safety audit during the planning, and designing and operation is at the beginning stage. Even though in our country, it is so less, therefore more effort is needed to cover these gaps by governments.

2.5. Countermeasures to reduce motorcycle crashes

According to the recent world health organization (2017) report, motorcycles and three-wheelers account for 23% of all road traffic deaths associating with more than 286,000 deaths around the world annually, and this figure is increasing unless urgent intervention is taken by the government of a certain country.

There are certainly not common ways of reducing the severity and injury rate of motorcycle crashes somewhat; it is different from place to place. However, the Ministry of interior, traffic accident report on Abu Dheli, 2013 outpointed that road traffic crashes have occurred for several reasons and it is challenging to decide the main causes of road traffic crashes due to a variety of crashes. Even though, identifying different types of measurement is crucial for road user safety.

Therefore, the transfer of effective interventions of motorcycle injuries from developed countries to developing countries like Ethiopia is essential and greatly needed so much.

2.5.1. Enforcement

Strict enforcement is a key measurement for preventing road traffic crashes and it requires that authorities like traffic police ensure that road users comply with traffic regulations. However, Police enforcement is very important for decreasing the problem of motorcycle crashes because they are the primary source of information on road crashes. However, most researchers found that police enforcement and traffic campaigns are very effective in preventing motorcycle riders from speeding and destructive riding like using mobile phones while riding motorcycles and so on. Moreover, police enforcement plays a vital role in addressing the problem of road crashes in motorcycles. According to the (WHO, 2009) report, police enforcement reduces the number of serious injuries and fatalities in the United Kingdom by 33% and in Europe; law enforcement could reduce the number of road traffic death and serious injuries by 50%. Hence, effective enforcement addresses all risk factors for safe road users.

2.5.1.1. Enforcement of speed limit

Moreover, enforcing speed limits is critical for effective reduction of the severity of motorcycle crashes as well as motor-vehicle crashes. However, serious consideration should be taken into account before determining speed limit, it must be depend on the traffic composition and the function of the road for instance; According to world health organization (WHO), 2013; report the speed limit for developed countries like Australia and Sweden is not more than 50km/h but in our country Ethiopia, According to federal police commission, 2012/2013 data, the maximum speed limit for urban and rural area is 60km/h and 70km/h respectively. However, this idea is different from the earlier one because many vulnerable road users are settled in the urban area. Therefore, some modification of the speed limit is needed for safe road users.

In addition, speed cameras have proved to be very effective in reducing the number of riders from over speeding. The government must consider those aforementioned parameters to better achievement of motorcycle safety.

2.5.1.2. Enforcement of alcohol in motorcycle crashes

Motorcycle riding demands greater coordination, balance, and concentration than that required to drive a car. According to the world health organization 2015, report strictly enforcing a drink driving law can reduce the number of road death by 20%. The report moreover; suggest that drinking alcohol and driving increases the risk of a road traffic crash. Therefore, strict enforcement is necessarily effective for reducing drink driving for road safety.

2.5.1.3. legislation and enforcement of helmet use by motorcycle riders

A helmet is the most effective intervention currently to reduce motorcyclist injuries. The most critical injuries to motorcyclists in crashes are head injuries. Riders of motorcycles have a greatly elevated risk of road traffic injury, particularly head injuries. Effective enforcement of motorcycle helmet laws can increase helmet-wearing rates and thereby reduce head injuries. As have seen from the above facts most motorcycle injuries lead to head injury. However, according to (WHO, 2013) usually wearing a motorcycle helmet can reduce the risk of injury by 70% and death by over 40%. (Nyagwuyi, 2012) recommended that educating motorcycle riders and impressing the importance of helmets, traffic rules, and other safety measures should be effective to reduce motorcycle crashes. As a result, wearing a helmet is the single most effective way of reducing head injuries and fatalities resulting from motorcycle crashes. Even at that, Not wearing a helmet can:-

- Increases the risk of sustaining a head injury
- Increases the severity of head injuries
- Increases the time spent in hospital
- Increases the likelihood of dying from a head injury
- Increases the likelihood of long-term disability

As the above-listed facts, public education programs regarding helmet and also strict enforcement to use helmet are extensively needed to reduce motorcycle injury in the study area as well as for Ethiopia. And also, the government could consider enhancing the visibility of enforcement activities and to improve punishments for un-helmeted motorcycle riders is a key way for road safety.

2.5.2.Providing valuable education on road safety issues

Education can have a huge impact by raising awareness for all road users in road safety issues and it ranges from an awareness campaign to rider training (Who, 2013).Therefore, the Government should, therefore, provide traffic safety education programs in all-important training places, which is the rider training center so that road safety for those who need education can be achieved through these programs.

In addition, riders need to understand what acceptable riding behavior is, and, in this way, education would be helped to reduce traffic hazards, especially for those peoples who break traffic laws. Education programs should, therefore, focus on traffic safety issues, such as speeding, drink riding, using mobile phones, and not using the safety helmet and other types of distractions like side talking with friends when riding motorcycle. As the issue of road safety is vital by its virtue it needs a special treatment in order to save the lives of citizens. In fact, in our country, these factors are not more focused for road safety. And, it needs more attention from the government and other stakeholders for effective road safety. However, so much effort can be needed to reduce the problem for not only motorcycles crashes but also other motor vehicle crashes.

2.6. Summary of literature review

When just writing the literature review by researching for available published and unpublished research notes and journal papers on the magnitude and main risk factors affecting motorcycle crashes, these are classified on three main factors such as human, vehicle (motorcycle) and environmental factors.

Human factors included increasing age, alcohol and drug use before riding a motorcycle, inexperience and lack of training, lack of education on road safety, over speeding, inattention when riding a motorcycle, improper wear of helmet was considered as the main human factors affecting for motorcycle crashes.

Vehicle (motorcycle) factors included lack of proper maintaining of motorcycle-like brake failure, tire damage, light condition of motorcycles and other mechanical problems were considered as the main vehicle (motorcycle) factors affecting motorcycle crashes.

Environmental factors included damaged roads like potholes on the road, poor traffic lightings on the roadside, poor weather condition especially the rainy season was considered as the main environmental factor affecting motorcycle crashes.

Finally, countermeasures to reduce those problems mentioned on the above could be considered are enforcement especially police enforcement and traffic campaigns, observing the speed limit, controlling alcohol and drug use, proper wearing of safety helmets and providing valuable education for riders regarding on road safety issues were considered as the main countermeasures to reduce motorcycle crashes.

3. RESEARCH METHODOLOGY

3.1. Introduction

The research methodology employed in this thesis outlines the steps used to answer the research questions as described in section 1.3 above with a clear description of the specific steps that have been used for the study.

3.2. Description of the study area

The study area is located in south omo zone. It is located in the Ethiopian Southern Nations, Nationalities and Peoples' Region (SNNPR). Its administrative city is Jinka, which is seven hundred fifty (750 Km) from Addis Ababa (capital city of Ethiopia) and five hundred thirty (530 Km) from Hawassa, which is main region of southern nation's nationality and peoples region (SNNPR) of Ethiopia and also it is bordered on the south by Kenya, on the southwest by the Elemi Triangle, on the west by Benchi Maji, on the northwest by Keffa, on the north by Konta, Gamo Gofa, and Basketo, on the northeast by Dirashe and Konso, and on the east by the Oromia region.

Jinka is the main market town in south omo zone, Ethiopia and located in the hills north of the Tama Plains, this town is the capital of the South Omo Zone of the Southern Nations, Nationalities, and Peoples Region. It has a latitude and longitude of 5°47′ N 36°34′ E Coordinates: 5°47′ N 36°34′ E and an elevation of 1490 meters above sea level. It is one of the most known tourist destination places in the country. There are also many government and private schools, government institutions, business agencies, a sugar factory, and other infrastructures that are built on the area. It is also called us the center for sixteen indigenous ethnic groups and other ethnic groups from the rest of the country. The study setting is represented on a map below (Figure 3.1).

Figure 3.1: Map of the study area with Southern Nations, Nationalities, and People's regions of Ethiopia.

Source: Google map web site, 2017

3.3. Study design

This descriptive cross-sectional study was conducted in south omo zone, Ethiopia and included all recorded motorcycles crashes on relevant police reports obtained from four main police stations in south omo zone included reports from January 2014 to December 2017. The register covers only motorcycle crashes occurring within the south omo zone.

In addition, structured questionnaires were prepared in well-organized ways for the participants who are motorcycle riders for a detail understanding of the problems in the study area. The reason for including a questionnaire in this study is that getting information from a wide range of participants from the study area why because recorded police crash data has not included relevant information as a whole.

3.4. Questionnaire

In addition to motorcycle crash data from police reports, the researcher utilized close-ended and some open-ended questionnaires for the sake of obtaining a free response from motorcyclists towards the subject of the study. This was designed with the objective of obtaining information about motorcycle rider behavior and attitudes. Because of motorcycle riders are responsible for numerous road traffic crashes occurring through motorcycles. The questionnaire was prepared to identify the main risk factors that affect motorcycle crashes.

3.5. Study population

A population means a set of subjects such as individuals, groups, institutions, countries and exists when its subjects can be distinguished from other subjects that do not belong to the very population.

All motorcycle crashes from January 2014 to December 2017 reported in the registry of four main police stations in the south omo zone were included in the study. And, all of them were found in Agriculture based populations. Besides, the standard questionnaire is prepared for the key respondents of motorcyclists.

Most of the peoples in the study areas are both pastoralists and agriculture-based. However, the study is focused on agriculture-based populations why because frequently this population used motorcycles mostly for their daily activities. Pastoralist populations were excluded from this study because they rarely use motorcycles. The target populations of the study were only motorcyclists which have road crashes on selected traffic police station of south omo zone.

3.6. Sampling technique

The sample areas of the investigation were selected based on a preliminary assessment made by the author of this research. Therefore, all motorcycle riders were selected randomly based on their presence in a particular area of the city at specific times. The goal of the study was explained to the motorcycle riders who were asked to fill out the questionnaire after giving their written informed consent in the space provided in the questionnaire.

3.7. Sample size determination

All registered road traffic crashes in the motorcycles for the past four years (January 2014 to December 2017) were recorded in each police station of south omo zone, were included in the sample. The reason why the researcher selected four-year data for the study is that most of the data prior to four years is not completely recorded in each police station.

Besides, motorcyclists were used for the key participants to respond to a questionnaire for a detailed understanding of the problems in the study area. The total sample size needed for participants for the questionnaire is calculated using the following formula.

The total number of registered motorcycles within four years is almost 3045 (three thousand forty-five).

Sampling was done randomly based on riders' presence in a particular area of the city at specific times. However, the reference (Creswell, 2012) developed the equation to determine the total sample size as follows:

$$n = \frac{Z^2 * p(1-p)}{e^2}$$

Where,

- n=sample size required for the study
- Z=1.96 (critical value) for the 95% confidence level, the amount of uncertainty that one can tolerate. Most researchers recommend 95% confidence level
- P=50% (0.5), which is the proportion of people expected to have the basic knowledge about the problem i.e. occurrence of motorcycle crashes in this case.
- e = 5 % (0.05), which is a margin of error that can be tolerated: it is a discrepancy between the sample size and the population. The main reason that the researcher of this study selected a 5% margin of error is that it is the most selected and acceptable confidence interval for many scientific kinds of research works and analysis related to road traffic accidents.
- Substituting the values in the above equation;

$$n = \frac{1.96^2 * 0.5(1-0.5)}{0.05^2}$$

$$\text{n} = 384$$

Adding 5% of the sample size to offset, the possible non-respondents from the sample frame

$$n = 384 + (0.05 * 384),$$

$$n = 384 + 19$$

$$n = 403$$

$n = 403$, which is the total number of samples needed for participants to respond to the questionnaire data.

3.8. Data collection procedure and source of data

In order to achieve the stated objective of the study, both primary and secondary data were used for the purpose of drawing conclusions and suggestions. The main instrument used for data collection was mostly all motorcycle crash data which was recorded in selected traffic police officers covering the past four years and mostly a designed close-ended and some open-ended questionnaire prepared for an in-depth understanding of the problems.

3.8.1. Primary data

The primary data were collected through observation and also questionnaires that were distributed to motorcyclists who are willing to complete the questionnaire in the study area. The standard format of the questionnaire is taken from London (Clarke et al., 2004). The questionnaire was modified and designed to fit three main causes of crashes such as human, vehicular (motorcycle in this case) and environmental factors.

3.8.2. Secondary data

The secondary data were collected from, south omo zone from selected traffic police offices (SOZTPO) which is from prepared data record checklist book, road, and transport development department (RTDD) and also central statistical Authority (CSA), as well as other pertinent published and unpublished information sources.

3.9. Study Variables:

3.9.1. Dependent variable

These are types of response variables that are influenced by independent variables which are classified into two classes such as is either fatal or nonfatal.

In Ethiopia, road crashes are classified into four main crash severities: fatal, serious injury, slight injury and property damage. A motorcycle fatal crash is defined as at least one motorcyclist killed in the event of a crash. Injured causalities are divided into two subcategories: slight injury and serious injury. Slight injury refers to persons with minor fractures, scratches, etc. not requiring hospitalization whereas serious injury denotes persons with major but not life-threatening injuries as in-patients in hospital. All reported accidents not involving injuries or death are classified as property damages. However, the common understanding is that a road traffic accident is one that results in property damages and or injuries of road users and involves at least one motorized vehicle.

3.9.2. Independent variables

These are an attribute or characteristic that influences or affects an outcome or dependent variables. These variables are explained briefly in the following sections.

3.9.2.1.Rider related variables

- Age of rider

Age was denoted as age group and was categorized into four categories: below 18; between 18-30; between 31-50; and 51 and above.

- Gender of rider

This was categorized into two groups: Male and Female.

- Educational background

This was structured based on the educational standard of certificate in Ethiopia which is 0 to 4, 5 to 8, 9 to10, 11 to 12, Above 12 and unknown.

- Riding Experience

This is the number of years of the motorcycle rider. Therefore, the information obtained from the rider is recorded fewer than one of the following five categories: 0-2, over 2-5, over 5-10, 11 and above and unknown.

- Rider motorcycle relationship

This is categorized as, the owner; hired; unknown and other (this may be relative, friend, or one who ranted the motorcycle).

- Speed

This is the speed in which the rider is used above the limited speed during the crash which is responded by 'Yes' or 'No' question. According to the study area traffic police rule and regulation, the speed limit for urban and rural areas is 30kph and 40kph respectively. Actually, traffic police simply observe the motorcyclists speed coming from far away whether the rider was riding the limited speed or not.

- Wearing helmet

This is the equipment used to protect from a head injury at the time of the crash which is checked by using 'Yes' or 'No' response. This is checked by visualization whether riders wear a safety helmet or not. However, riders wear a nonstandard helmet. Actually, according to national motorcycle helmet law, helmet standard is not specified. However, regarding the type of helmet, riders wear different types of a helmet depends on their willing that is some of them wear full-faced, others wear half-faced and so on.

- Riding license

Is the level of license to ride a motorcycle which will be asked to indicate if they have a riding license or not?

- Motorcycle rider training

This will be classified into three categories: formal training, informal training, and no training at all.

3.9.2.2.vehicle (motorcycle) related variables

- Motorcycle year of service

This is the number of years from the date of bought. These categories are: 0 to1, over 1 to 2, over 2 to 5, over 5 to 10, 11 and above, and unknown years

- technical problem of motorcycle

This is categorized into 'Yes' or 'No' response.

3.9.2.3.Environment-related variables

- weather condition

This is the condition of the weather which is good, rainy and other.

- road condition

This is the condition of the road which is dry, moisture and muddy

- surface type

This is categorized as asphalt, gravel and earth road

- light condition

This indicates that the light condition of time either day or night.

3.10. Data quality control

Primary data such as questionnaires were prepared in well-organized standards. And also, it was checked by the main investigator and research advisor before the actual data collection could be started. Besides, secondary data which is motorcycles crash data from the police officer was recorded from the standardized checklist which is used as a main source of information. During the data collection procedure, all the collected data were checked and cleaned for completeness and consistency at the same time, incomplete records were rejected.

3.11. Method of data Analysis

Both primary and secondary collected data were coded and cleaned for its completeness. Descriptive statistics of percentages and frequency distribution were carried out to explore the demographic characteristics related to the motorcycle rider, vehicle (motorcycle) and environment factors and the occurrence of motorcycle crashes.

To analyze secondary data, multinomial logistic regression model were used to assess the association between the dependent and independent variables, outcome of motorcycle crashes with demographic characteristics related to motorcycle riders such as age, sex, educational background, riding experience and rider motorcycle relationship and cause of the accident road user, road condition, weather condition, light condition, motorcycle year of service. At Initial level, odds ratio (OR) and corresponding confidence intervals i.e. (95% CI) were used to assess the relationships between dependent and independent variables. If P-values less than 0.05 ($P<0.05$) were considered statistically significant.

Like secondary data, primary data from participants were also analyzed using descriptive statistics like percentages and frequency distributions. Then, the p statistical significance test was conducted using the one-way analysis of variance (ANOVA) to identify the most important factors contributed to the occurrence of motorcycle crashes. Because, most of variables in primary data are also there in secondary data which is recorded data from the police department office. However, the primary data used in this study is to identify the deep understanding of motorcycle crash problems in the study area.

3.12. One-way analysis of variance (ANOVA)

It is the statistical method used to compare the means of two or more groups. The one-way analysis of variance (ANOVA) is used to determine whether there are any statistically significant differences between the means of three or more independent (unrelated) groups. The one-way ANOVA compares the means between the groups which are interested in and determines whether any of those means are statistically significantly different from each other. In addition to this, it is a statistical method used to determine whether there is any statistically significant difference between the means of two or more independent groups.

- The technique known as analysis of variance (ANOVA) uses tests based on variance ratios determine whether or not significance difference exits among the means of several groups of observation, where each group follows a normal distribution
- It is an extension of the t-test used to determine whether or not two means differ to the case where there are three or more means.
- The difference between ANOVA and t-test is that ANOVA can be used in situations where there are three or more means being compared, whereas the t-tests are limited to situations where only two means are involved.

One-way analysis of variance (ANOVA) is used to test whether the occurrence of motorcycle crashes in the study area is shown significant difference or not with the selected factors to contribute to the crashes. And that tests:

- H_0: $\mu_1 = \mu_2 = \mu_3 = \text{-----} = \mu_k$
  - ✓ All population means are equal
  - ✓ i.e.no treatment effect (no variation in means among groups)
- H_1: Not all of the population means are the same
  - ✓ At least one population mean is different
  - ✓ i.e., There is a treatment effect
  - ✓ Does not mean that all population means are different (some pairs may be the same

BASIC ASSUMPTIONS UNDERLYING THE ONE-WAY ANOVA

Actually, the data is checked before to interpret the results from the output of one-way analysis of variance. The final output of one-way analysis of variance was provided at the end of the Appendix part.

I. The observations are random and independent samples from the populations. This is commonly referred to as the assumption of independence. The null hypothesis actually says that the samples come from populations that have the same mean. The samples must be random and independent if they are to be representative of the populations. The value of one observation is not related to any other observation. That is, one event does not depend on another.

II. The distributions of the populations from which the samples are selected are normal. This is commonly referred to as the assumption of normality. This assumption implies that the dependent variable is normally distributed (a theoretical requirement of the underlying distribution, the F distribution) in each of the groups.

III. The variances of the distributions in the populations are equal. This is commonly referred to as the assumption of homogeneity of variance. This assumption (along with the normality assumption and the null hypothesis) provides that the distributions in the populations have the same shapes, means, and variances; that is, they are the same populations. In other words, the variances on the dependent variable are equal across the groups.

Null Hypothesis: H_O: $\sigma_1^2 = \sigma_2^2 = \ldots = \sigma_k^2$ (if retained = assumption met)

(if rejected = assumption not met)

Alternative Hypothesis: H_a: $\sigma_i^2 \neq \sigma_k^2$ for some i, k

3.13. Operational definition

Most countries in the world use nearly a similar definition on different levels of crash severities. However, the study conducted in Ethiopia; reported that there is no clearly documented definition on different crash severity levels (Murad, 2011).

RTC**:** is defined as any motor vehicle crash occurring on a public highway. It includes collision between vehicles and animals, vehicles and pedestrians, vehicles and animals, or vehicles and fixed obstacles. Single vehicle accidents, which involve a single vehicle that means without another road user, are also included (Safe car guide 2004).

RTI**:** it is the outcome of a road traffic accidents and can be slight /severe.

Motorcycle**:** is a two-wheel motorized vehicle for transporting one or two riders.

Rider**:** A person who rides or who can ride a motorcycle.

Fatal crash or killed: is a human casualty (motorcycle rider, or passenger) died within thirty 30 days, after the collision due to injuries received in the crash.

Slight Injury**:** is defined as a person hospitalized for less than 24 hours.

Serious injury**:** is defined as a person hospitalized, other than for observation, for more than 24 hours.

Property damage**:** is defined as it is a non-injury crashes e.g. roadside objects, vehicles, etc.

The outcome of motorcycle crashes**:** outcome of the crash whether it is injury or death.

Rider motorcycle relationship**:** this is categorized as, owner, hired and other (this may be relative, friend, or one who rented the motorcycle).

Riding experience**:** this is the number of years the motorcycle driver drove since receiving a driving license. The information obtained from the driver is recorded fewer than one of the following five categories: 0 to 2 years, over 2 to 5 years, over 5 to10 years, 11 and above years and unknown.

Motorcycle years of service**:** This is the number of years from the date of service. These categories are 0 to 1 year, over 1 to 2 years, over 2 to 5 years, over 5 to 10 years, 11 and above years and unknown years. These criteria were reviewed from different published articles that are conducted in Ethiopia and also from the supervision of the research advisor.

Road condition**: -** this is the condition of the road which is dry, moisture, muddy

Surface Type**: -**This is categorized as asphalt, earth, or gravel.

Light Condition**:** This indicates the light condition of time either day or night.

Drugged/Alcoholic riding**:** This indicates whether the rider is drunken alcohol or used the drug at the time of the crash.

Speeding**:** This is the speed in which the rider is used above the limited speed during the crash.

Helmet use**:** This is the equipment used to protect from a head injury at the time of the crash**.**

Level of rider license**:** is the level of license to ride a motorcycle.

4. ANALYSIS AND DISCUSSION

4.1. Results

Based on the results of this study, between (January 2014 to December 2017) there were a total of two hundred six motorcycle crashes happened in four police stations of south omo zone. Out of a total of, 36 (17.5%) were fatal and 170 (82.5%) were non-fatal. Among these, 36 (17.5%) was fatal, 88 (42.7%) was a serious injury,52 (25.2%) was slight injury and 30 (14.6%) caused property damages. In recent years, there has been a significant increase in the number of motorcycles crashes in the south Omo zone which is in parallel with an increasing use of motorcycle as multiple means of transport (South Omo zone road and transport development department report, 2017). Moreover, it is clear that this fact is witnessed not only for south Omo but also other cities in Ethiopia.

4.2. Descriptive statistics for police-reported crash data

4.2.1. Demographic characteristics of the motorcycle riders

The demographic variables related to motorcycle riders involved in motorcycle crashes describe the human factor of the crashes mainly focusing on the motorcycle riders' character. The human factors consider the motorcycle riders working fault as the primary phase in restraint of events that might lead eventually to a motorcycle crash. And, these demographic characteristics include the gender of a motorcycle rider, motorcycle riders age, educational background, riding experience and rider relation with a motorcycle.

As it can be seen from four years collected police-reported crash data, motorcycle crashes have occurred predominantly males, which means that almost all crashes were happened by males. There are no crashes that happened through females at all during the four years period. This study finding shows that almost males are more frequently affected by motorcycle crashes than females in the study area. From the motorcycle crash data registered between (January 2014 to December 2017), the result showed that none of the motorcycle crashes happened on females. On the contrary, result from the response of participants on this study, data which is collected from the respondent results shown that almost (89.4%) and (10.6%) were males and females respectively. However, the male predominance in motorcycle crashes was previously reported by many studies (Roehler et al., 2015 & Erhardt et al., 2016). In addition to this, the present study findings show that male riders are found to involved in most crashes but are significant risk factors in fatal, serious and slight crashes compared to females, which is implied that men have riskier behaviors compared to women. This finding is also consistence with the investigations done on Iran (Yazdanirad et al., 2017). Moreover, the other findings from studies conducted in Cambodia found that males are much more likely to die in motorcycle crashes roughly seven times more frequently than females (Roehler et al., 2015). However, the reason for the predominance might be the fact that males are more likely involved in this type of occupation than females which were seen from the real world.

Of the total crashes happened, more than half of the motorcycle crashes, almost one hundred eleven (53.9%) were caused by 18-30 years of age, and Another forty (19.4%) were caused by the riders of between 31-50 years of age, and also thirty-two (15.5%) were caused by the riders of below 18 years age, and, only fourteen (6.8%) were caused by unknown years of age. Finally, the least crashes that are only nine (4.4%) of the riders were caused by riders who had 51 and above years of age (Table 4.1).

Age of riders	Frequency	Percent (%)
Below 18	32	15.5
Between 18-30	111	53.9
Between 31-50	40	19.4
51 and above	9	4.4
unknown	14	6.8
Total	**206**	**100.0**

Table 4.1: Frequency distribution of age of riders involved in motorcycle crashes in police traffic offices of South Omo Zone from January 2014-December 2017.

According to Table 4.10 from multinomial logistic regression output, the finding of the present study result shows that the group of riders aged below eighteen and between thirty to fifty have shown a statically significant difference in slight injury with the odds ratio of 24.25 and 53.25 respectively. Besides, these results observed for the age of the rider are also shown significant difference using one-way analysis of variance which is sustained by Table 4.17. But, partially different from the results gained from the descriptive statistics analysis which shows only the productive age groups which are the age of between eighteen to thirty years are take the first rank to increase the severity of motorcycle crashes. Besides, the finding of this study shown that more than half of the motorcycle crashes, almost one hundred eleven (53.9%) were caused by between 18-30 years of age, in line with this finding, this age group was the most affected age group not only for motorcycle crashes but also other motorized vehicle crashes, which is slightly similar with the finding (Baumbach et al., 2012 & Fekede et al., 2014).

The majority of education level that is more than half of motorcycle crashes, almost one hundred ten (53.4%) riders were completed five to eight grade school. And thirty-six (17.5%) of the riders were completed zero to fourth-grade school and also twenty (9.7%) of the riders had unknown education levels. And, fourteen (6.8%) were completed eleventh to twelfth (preparatory) school level and above twelfth (diploma and degree education level) respectively. And only twelve (5.8%) of the riders were completed, ninth to a tenth-grade school (Table 4.2).

Education level	Frequency	Percent (%)
0-4	36	17.5
5-8	110	53.4
9-10	12	5.8
11-12	14	6.8
Above 12	14	6.8
Unknown	20	9.7
Total	**206**	**100.0**

Table 4.2: Frequency distribution of rider's education level involved in motorcycle crashes in police traffic offices of South Omo Zone from January 2014-December 2017.

According to Table 4.10 from multinomial logistic regression output, the results of the present study also revealed that the educational status of the rider was a predictor of motorcycle crashes. However, Motorcycle rider's education level is also a significant factor for serious crashes which is positively associated with five to eight (5 to 8) education level riders. These riders increase with the odds ratio of serious crashes by 8.98 compared with above eighth grade educated riders. These conform that riders educated below fifth education level are insignificant than above eighth-grade level has increased the probability of serious crashes. And, also the education level of riders was also showing significant difference with the occurrence of motorcycle crashes using a one-way analysis of variance which is sustained by Table 4.18. Moreover, with regard to the education level of motorcycle riders, the majority of 110(53.4%) motorcycle riders were completed five to eight (5 to 8) level school followed by zero to four (0 to 4) level school 36(17.5%). This might account for why the majority of these motorcycle riders are prone to crashes because it would be very difficult for them to interprets traffic signs on the roads. This finding was in agreement with previous studies on road traffic collision in Ethiopia and other studies in low and middle-income countries like Kenya (Fekede et al.,2014) & (Simba, 2015) respectively. But it shows some variation in response rate, 143(36.9%) were in nine to ten (9 to10) education level. This might lead to, poor knowledge of traffic signs on the road and violating traffic rules and regulations were also found to be a significant factor responsible for high rates of crashes among motorcycle riders. Furthermore, findings from other study revealed that riders with higher education level were the groups that were not at fault of crashes compared with those with low education levels (Yazdanirad et al., 2017). This might be attributed to the fact that because individuals with low education levels have usually less knowledge of traffic rules and regulations.

Based on the results of the this study experience of the motorcycle riding , almost above half, i.e. one hundred fourteen (55.3%) of the riders had over two to five riding experience, followed by thirty three

(16%) of the riders had zero to two (0 to 2) year experience and thirty (14.6%) a had unknown riding experience of the riders, and also fifteen (7.3%) of the riders had over five to ten (5 to10) years of experience and finally only fourteen (6.8%) of the riders had eleven and above years of experience (Table 4.3).

Experience of riders	Frequency	Percent (%)
0 to 2	33	16
over 2 to 5	114	55.3
over 5 to10	15	7.3
11 and above	14	6.8
Unknown	30	14.6
Total	**206**	**100.0**

Table 4.3: Frequency distribution of experience of riders involved in motorcycle crashes in police traffic offices of South Omo Zone from January 2014-December 2017.

According to Table 4.10 from multinomial logistic regression output, the present findings show that the riding experience of motorcycle riders on the road have an indirect relationship with fatal crashes. However, an increase in the riding experience of riders over two to five years of the riding experience is expected to reduce the relative log odds of fatal crash by 3.38. This result is indirectly suggesting that the other experienced riders and unknown experienced riders in all crash at all severity levels. This finding is parallel with the finding from Ethiopia (Temesgen, 2018).In addition to this, the present study findings also revealed that, riding experience was also the other determinant factor for motorcycle crashes and almost above half of total crashes 114 (55.3%) of riders had over two to five years of riding experience, followed by 33 (16%) zero to two year of riding experience. From the results, it was clear that the majority of riders are just been recent in motorcycle riding. This may be as a result of economic hardship and the increase in the rate of unemployment. However, this finding is almost similar to the results, from the participants of this study response and accounts,194(50%). This study is inconsistence with other studies found the result from Kenya which is 47.6% occurs over one to two years of riding experience followed by over three to four (3 to 4) years of riding experience (Nyatundo, 2014 & Allen et al., 2017). This might be due to insufficient skills to control motorcycles for those who have not sufficient experience in riding.

The results of this study with the rider motorcycle relationship show that motorcycle crashes by owners of the motorcycle are accounted, one hundred twelve (54.4%), then those by hired riders i.e. fifty-one (24.8%). And also, twenty-four (11.7%) were unknown riders, whether they are hired or owner of a motorcycle, and finally, nineteen (9.2%) of riders were others whether a motorcycle is their friends or relatives and so on (Table 4.4).

Rider motorcycle relationship	Frequency	Percent (%)
Hired	51	24.8
Owner	112	54.4
Unknown*	24	11.7
Other**	19	9.2
Total	**206**	**100.0**

*Riders who are neither hired nor owners and **Friends, relatives of the owner, ranted.

Table 4.4: Frequency distribution of rider's motorcycle relationship involved in motorcycle crashes in police traffic offices of South Omo Zone from January 2014-December 2017.

According to Table 4.10 from multinomial logistic regression output, the present finding also revealed that the relation of the motorcycle rider with the motorcycle is a significant factor with the 'other (like friends, relative)' set as a reference. This factor indicates that the relative log odds increased by 3.52 for fatal crashes and 2.37 for serious crashes. This suggests that the severity of crashes increased when a motorcycle was ridden by the owner rather than others like relatives or friends. This study is inconsistence with the study conducted on Nairobi and found that 73.7% of motorcycle crashes were happened by hired riders (Chepngetich, 2016). Mostly, this might be, the owners of the motorcycle are over confidential to ride their motorcycle and assumes them just like skilled and experienced riders and finally leads to crash without any care. In addition to this, the finding of this study also revealed that rider versus motorcycle relationship, motorcycle crashes were common among owner ones 112 (54.4%) than hired riders 51 (24.8%). This finding is similar to the response rate from the participants of this study, which is 186 (47.9%). This is due to most of the motorcycle riders in the area have their own motorcycles which are used for their commercial transport purposes. This finding is consistency with the study conducted in Nigeria, 43.6% (Adewunmi et al., 2015). And, the possible reason might be the general increase in the use of motorcycles for commercial transport purposes. On the contrary, these studies are inconsistence with the study conducted in Sweden (Nyagwuyi, 2012). This could be the number of motorcycles in this area could be greater compared with our country.

4.2.2.Vehicle (motorcycle) related factors

The variables related to the motorcycle factors are responsible for the crash and described based on the number of years that the motorcycle has served and checked whether or not the motorcycle has mechanical problems or not.

Depends on the results of this study the service year of a motorcycle; the majority of crashes, 62(30.1%) is happened in over 1-2 years followed by 49(23.8%) crashes that happened in unknown services years.

And, regarding motorcycle defects 172(83.5%) of the motorcycle had no defects means that there is no mechanical problem and only 34(16.5%) of a motorcycle has some defects (Table 4.5).

Service of a motorcycle (years)	Frequency	Percent (%)
0 to 1	23	11.2
over 1 to 2	62	30.1
over 2 to 5	46	22.3
over 5 to10	20	9.7
11 and above	6	2.9
Unknown	49	23.8
Motorcycle defects		
Yes	34	16.5
No	172	83.5

Table 4.5: Frequency distribution of Motorcycle factors involved in motorcycle crashes in police traffic offices of South Omo Zone from January 2014-December 2017.

The motorcycle year of service and defects of the motorcycle were the other risk factors considered to explain the influence of motorcycle. According to Table 10 from multinomial logistic regression output, the log odds of a fatal crash with a motorcycle of over five to ten years' service is increased by 3.564 with the odds ratio of 35. 313. This result shows that the risk of motorcycle crashes is fortunate for those motorcycles which have the service years of over five to ten years. However, the service year of a motorcycle is also showing a significant difference with the occurrence of crashes using a one-way analysis of variance. In fact, the number of service years of motorcycle increases, the condition (performance) of the vehicle (motorcycle) is also decreased. This could be due to a lack of maintenance or on-time service within an important period. With regard to service year of a motorcycle the majority of motorcycle crashes 62(30.1%) & 49(23.8%) happened in over one to two and unknown years of services respectively. This finding was in disagreement with the questionnaire response rate from the participants which are motorcycle riders in this study, which were found that 146 (37.6%) followed by 136 (35.1%).

These study findings also have shown that the sudden mechanical problem of a motorcycle is another factor categorized under vehicle (motorcycles in this study) factors and it is analyzed with no defects taken as the reference. According to Table 10 from multinomial logistic regression output, the result shows that motorcycle which has defects or mechanical problem was a significant factor for serious crashes and the relative odd ratio of serious crashes than a motorcycle with no defects is 0. 040. Thus, this result shows that motorcycle with a mechanical problem or any problem has increased serious crashes unless the immediate measurement is implied. On the other hand, motorcycles with no defects or mechanical problems contribute less involvement in the severity of traffic crashes. In addition to this, a

motorcycle with the mechanical problem is associated with a relative log odd of 3.23 and this revealed that decrease being in a serious crash than property damage. However, the presence of motorcycle defects or mechanical problems has a significant effect in reducing the severity of traffic crashes. This finding is in line with that of studies conducted in Nigeria and Iran found that sudden mechanical defects lead to crashes especially on commercial motorcycles (Ainila et al., 2012 and Heydari et al., 2016) respectively. Moreover, this variable shows a significance difference with the occurrence of motorcycle crashes using a one-way analysis of variance from Table 4.32. Moreover, almost 172 (83.5%) of motorcycle has not any mechanical problems and this is similar with what the participants or motorcycle riders in this study results shown that, and almost 366 (94.3%) and the remaining have some problems like tire, brake, tire and so on are 22 (5.7%). This finding is partially different from other findings on motorcycle defects or mechanical problems from Tanzania which is accounted, (89%) (Minzava, 2013).

4.2.3.Environmental factors

The main purpose to understand the factors that affect environmental conditions is to observe the occurrence of motorcycle crashes on the study area related to environmental factors.

However, the result of the descriptive analysis shows that a large number of crashes happened by dry air condition 179 (86.9%) followed by Moisture 19 (9.2%). This might be due to several factors like over speeding, overtaking other vehicles, careless riding and so on; that the riders take under dry air condition. The present study findings show that riding on weather conditions shows statically significance difference with the occurrence of motorcycle crashes. This study is also revealed that almost one hundred seventy-nine (86.9%) of the motorcycle crashes were happened in the dry air condition during four years followed by the moisture, accounted nineteen (9.2%). This finding is consistent with the group of other studies reported from Sweden, New Zealand and southeastern Iran (Zamboni, F & Hasselberg, M, 2006, Baumbach et al., 2012 & Rad et al., 2016) respectively.

Concerning the light condition, almost 108 (52.4%) of the crashes happened during Nighttime and 98 (47.6%) of crashes happened during day time. Of course, the visibility state at the time of the crash can be influenced by the lighting condition of the roads. However, a researcher of this study observed from the study area is that most of the time, commercial motorcycle riders run their business at night time and carry two or more than two passengers including them at a time to get additional coinage. The finding of this study revealed that more motorcycle crashes happened in the night time and shows statically significance difference with the occurrence of motorcycle crashes; and accounted for 108 (52.4%). This finding is similar with other studies reported from Northern Laos (Silesak, et al., 2015) and in contrast, studies found from Ethiopia and Rwanda showed that motorcycle crashes most of the time happened at the day time (Fekede et al., 2014) & (Ingabire et al., 2015) respectively. Additionally, other studies found the same result, almost 62.7% of the motorcycle crashes happened at day time. This might be probably, at

night, motorcycle riders, rode their motorcycle carelessly and carrying more than three or more passengers including them to earn extra money from the passengers because at the time there is no traffic police to control them when they are violating traffic rules and regulations.

The majority of motorcycle crashes, 92 (44.7%) happened on a gravel road and the remained crashes 64 (31.1%) and 50 (24.3%) were happened on Asphalt paved and Earth roads respectively. This could be observed visually by the author of this study and fact from the data collected from police stations revealed that most of the road surface in the study area is gravel road compared to another type of pavements. The present study findings show that surface type shows a statically significance difference with the occurrence of motorcycle crashes. However, in this study, almost 92 (44.7%) of the motorcycle crashes happened on gravel roads followed by 64 (31.1%) that happened in the asphalt road. Almost, 303 (78.1%) crashes happened at the time of riding motorcycle. This result is similar to the response from the respondents which is 58 (14.9%) crashes happened on not asphalt might be gravel or earth roads. The reason might be due to the fact that most of the roads in the area are gravel and earth roads. This type of road is not comfortable especially for a motorcycle rather than other motorized vehicles. Unlike other studies found from Sweden and Ethiopia (Nyagwuyi, 2012 & Tariku et al., 2017).

Regarding the weather conditions majority of crashes happened, about 100 (48.5%) happened during rainy conditions followed by good weather conditions, about 91 (44.2%) and other weather conditions like cloudy, windy, etc., which is 15 (7.3%). This is due to the fact that motorcycle is small in their physical and it is enough to fail into crashes if a little adverse condition has happened. As such, the crashes that occur under rainy conditions is increased. This finding is consistent with previous studies from Kenya and Malaysia found that rainy season was one the main factor to increase the motorcycle crashes, which is (45.4%) crashes happened in rainy weather condition were due to difficulties to control motorcycles (Nyatundo, 2014 & Sultan et al., 2016). Moreover, this finding explained that road and weather conditions are considered to greatly influence the motorcycle rider behavior on the traveling road.

The majority of severity crashes happened by motorcycles with pedestrian and rollover 76 (36.9%) and 53 (25.7%) respectively. The reason for those severities is attributed to 68 (33%) failure to give priority, 64 (31.1%) careless riding and 54 (26.2%) were over speeding (Table 4.6). This finding is almost similar to the recent finding conducted by (Temesgen, 2018).

	Frequency	Percent (%)
Road condition		
Dry	179	86.9
Moisture	19	9.2
Muddy	8	3.9
Light condition		
Daytime	98	47.6
Nighttime	108	52.4
Surface type		
Asphalt road	64	31.1
Gravel road	92	44.7
Earth road	50	24.3
Weather condition		
Good	91	44.2
Rainy	100	48.5
Other*	15	7.3
Cause of crashes		
Over speeding	54	26.2
Failure to give priority for pedestrian	68	33.0
Careless riding	64	31.1
Follow to closely	13	6.3
Overtaking other Vehicles	7	3.4
Type of Severity		
Rollover	53	25.7
Motorcycle with Motorcycle	21	10.2
Motorcycle with another vehicle	29	14.1
Motorcycle with pedestrian	76	36.9
Motorcycle with fixed objects	15	7.3
Other**	12	5.8

***Cloudy, Windy and**with animals

Table 4.6: Frequency distribution of Environmental factors involved in motorcycle crashes in police traffic offices of South Omo Zone from January 2014-December 2017.

4.3. The magnitude of motorcycles crashes in south Omo Zone

Based on the descriptive analysis of police-reported crash data, a total of two hundred six motorcycle crashes happened during the period of (January 2014-December 2017). Of those causalities 36(17.5%) were fatal, 88(42.7%) Serious injuries, 52(25.2%) Slight injuries and 30, (14.6%) were Property damage (Figure 4.1). During the instance or event of motorcycle crashes, the occurrence of motorcycle riders, pedestrians and passengers would be under the risk of crashes. Among those dead in motorcycle crashes, 17(47.22%) were motorcycle riders,15(41.67%) were pedestrians and 4(11.11%) were passengers.

Overall,175 people 54(30.86) motorcycle riders, 19(10.86) passengers and 102(58.29) pedestrians) were affected on the motorcycle crashes. In fact, regarding the type of causality, pedestrians and motorcycle riders have a higher share as victims of motorcycle crashes which accounts to be 102(58.29%) and 54(30.86%) respectively (Table 4.7). This finding is inconsistent with the finding from Rwanda which is found that about motorcycle rider (46.8%) and pedestrian (28.6%) (Ingabire et al., 2015).

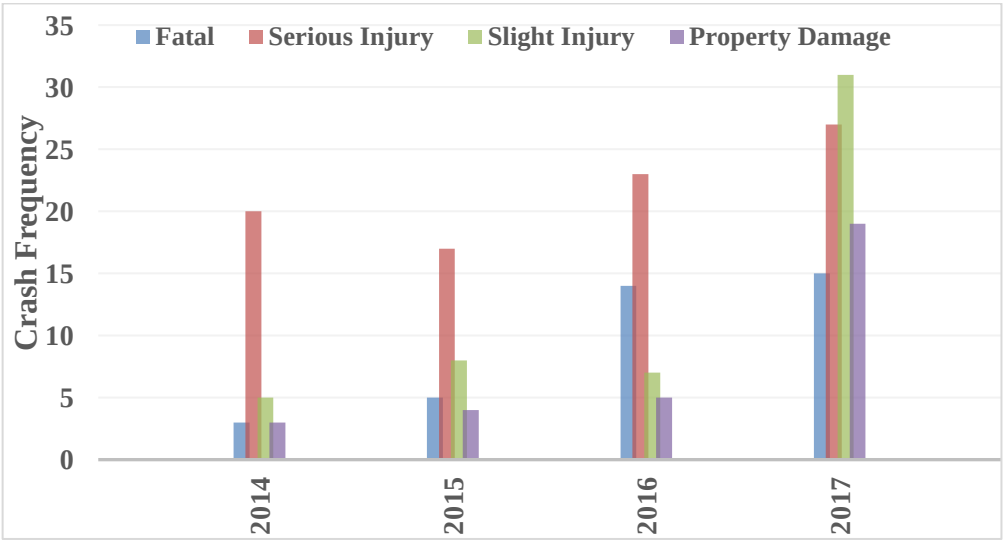

Figure 4.1: Trends of Motorcycle crashes in South Omo Zone, Ethiopia from January 2014 to December 2017

No.	Peoples injured	Fatal	Serious injury	Slight injury	Total	Percent (%)
1	Motorcycle riders	17	26	11	54	30.86
2	Pedestrians	15	53	35	102	58.29
3	Passengers	4	9	6	19	10.80
	Total	**36**	**88**	**52**	**175**	**100**

Table 4.7: The type of peoples Injured by Motorcycle crashes

This finding is similar to the report from world health organization (2015) literature stating pedestrians are the most victimized by road traffic crashes. This revealed more focus on the attitudes of pedestrians, design of roads in addressing pedestrian facilities.

Descriptive results of the police-reported crash data show that the number of motorcycle crashes increased from 28(16%) to 74(42.05%) during the four-year period. The reason for the frequency of victims for the year 2017 is very high is that the number of motorcycling populations is increased from time to time due to the expansion of the urbanization and development of infrastructures like public infrastructures, government institutions, transport infrastructures so on (Table 4.8).

Year	Frequency of victims	Percent (%)
January 2014 - December 2014	28	16
January 2015- December 2015	30	17.05
January 2016- December 2016	43	24.57
January 2017- December 2017	74	42.05

Table 4.8: Frequency distribution of Motorcycle crash victims between four police stations of South Omo Zone, Ethiopia from January 2014 to December 2017.

Descriptive analysis on the days of week shows that more motorcycle crashes, 38(18.4%) were registered on Saturday followed by Monday 37(18%);36(17.5%) on Tuesday, and also 32(15.5%) registered on Thursday, and 24(11.7%) on Sunday and 20(9.7%) were registered on Friday. Finally, the lowest number of crashes registered was on Wednesday 19(9.2%). This needs a brief explanation of why the majority of crashes occurred on those two days such as Saturday and Monday and as follows. (Figure 4.2)

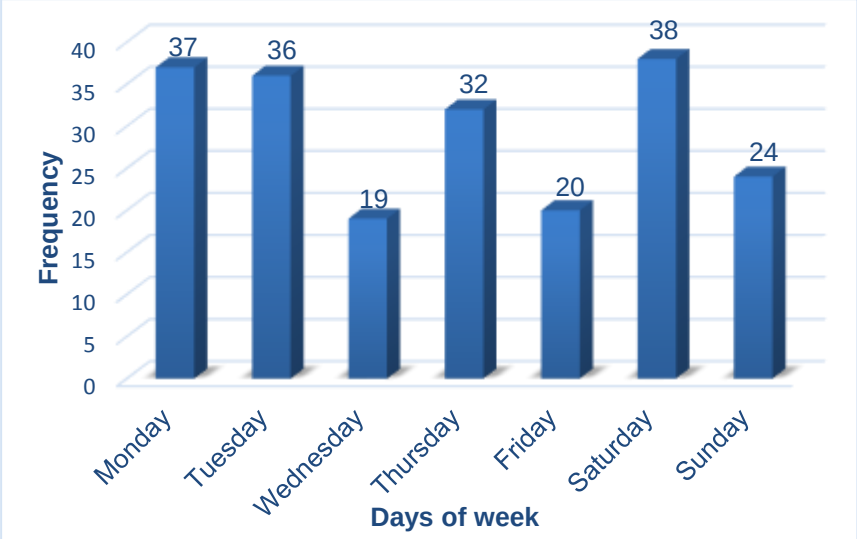

Figure 4.2: Distribution of motorcycle crashes happened by day of the week in police traffic offices of south Omo zone (January 2014 to December 2017)

Actually, Saturday and Monday are the two main market days in the study areas specially Jinka and Debub Ari towns. During these days, the number of other motorized and non-motorized traffic like carts as well as the number of pedestrians coming from a nearby rural areas is high. Actually, the night market is common in the study area also. However, most of the time motorcyclists work their commercial transport service at night time and traveled from urban areas to rural areas by carrying more than two or passengers including riders because at a time there is no traffic police controlling them when riders are violating traffic rules and regulations. Moreover, most of the pedestrians during this area have no detailed knowledge about traffic rules and regulations and also pedestrian walkways as they simply cross the road whether the vehicle is coming or not. The same is true as the area, there is also a pedestrian walkway is provided that why they have no awareness about it.

The analysis results show on the outcome of motorcycle crashes on different woredas in the south Omo zone, Jinka had the highest number of crashes 59(28.64%), followed by Debub Ari (Gazer) woreda 57(27.67%), and keyafer (Bennastemayi) woreda 48(23.30%). The lowest record of motorcycle crashes 42(20.39%) was recorded in the maalle (lemo gento) woreda. The reason that the highest number of crashes happened in the Jinka is that it is the main city for the south Omo zone and several numbers of motorcycle populations are coming to this city for their daily activities (Table 4.9).

Name of police stations	The outcome of motorcycle crashes				Total
	Fatal	Serious	Slight	Property Damage	
Debub Ari	11	36	7	3	57
Jinka	3	21	20	15	59
Keyafer	9	16	14	9	48
Maalle	13	15	11	3	42
Total	**36**	**88**	**52**	**30**	**206**

Table 4.9: Distribution of Motorcycle crashes by woredas in south Omo zone :(January 2014-December 2017).

Based on the main causes of motorcycle crashes, failure to give priority for pedestrians is the primary cause of the crash 68(33%), and followed by 64(31.1%) were due to careless riding like using cell phone during riding, chewing khat, drink riding and so on and also 54(26.2%) were due to over speeding. And, overtaking another vehicle without getting enough gap acceptance were recorded the lowest cause of crash severities in the study area 7(3.4%) (Figure 4.3)

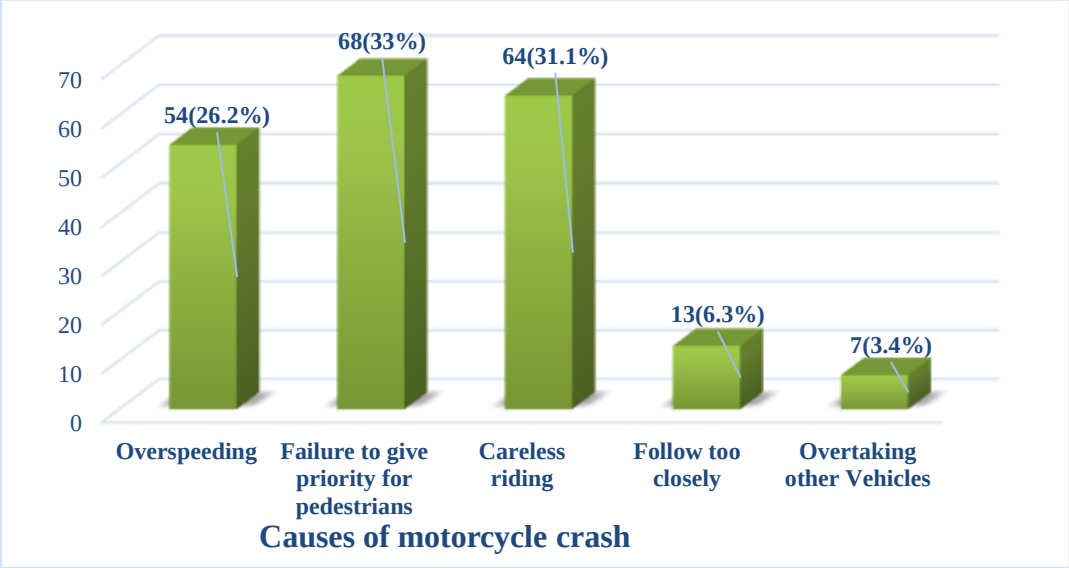

Figure 4.3: Distribution of Motorcycle crashes by causes in woredas of south Omo zone traffic police offices from (January 2014-December 2017).

These results are also consistency with other authors identified over speeding and failure to give priority for pedestrians as being associated with increased risk of severity amongst motorcycles

(Bambach et al., 2012).In addition, these finding is also in agreement with the finding from southeast Iran in which human factors like careless riding, violating traffic laws and speeding were the most important causal factors accounting for 90% of motorcycle crashes (Rad & Heydari et al., 2016).

4.4. Trends of Motorcycle Crashes (January 2014-December 2017)

Generally, motorcycle crashes increased in number from January 2014 to December 2017. However, From January 2014 to December 2014 the trend shows a small increment. Similarly, this trend is also increased from January 2015 to December 2015. But the trend is almost doubled to 92 (44.66%) from January 2017-December 2017 compared to other years (Figure 4.4).

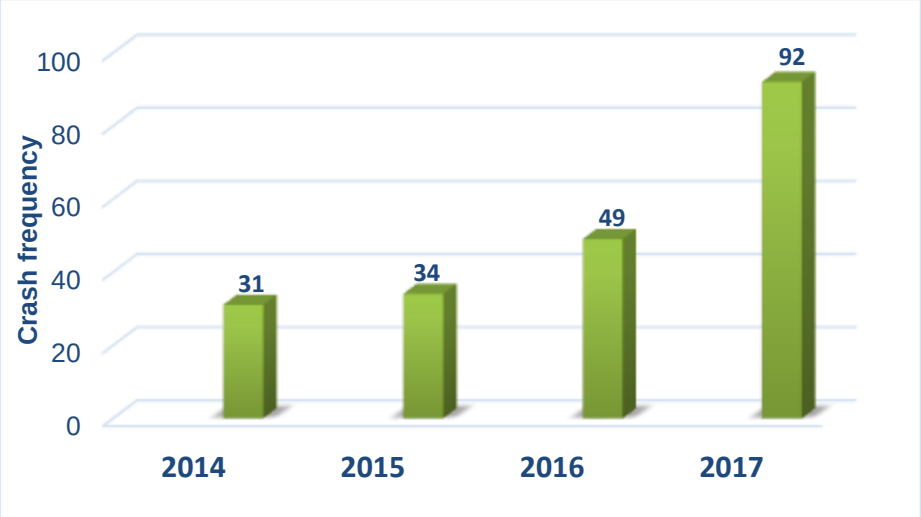

Figure 4.4: Distribution of motorcycle crashes in South Omo Zone, Ethiopia from January 2014 to December 2017.

The analysis result shows that 28(16%) motorcycle crashes occurred during the period of January 2014 to December 2015. However, this is gradually increased to 30(17.0%) during the period of January 2015 to December 2016. However, it showed also increased to 44(25%) between January 2016 to December 2016. Between January 2017 to December 2017, it increases about three fourth, which is 74(42.0%) of motorcycle crashes occurred. Compared to January 2017 through December 2017, showing the highest increment compared to all other years. Fatal motorcycle crashes are highly increased from 3(8.33%) to 15(41.67%) during a four-year period. And, Non-fatal motorcycle crashes are increased as well from 25(17.9%) to 59(42.14%). Generally, the magnitude of motorcycle crashes shows an increasing trend during the four-year period. This could be due to increasing the popularity of motorcycles through time and also the expansion of the urbanization (Figure 4.5)

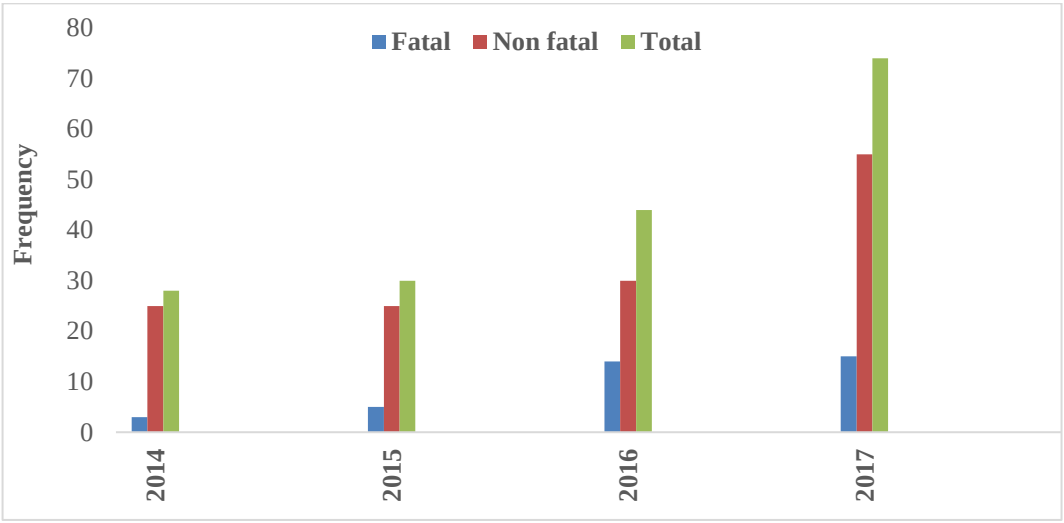

Figure 4.5: Trends of fatal and non-fatal motorcycle crashes in South Omo Zone, Ethiopia from January 2014 to December 2017.

4.5. Factors Associated with motorcycle crashes in South Omo Zone

Overall, most of the factors that increase the risk of road traffic crashes for the other vehicle do so similarly for motorcycles. Thus, motorcycle riders are affected by the aspects related to human and the features connected to the vehicle (Motorcycle) and road environment factors. Of the entire motorcycle crashes,102(58.29%) pedestrians,54(30.86%) motorcycle riders and 19(10.86%) passengers were affected by the crashes. From the results of descriptive analysis, it is clear that more than half of the motorcycle crashes happened, almost 111(53.9%) were caused by 18-30 years of age. Regarding the level of education, 110 (53.4%) riders were completed five to eight school level. And 36(17.5%) of the riders were completed zero to four (junior elementary) school level. Regarding the experience of motorcycle riding, almost above half, i.e. 114(55.3%) of the riders had over two to five riding experience, followed by 33(16%) of the riders had between zero to the two-year riding experience.

Based on the results of the descriptive analysis rider motorcycle relationship, motorcycle crashes by owners of the motorcycle are accounted, 112(54.4%), then those by the hired rider's i.e.51 (24.8%). Regarding service of a motorcycle the majority of crashes, 62 (30.1%) is happened in over 1 to 2 years followed by 49 (23.8%) crashes in unknown services. Regarding motorcycle defects, 172 (83.5%) of the motorcycle had no mechanical problems and only 34 (16.5%) had some mechanical problems like brake failure, tire defect and so on.

A large number of crashes happened by dry air condition 179 (86.9%) followed by Moisture 19 (9.2%). Regarding the light condition during the crashes, almost above half, i.e.108 (52.4%) of the crashes happened during Nighttime and 98 (47.6%) of crashes happened during day time. The researcher observed from the study area during data collection time is that most of the motorcyclist do their commercial transport service at night time because at the market time most of the peoples come from rural areas to the

market town to fill their daily activities. In fact, at the night time, there is no traffic police to control those riders who violate traffic rules and regulations. And, it is very common to ride a motorcycle more than two or more passengers including the riders themselves. In addition, the riders at this time do not wear helmets to protect them from head injury because there is no traffic police to control them. The majority of motorcycle crashes, 92 (44.7%) have happened on the gravel road and the remaining crashes 64 (31.1%) and 50 (24.3%) have happened on Asphalt and Earth roads respectively.

Regarding weather conditions majority of crashes have happened, about 100(48.5%) have happened during rainy conditions followed by good weather conditions, about 91(44.2%) and other weather conditions like cloudy, windy, etc., which is 15(7.3%). This might be clear that due to their small physical body it is very difficult to control motorcycles during rainy seasons.

The majority of severity happened by motorcycle with pedestrian and rollover 76(36.9%) and 53(25.7%) respectively. However, the reason for those severities is attributed to 68(33%) and 64(31.1%) have occurred during the failure to give priority and careless riding respectively. And, 54(26.2%) were occurred during over speeding.

4.6. Analysis and discussions using multinomial logistic regression

Multinomial logistic regression is used when the dependent (response) variable is categorical. For crash severity (fatal, serious injury, slight injury and property damage) as the dependent variable, twelve independents (explanatory) variables were selected from the data set. The severity indicators, that is, number of fatalities, number of injuries such as serious and slight injuries and property damage, are studied with multinomial logistic regressions. However, the multinomial logistic regression is used to get the interrelation of the explanatory variables include age, educational background, riding experience, rider motorcycle relationship, service years of motorcycle, road condition, light condition, surface type, weather condition, motorcycle defects, causes of crashes and finally types of severities are included in the model which have on the severity of motorcycle crashes.

Completely assumed factors that are predictable to affect the severity of motorcycle crashes were included in the regression model but finally, the statically significant variables are only considered from the analysis output to interpret the results. The major contributing factors and their effects are identified based on the significance of the outputs. The results of step by step analysis are summarized in Table 4.10 below and combined for interpretation. The final output of multinomial logistic regression was provided at the end of the Appendix part.

Explanatory variables		Motorcycle crashes severities											
		Fatal				serious injury				Slight injury			
		B	std. error	sig.	Exp(b)	B	std. error	sig.	Exp(b)	B	std. error	sig.	Exp(b)
Age	Below 18									3.19	1.54	0.038*	24.25
	18-30												
	31-50									3.98	1.62	0.014*	53.25
	Above 50												
	unknown												
Education level	0 to 4												
	5 t0 8					2.19	1.02	0.03*	8.98				
	9 to10												
	11 to12												
	Above 12												
	Unknown												
Experience of riders	0 to 2												
	Over 2 to 5	-3.38	1.636	0.039*	0.034								
	Over 5 to 10												
	11 and Above												
	Unknown												
relationship with motorcycle	Hired												
	Owner	3.52	1.686	0.037*	33.65	2.37	1.21	0.05*	10.7				
	unknown												
	other**												
Service of motorcycle	0 to 1												
	Over 1 to 2												
	Over 2 to 5												
	Over 5 to10	3.56	1.809	0.049*	35.31								
	Above 10												
	Unknown												
motorcycle defects	yes					-3.23	1.02	0.002*	0.04				
	No												

Overall P value less than(*P<0.05) and **Friends, relatives.

Table 4.10: Results of multinomial logistic regression on crash severity

Source: Own survey from multinomial logistic regression Output.

4.6.1. Demographic characteristics of motorcycle riders

From the descriptive variables of the driver in the daily crash records from police reports, the characteristics of motorcycle riders are riders sex, age, education level, the experience of riding and the relation with the motorcycle. However, world health organization, 2015 world report on road traffic injury prevention are reported similar factors.

From the step by step analysis of multinomial logistic regression output show that the age of the motorcycle riders, educational background, riding experience, rider motorcycle relationship, service years of motorcycle and motorcycle defects shows statically significant effect on dependent variables and the

others like road condition, light condition, surface type, weather condition, causes of crashes and types of severities shows non-significant effect with dependent variables.

However, step by step analysis of the multinomial logistic regression model in table 4.10 reveals that the errors committed by motorcycle rider took the highest proportion than the vehicle(motorcycle) factors. But environmental factors show a non-significant effect.

From table 4.10, the multinomial logistic regression model result shows that the group of motorcycle riders aged below eighteen (below 18) and between thirty-one to fifty (between 31 to 50) years have statically significant relationships in the slight injury crashes with the odds ratio of 24.25 and 53.25 respectively. This result indicated that the riders whose age belongs to below eighteen (below 18) and between thirty-one to fifty (between 31 to 50) years are 24.25 and 53.25 times more likely to slight injury respectively compared with above fifty years age.

In addition, based on the output of the regression model, motorcycle riders who are having below eighteen (below 18) and between thirty-one to fifty (between 31 to 50) years are crash severity of 3.19 and 3.98 (relative log odds) times the property damages with a significance value of (p=0.038 and 0.014) respectively. This result is generally in partial agree with the study of Australia shown that riders with aged (31 to 39) riders have high probabilities of fatality and severe injuries (Bambach et al., 2012). In addition, other findings from southeast Iran also show a similar finding (Rad et al., 2016).

Based on the output of the regression model, motorcycle riders who are having five to eight (5 to 8) education levels have significant relationships in serious injury crashes with an odds ratio of 8.983. This result revealed that motorcycle riders who are having five to eight (5 to 8) education levels are 8.983 times more likely to serious injury compared with above twelve education levels. This result predicted that having a higher education background promotes improved decisions of motorcycle riders and accountable behaviors. The result of the regression model revealed that the motorcycle riders educated between zero to four (0 to 4) are insignificant with the reference of high school levels (9 to 10), preparatory school (11 to 12) and some college or universities (Above 12) educated levels. This enables to the deduction that motorcycle riders with five to eight (5 to 8) levels of education than above secondary educated levels have an increased the probability of serious crashes.

However, the motorcycle rider's education level is a significant factor for serious injury crashes which is positively associated with five to eight (5 to 8) education levels. The results of the regression model show that motorcycle riders who are having five to eight (5 to 8) education levels are crash severity 2.195 (relative log odds) times the property damages with a significance value of (p=0.031). This finding is inconsistence with the study conducted on Iran which has found p=0.320 which is much greater than p=0.05 for five to eight education levels (Heydari et al., 2016).

Motorcycle riders who are having the riding experience of over two to five (2 to 5) years have statically significant relationships in fatal with an odds ratio of 0.034. This means that the riders who are having the riding experience of over two to five (2 to 5) years are 0.034 times less likely to be a fatal compared with unknown experienced riders.

The motorcycle riders who are having the riding experience of over two to five (2 to 5) years are crashed severity 3.38 (relative log odds) times less the property damage with a significance value of (p=0.039).

From the output of the multinomial logistic regression model, the relation of the motorcycle rider with a motorcycle is considered as a significant factor with the 'other (relatives, friends)' set as a reference. This variable indicates a statically significant relationship in fatal and serious crashes by the owners of motorcycle riders with an odds ratio of 33.66 and 10.70 respectively. This result revealed that the severity of crashes increases when a motorcycle was ridden by an owner of a motorcycle are 33.66 and 10.70 times more likely to fatal and serious crashes respectively, compared with the others like relatives and friends.

From the output of the regression model, the relation of the rider with the motorcycle shows the crash severity 3.516 and 2.370 (relative log odds) times the property damages with a significance value of (p=0.037 and p=0.050) respectively. Generally, this result demonstrates that the owners of the motorcycle riders are over confidential to rides their motorcycle and simply lead them to crashes by taking without any care about their lives.

4.6.2.Vehicle (motorcycle) factor

Both factors which are motorcycle years of service and motorcycle defects (like tire, brake and so on) are the other main factors considered to explain the influence of the motorcycle.

The output of the regression model revealed that the number of years that the motorcycle served indicates the effect on crash severity with reference to unknown years of service.

In addition, the motorcycle which has had the service year of over five to ten (5 to 10) years shows a statically significant relationship is fatal with an odds ratio of 35.31. This reveals that motorcycles which have had the service year over five to ten (5 to 10) years are 35.31 more likely to be fatal crashes compared with no service year of motorcycles.

The motorcycle which has to have the service year over five to ten (5 to 10) years has crash severity 3.564 (relative log odds) times the property damage with the significance value of (p=0.049). However, the hazard of a motorcycle crash increases for those motorcycles which has a service of over five to ten (5 to 10) years. In fact, the number of service years of motorcycle increases, as the performance of the motorcycle is also decreasing and directly gone to crashes. Furthermore, this might be due to lack of on-time maintenance or forgiving service within important time.

Based on the results of the multinomial logistic regression model, the last determining factor for the motorcycle crash severity is motorcycle defect which was categorized under vehicle (motorcycle) factors. This is analyzed with the reference of motorcycles with no defects. However, the result shows that motorcycle with mechanical problems has a significant risk factor for serious crashes. The motorcycles with mechanical problems show a statically significant relationship with the odds ratio of 0. 040. This implies that motorcycles with any mechanical problems are 0.040 are less likely to be a serious crash compared with motorcycles which have no mechanical problems. In addition to this, a motorcycle with the technical problems has increases the serious crashes compared with the motorcycles which have no mechanical problems unless immediate maintenance or service is provided.

The motorcycles with mechanical problems have crash severity -3.227 (relative log odds) times less the property damage with the significance value of (p=0.002). This result allowed that that motorcycle with mechanical problems is less likely involved in being in serious crashes than property damages. On the other hand, a motorcycle with no mechanical problems contributes less involvement in the severity of crashes.

The presence of motorcycle mechanical problems has a significant effect in reducing the severity of motorcycle crashes. Moreover, a motorcycle with no mechanical problems is seen to be the most factor to contribute crashes of higher severity. However, this finding is generally similar to the study conducted on Iran which has found p=0.001 which is much less than p=0.05 (Heydari et al., 2016).

4.7. Analysis of questionnaire results

The analysis of descriptive statistics results presented below summarizes the responses of motorcycle riders. Respondents view about the overall situation of occurrence of motorcycle crashes in the study area, causes and contributing factors for motorcycle crashes and its trend, possible reasons for riders to exercise hazardous riding behaviors, pedestrians and road-related factors for motorcycle crashes were assessed for a deep understanding of the problems during the study period.

Overall, a total of four hundred three motorcycle riders were recruited for the study. However, analysis of only three hundred eighty-eight individuals sustained for motorcycle riders was included in the study due to a response rate which was 96.27%. Fifteen respondents were excluded from the study as a result of an incomplete responses to the survey. This section presents the background of respondents by considering human, vehicular (motorcycle) and environmental factors associated with the occurrence of motorcycle crashes in the study area.

4.7.1. Socio-demographic information of the respondent

This section outlines the respondent's demographic features that were believed to be significance to the study. It was assumed that age was a crucial feature of the respondents that would influence the experience and involvement of respondents in motorcycle crashes. The study depicts that more than three

fourth 347(89.4%) of the respondents sustained motorcycle crashes in was male. This shows that males are more involved in such types of occupations than females. Age group between 18 to 30 years were the most affected age group by motorcycle crashes followed by the age group of between 31 to 50 years, and they account 257(66.2%) and 85(21.9%) respectively. Regarding the level of education, the majority of the crash happened, about 143 (36.9%) of the crash occurred in 9 to 10 education levels followed by 88(22.7%) which is happened by above twelve levels of education. Then, regarding the riding experience of motorcycle riders about 194(50%) of the crashes occurred over 2 to 5 followed by 90(23.2%) which is happened by between 0 to 2 riding experience (Table 4.11).

Variables	Total(N=388)	
Gender	**Frequency**	**Percent (%)**
Male	347	89.4
Female	41	10.6
Age category of riders (years)		
Below 18	38	9.8
18-30	257	66.2
31-50	85	21.9
Above 50	8	2.1
Level of Education		
0 to 4	16	4.1
5 to 8	70	18
9 to 10	143	36.9
11 to 12	71	18.3
Above 12	88	22.7
Riding Experience (years)		
0 to 2	90	23.2
Over 2 to 5	194	50
Over 5 to 10	77	19.8
11 and above	27	7

Table 4.11: Description of demographic characteristics of the respondents, in South Omo Zone, Ethiopia

4.7.2.Basic characteristics of the respondents

Out of the total respondents (motorcycle riders), above half of the total riders took training before riding a motorcycle and accounts 226(58.2%) and the remaining riders who are not taken rider training were accounted for 162(41.8%). With regard to the type of training, 145(37.4%) of the riders had taken formal training prior to the date of riding motorcycle. But, the majority of the riders had no riding license which is 213 (54.9%) while a minority had a valid motorcycle license which is accounted for 175 (45.1%). From table 4.12, motorcycle riders who took formal training are less than those who have a riding license. This

implies that there is an illegal way of giving riding licenses in the study area. With regard to service year of riding license, almost 83(21.4%) of the riding license belongs to over 2 to 5 years of service followed by 44(11.3%) riding license belongs to over 5 to 10-year service. Concerning the regular riding of motorcycle, about 147(37.9%) riders are riding their motorcycle sometimes for certain purposes followed by 75(19.3%) of riders are always riding their motorcycle. Concerning the wearing of safety helmets, about 241(62.1%) wear helmet and 147 (37.9%) of motorcycle riders are not wearing safety helmets. Actually, the researcher of this study observed from the study area is that most of the riders are simply bought a safety helmet from the market. In addition to this, at the time of collecting data, a researcher was tried to ask the riders whether they used a standard helmet or not, but riders responded that traffic police is only checked whether riders are wearing helmet or not but not checked whether the riders wear the standard helmet or not. This observation is witnessed that; the riders are not wearing a standard helmet in the study area. With regard to wearing safety helmets, most of the motorcycle riders, about 155(39.9%) usually wear safety helmets and 132 (34%) never wear safety helmets. With regard to the riding above the limited speed, most of the motorcycle riders, about 325(83.8%) never ride above the limited speed followed by about 46(11.9%) are occasionally riding above the limited speed. Regarding the alcohol and drug use before riding, most of the motorcycle riders, almost 361(93%) never used alcohol and drug before riding their motorcycle followed by 25(6.4%) were occasionally used alcohol and drugs before riding their motorcycle (Table 4.12).

Variables	**Total(N=388)**	
Training	**Frequency**	**Percent (%)**
yes	226	58.2
not	162	41.8
Type of training		
Formal training	145	37.4
Informal training	76	19.6
not training at all	15	3.9
Missing Values	152	39.2
Riding license		
yes	175	45.1
No	213	54.9
Service of riding license(years)		
≤ 2	38	9.8
Over 2 to 5	83	21.4
Over 5 to 10	44	11.3
Above 10	24	6.2

Missing Values	199	51.3
How often use a motorcycle?		
always	75	19.3
Sometimes	147	37.9
never	6	1.5
Missing Values	160	41.2
Do you wear a safety helmet		
yes	241	62.1
No	147	37.9
How often do you wear a safety helmet?		
Always	155	39.9
occasionally	85	21.9
never	132	34
Missing Values	16	4.1
Do you ride the above the speed limit?		
yes	63	16.2
no	325	83.8
How often do you ride above the speed limit?		
Always	17	4.4
occasionally	46	11.9
never	325	83.8
Ride under the influence of alcohol/drugs?		
Always	2	0.5
occasionally	25	6.4
never	361	93

Table 4.12: Description of motorcycle factor condition of the respondents, in south Omo Zone, Ethiopia

Road user-related risk factors concern the behavior of riders as well as other road users with whom they interact in the traffic environment. Some of the most common road user-related risk factors such as not wearing of safety helmet, alcohol drinking and riding, speeding, overloading, mechanical problems on motorcycles like braking errors, steering problems and so on.

Furthermore, the respondents selected the motorcycle crash types at which motorcyclist was exposed. Most of the respondent's, almost 301(77.58%) replied that poor riding technique leading to loss of control of the motorcycle and 165(42.53%) thought collision while overtaking other road users were the most motorcycle crash types for the occurrence of motorcycle crashes. In addition, wet pavement is also another factor for motorcycle crashes related to the aforementioned factors. However, for those riders who have less control of the motorcycle and overtaking other road users is mainly connected with wet pavement unless due attention is taken to ride on it. Finally, the respondents about 46(11.86%) also thought that motorcyclists were least exposed to risk when it comes to collisions with left-turning

vehicles. Furthermore, it is not to means that the above-mentioned factors are not the only most risk factors for motorcycle crashes (Figure 4.6).

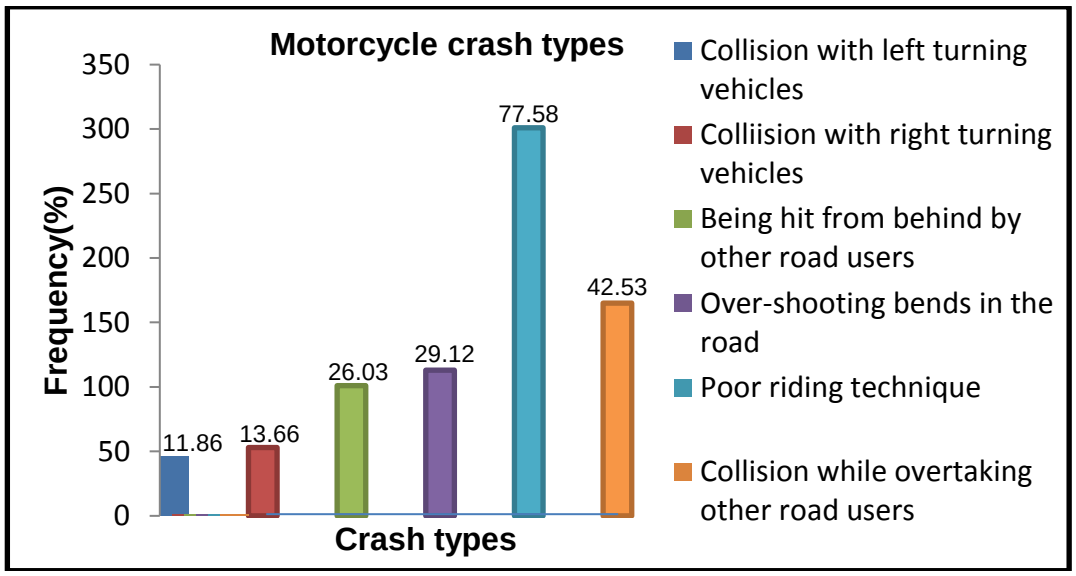

Figure 4.6: Motorcyclists opinion on the crash types that affect motorcycle crashes

As shown below in figure 4.7; the majority of the motorcycle riders responded that observing the speed limit, wearing protective instruments like helmet and positioning of a motorcycle according to road conditions were the most important safety measures. Lastly, most of the motorcycle riders acknowledged that the least important safety measure was carrying appropriate number of passengers when riding a motorcycle. However, these finding is almost consistency with the finding from the motorcycle crash data collected from each police station.

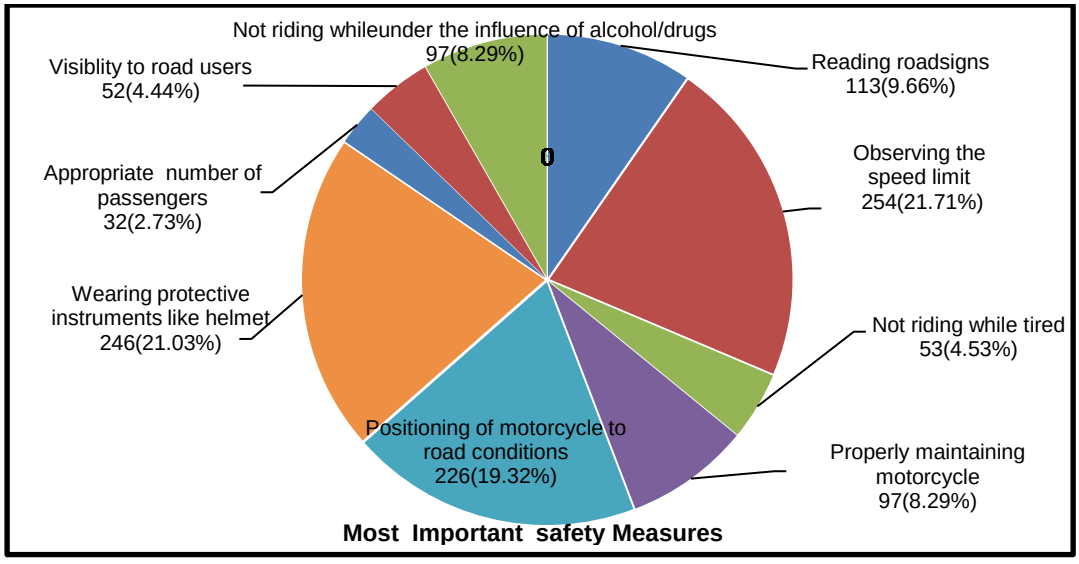

Figure 4.7: Motorcyclists opinion on the most important safety measures

4.7.3.Basic Motorcycle factor conditions of the respondents

Based on the descriptive analysis of the result on the service year of motorcycle, 146 (37.6%) were over 2 to 5 years of service followed by over 1 to 2 years of service, which is almost, 136 (35.1%).

Concerning ownership of the motorcycle, about 186 (47.9%) have their own motorcycles followed by hired motorcycle riders, 135 (34.8%) and the rest one is other like relatives, friends and so on, 67 (17.3%). Regarding the mechanical problem of motorcycle riders about 366 (94.3%) has not mechanical problem whereas only 22 (5.7%) has the problem only at the time of crashes which includes brake 2 (0.5%), lighting 3 (0.8%) and 7 (1.8%) were tire problems (Table 4.13).

Variables	Total(N=388)	
Service of a motorcycle(years)	**Frequency**	**Percent (%)**
0 to 1	61	15.7
Over 1 to 2	136	35.1
Over 2 to 5	146	37.6
Above 5	45	11.6
Ownership of motorcycle		
Owner	186	47.9
Hired	135	34.8
Other	67	17.3
Motorcycle encounter mechanical problem		
Yes	22	5.7
No	366	94.3
Kind of mechanical problems that the motorcycle encounter		
Brake	2	0.5
Lighting	3	0.8
Tire	7	1.8
Missed values	366	94.3

Table 4.13: Description of Motorcycle factor condition of the respondents, in south Omo Zone, Ethiopia

4.7.4.Road and Environmental condition for motorcycle crashes

Out of total of 388 respondents, almost 303(78.1%) have not happened any crash at the time of riding a motorcycle, but only 85(21.9%) crash has happened at the time riding. With regard to surface type when riding a motorcycle, almost all riders had not happened crashes but 58(14.9%) have happened during not asphalt surface, and also 31(8%) have happened on Asphalts roads only. Forty-six crashes (11.9%) have happened in dry weather conditions followed by rainy weather conditions, 32(8.2%).

With regard to light condition, 67(17.3%) crash happened in daytime whereas only 18(4.6%) crashes happened during night time (Table 4.14).

Variables	Total(N=388)	
Have a crash when riding a motorcycle	**Frequency**	**Percent(%)**
Yes	85	21.9
No	303	78.1
The surface type when the crash happened		
Asphalt	31	8
Not Asphalt	58	14.9
Weather condition when the crash happened		
Dry	46	11.9
Rainy	32	8.2
other	11	2.8
The light condition when the crash happened		
Day time	67	17.3
Nighttime	18	4.6

Table 4.14: Description of road and Environmental factor condition of the respondents, in South Omo Zone, Ethiopia

Regarding the main factors that facilitate the occurrence of motorcycle crashes, most of the motorcycle crashes happened by the human (motorcycle rider) factor about 266(68.6%) followed by environmental factors which are about 44(11.3%). The rest ones are least in number which is accounted for 42(10.8%) were happened during enforcement of legislation and regulation and also 36(9.3%) were occurred by vehicular(motorcycle) factors (Figure 4.8).

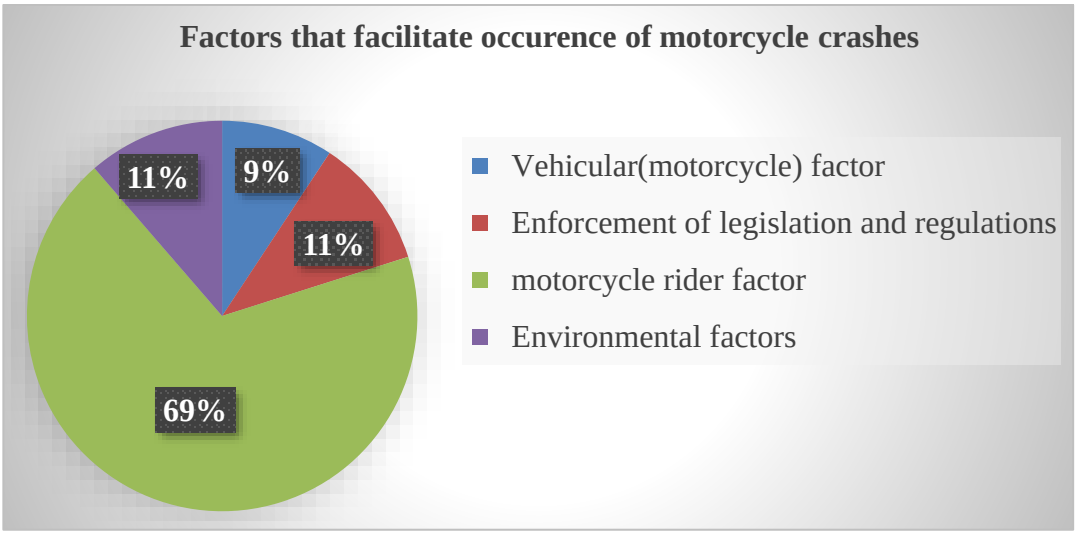

Figure 4.8: Motorcyclists opinion on the factors that facilitate the occurrence of motorcycle crashes

With regard to response of motorcycle riders, to reduce motorcycle crashes, most of motorcycle riders responded that 210(54%) were recommended that Undergo intensive rider training was one of best way to reduce motorcycle crashes followed by 79(21%) were recommended that creating public awareness on

road safety is also essential way. This shows that most of the community in the area has not enough knowledge regarding traffic safety. In addition, 75(19%) were recommended to reduce crashes that Traffic laws must be implemented strictly for the area is also another way to reduce motorcycle crashes. And, only 24(6%) were recommended that avoiding drink riding during working hours with another way to reduce motorcycle crashes (Figure 4.9).

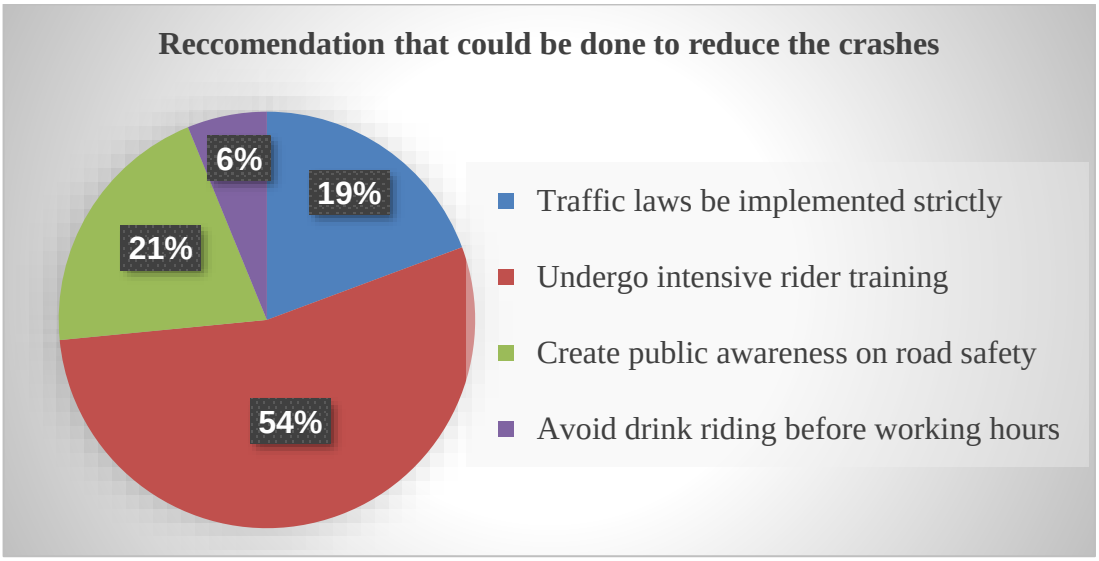

Figure 4.9: Motorcyclists opinion on the recommendation that could be done to reduce the problems

These studies might be similar with other studies reported from Tanzania (Mnzava, 2013). This study alarms and calls for action because of the huge magnitude of the problem in the area unless the urgent measurement is taken.

4.8. One-way Analysis of variance (ANOVA) result for questionnaire data

One-way analysis of variance is used when the factor (independent) variable has two or more groups and used to determine whether there is any statistically significant difference between the means of two or more independent groups. Procedures to analyze the one-way analysis of variance is Analyze-compare means-one-way ANOVA-between occurrence of crashes (factor variable) and factors that affect the motorcycle crashes (dependent variable). ANOVA result was discussed in the following three main sections such as human, vehicle(motorcycle) and road and environmental factors. The summary of the initial data with One-way Analysis of Variance (ANOVA) was tabulated in (Table 4.15).

ANOVA RESULTS					
Response variables	**Sum of Squares**	**df**	**Mean Square**	**F**	**Sig.**
Gender	.206	3	.069	.724	.538
Age of riders	3.214	3	1.071	2.907	.035
Level of education	8.447	3	2.816	2.187	.089
Riding experience	16.715	3	5.572	8.425	.000
Training rider before riding	1.219	3	.406	1.676	.172
Kind of training	2.682	3	.894	.499	.683
Riding license	3.894	3	1.298	5.407	.001
Serviced years of motorcycle riding license	43.517	3	14.506	6.685	.000
Whether often using motorcycle or not	12.568	3	4.189	2.946	.033
Wearing safety helmet	.594	3	.198	.838	.474
whether often wearing helmet or not	2.033	3	.678	.746	.525
Riding above the speed limit	2.645	3	.882	6.754	.000
whether often riding above the speed limit or not	4.912	3	1.637	6.790	.000
Riding under the influence of alcohol/drugs	1.410	3	.470	6.135	.000
Service year of motorcycle	14.510	3	4.837	6.327	.000
Ownership of motorcycle	2.322	3	.774	1.388	.246
Motorcycle encounter mechanical problem	.940	3	.313	6.071	.000
Kind of mechanical problem	6.974	3	2.325	8.645	.000
Had a crash at the time of riding motorcycle	1.587	3	.529	3.135	.026
Types of surface	6.670	3	2.223	6.177	.000
Weather condition	14.274	3	4.758	4.332	.005
Light condition	5.844	3	1.948	3.391	.018
Recommendations that could be done to reduce the occurrence of motorcycle crashes.	31.541	3	10.514	19.090	.000

Table 4.15: Summary of the initial data with One-way Analysis of Variance (ANOVA)

4.8.1. Human factors

Human factors include the motorcycle rider characteristics like gender of the rider, age of the rider, level of education, riding experience and motorcycle ownership status. The descriptive analysis was discussed in the previous section. However, the following section only describes output of one-way analysis (ANOVA) for each factor.

Gender

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.206	3	.069	.724	.538
Within Groups	36.461	384	.095		
Total	36.668	387			

Table 4.16: Differences in the occurrence of motorcycle crashes among gender (one-way ANOVA Output).

The difference in the occurrence of motorcycle crashes with the gender of riders was shown in the above table 4.16. The result of one-way analysis of variance (ANOVA) table shows that F (3,384) =0.724, p=0.538) which is greater than (α=0.05). This result allowed failing to reject the null hypothesis (H_0) and supporting the conclusion that the variation of gender has no significant difference with the occurrence of motorcycle crashes. This finding is almost consistency with the finding from California at which p=0.103 (Erhardt, et al.,2016).

Age of riders in years

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.214	3	1.071	2.907	.035
Within Groups	141.556	384	.369		
Total	144.771	387			

Table 4.17: Differences in the occurrence of motorcycle crashes among riders age (one-way ANOVA Output).

The difference in the occurrence of motorcycle crashes with the age of riders was shown in the above table 4.17. The result of a one-way analysis of variance (ANOVA) table shows that (3,384) =2.907, p=0.035) which is less than (α=0.05). Hence, this result revealed that fail to reject the null hypothesis(H_0) and concluding the suggestion that the variation of motorcycle riders age does not more impact on motorcycle crashes. Means that, age variation does not protect the occurrence of a crash but might minimize the severity of a crash.

Level of education

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	8.447	3	2.816	2.187	.089
Within Groups	494.365	384	1.287		
Total	502.812	387			

Table 4.18: Differences in the occurrence of motorcycle crashes among the level of education (one-way ANOVA Output).

The difference in the occurrence of motorcycle crashes with the level of education was shown in the above table 4.18. The result of one-way analysis of variance (ANOVA) table shows that F (3,384) =2.187, p= 0.89) which is greater than (α=0.05). Therefore, this outcome allowed fail to reject the null hypothesis(H_0) and supporting the conclusion that the variation of the level of education of motorcycle riders has no significant difference with the occurrence of motorcycle crashes.

Riding experience

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	16.715	3	5.572	8.425	.000
Within Groups	253.952	384	.661		
Total	270.668	387			

Table 4.19: Differences in the occurrence of motorcycle crashes among riding experience (one-way ANOVA Output).

The difference in the occurrence of motorcycle crashes with the riding experience of a motorcycle was shown in the above table 4.19. The result of one-way analysis of variance (ANOVA) table shows that F (3,384) =8.425, p=0.000) which is much less than (α=0.05). So, this result allowed that there is significant evidence to rejecting the null hypothesis (H_0), and conclude that the variation of riding experience of a motorcycle has too much significant difference with the occurrence of motorcycle crashes.

Training riders before riding

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.219	3	.406	1.676	.172
Within Groups	93.141	384	.243		
Total	94.361	387			

Table 4.20: Differences in the occurrence of motorcycle crashes among rider training before riding a motorcycle (one-way ANOVA Output)

The difference in the occurrence of motorcycle crashes with the training riders before riding motorcycle was shown in the above table 4.20. The result of one-way analysis of variance (ANOVA) table shows that F (3,384) =1.676, p=0.172) which is greater than (α=0.05). Consequently, this result allowed fail to reject the null hypothesis (H_0) and supporting the conclusion that the variation of training rider before riding a motorcycle does not have a significant difference with the occurrence of motorcycle crashes. The implication should be strict enforcement of traffic law on the road.

Kind of training that the rider undertook

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.682	3	.894	.499	.683
Within Groups	687.287	384	1.790		
Total	689.969	387			

Table 4.21: Differences in the occurrence of motorcycle crashes among the kind of training that the rider undertook (one-way ANOVA Output).

The difference in the occurrence of motorcycle crashes with the kind of training that the rider undertook were shown in the above table 4.21. The result of one-way analysis of variance (ANOVA) table demonstrated that F (3,384) =0.499, p=0.683) which is greater than (α=0.05). Accordingly, this result is indicated fail to reject the null hypothesis(H_0), and supporting the conclusion that the variation of kind of training that the rider undertook does not have a significant difference with the occurrence of motorcycle crashes. Actually, the kind of training that the rider undertaken before riding the motorcycle is very important for full confidentiality during riding because those riders who took formal training has enough confidence to ride on the public roads compared with those riders who have not formal training.

Riding license

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	3.894	3	1.298	5.407	.001
Within Groups	92.176	384	.240		
Total	96.070	387			

Table 4.22: Differences in the occurrence of motorcycle crashes among riding license (one-way ANOVA Output).

The difference in the occurrence of motorcycle crashes with their own riding license was shown in the above table 4.22. The result of a one-way analysis of variance (ANOVA) table shows that F (3,384) =5.407, p=0.001) which is less than (α=0.05). Therefore, this result indicated that there is significant evidence to rejecting the null hypothesis(H_0), and concluded that the variation of own riding license of motorcycle rider has too much significant difference with the occurrence of motorcycle crashes.

Service year of motorcycle riding license

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	43.517	3	14.506	6.685	.000
Within Groups	833.212	384	2.170		
Total	876.729	387			

Table 4.23: Differences in the occurrence of motorcycle crashes among the service year of motorcycle riding license (one-way ANOVA Output).

The difference in the occurrence of motorcycle crashes with service year of motorcycle riding license was shown in the above table 4.23. The result of one-way analysis of variance (ANOVA) table shows that F (3,384) =6.685, p=0.000) which is much less than (α=0.05). Hence, this result indicated that there is significant evidence to rejecting the null hypothesis(H_0), and concluded that the variation of service year of motorcycle riding license has too much significant difference with the occurrence of motorcycle crashes.

Often riding motorcycle

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	12.568	3	4.189	2.946	.033
Within Groups	546.058	384	1.422		
Total	558.626	387			

Table 4.24: Differences in the occurrence of motorcycle crashes among often riding of a motorcycle (one-way ANOVA Output).

The difference in the occurrence of motorcycle crashes with often riding of a motorcycle was shown in the above table 4.24. The result of a one-way analysis of variance (ANOVA) table shows that F (3,384) =2.946, p=0.033) which is less than (α=0.05). Subsequently, this result revealed that there is significant evidence to reject the null hypothesis(H_0), and concluded that the variation of often riding of a motorcycle has a significant difference with the occurrence of motorcycle crashes.

Wearing safety helmet

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.594	3	.198	.838	.474
Within Groups	90.713	384	.236		
Total	91.307	387			

Table 4.25: Differences in the occurrence of motorcycle crashes among wearing a safety helmet (one-way ANOVA Output).

The difference in the occurrence of motorcycle crashes with wearing safety helmet was shown in the above table 4.25. The result of one-way analysis of variance (ANOVA) table shows that F (3,384) =0.838, p=0.474) which is greater than (α=0.05). Consequently, this result shown fail to reject the null hypothesis(H_0) and supporting the conclusion that the varying the duration of wearing a safety helmet on the riding time of motorcycle does not increase head injury because the occurrence of the crash might be sudden. However, the main purpose of wearing a safety helmet during riding is to reduce head injury. This finding is almost similar to the study conducted on the united states at wearing a safety helmet that shows nonsignificant association (Rice et al., 2017).

Often wearing helmet

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.033	3	.678	.746	.525
Within Groups	348.759	384	.908		
Total	350.791	387			

Table 4.26: Differences in the occurrence of motorcycle crashes among often wearing a helmet (one-way ANOVA Output).

The difference in the occurrence of motorcycle crashes with the wearing style of the helmet was shown in the above table 4.26. The result of one-way analysis of variance (ANOVA) table shows that F (3,384) =0.746, p=0.525) which is greater than (α=0.05). Thus, this result allowed fail to reject the null hypothesis(H_0) and supporting the conclusion that the variation of often wearing safety helmet does not prevent the occurrence of motorcycle crashes. Eventually, the meaning is that whether changing the time of wearing a safety helmet does not protect from a head injury. In addition to this, it means that usually wearing a safety helmet during riding time reduces the head injury but not reduces the crashes. However, the difference between wearing a safety helmet and often wearing a safety helmet is that the first case describes generally wearing of a safety helmet but the second case describes the regular wearing of a safety helmet during riding time.

Riding above the limited speed

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.645	3	.882	6.754	.000
Within Groups	50.126	384	.131		
Total	52.771	387			

Table 4.27: Differences in the occurrence of motorcycle crashes among riding above the limited speed (one-way ANOVA Output).

The difference in the occurrence of motorcycle crashes with riding above the limited speed was shown in the above table 4.27. The result of one-way analysis of variance (ANOVA) table shows that F (3,384) =6.754, p=0.000) which is much less than (α=0.05). Accordingly, this result has shown that there is significant evidence to reject the null hypothesis(H_0), and supporting the conclusion that the variation of riding above the limited speed has too much significant difference with the occurrence of motorcycle crashes. However, this finding is generally in agreement with other studies conducted in California and Iran at which p=0.001 which is much less than p=0.05 (Erhardt & Heydari et al., 2016).

Often riding above the limited speed

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	4.912	3	1.637	6.790	.000
Within Groups	92.593	384	.241		
Total	97.505	387			

Table 4.28: Differences in the occurrence of motorcycle crashes among often riding above the limited speed (one-way ANOVA Output).

The difference in the occurrence of motorcycle crashes with often riding above the limited speed was shown in the above table 4.28. The result of one-way analysis of variance (ANOVA) table shows that F (3,384) =6.790, p=0.000) which is much less than (α=0.05). Therefore, this result revealed that there is significant evidence to reject the null hypothesis(H_0), and supporting the conclusion that the variation of often riding above the limited speed has too much significant effect on the occurrence of motorcycle crashes.

Riding under the influence of alcohol/drugs

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.410	3	.470	6.135	.000
Within Groups	29.422	384	.077		
Total	30.832	387			

Table 4.29: Differences in the occurrence of motorcycle crashes among riding under the influence of alcohol/drugs (one-way ANOVA Output)

The difference in the occurrence of motorcycle crashes with riding under the influence of alcohol/drugs were shown in the above table 4.29. The result of a one-way analysis of variance (ANOVA) table shows that F (3,384) =6.135, p=0.000) which is much less than (α=0.05). Hence, this result has shown that there

is significant evidence to rejecting the null hypothesis(H_0), and supporting the conclusion that the variation of riding under the influence of alcohol/drugs has too much significant difference with the occurrence of motorcycles crashes. This finding is inconsistence with the finding from Rwanda which shows that there is no statically significant association between motorcycle crash and alcohol or drug use (Ingabire et al., 2015)

4.8.2.Vehicle(motorcycle) factors

Vehicle factor was found to be an important factor that affects the occurrence of motorcycle crashes. These could be service year of motorcycle and any kind of mechanical problem like tire defect, brake, steer and so on.

Service year of motorcycle

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	14.510	3	4.837	6.327	.000
Within Groups	293.559	384	.764		
Total	308.070	387			

Table 4.30: Differences in the occurrence of motorcycle crashes Service year of a motorcycle (one-way ANOVA Output).

Based on the output of one-way analysis of variance, the difference in the occurrence of motorcycle crashes with service year of a motorcycle was shown in the above table 4.30. The result of one-way analysis of variance (ANOVA) table shows that F (3,384) =6.327, p=0.000) which is much less than (α=0.05). So, this result has shown that there is significant evidence to rejecting the null hypothesis(H_0), and supporting the conclusion that the variation of service year of a motorcycle has too much significant difference with the occurrence of motorcycle crashes. Most of the time long year serviced motorcycles has a sudden mechanical problem and occurred on the traveled road.

Ownership of motorcycle

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	2.322	3	.774	1.388	.246
Within Groups	214.181	384	.558		
Total	216.503	387			

Table 4.31: Differences in the occurrence of motorcycle crashes among the ownership of motorcycle (one-way ANOVA Output)

Based on the output of one-way analysis of variance, the difference in the occurrence of motorcycle crashes with the ownership of motorcycle was shown in the above table 4.31. The result of one-way analysis of variance (ANOVA) table shows that F (3,384) =1.388, p=0.246) which is greater than (α=0.05). Consequently, this result allowed fail to reject the null hypothesis(H_0) and supporting the conclusion that the variation of ownership of motorcycle does not have a significant difference in the occurrence of motorcycle crashes.

Motorcycle encounter mechanical problem

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	.940	3	.313	6.071	.000
Within Groups	19.813	384	.052		
Total	20.753	387			

Table 4.32: Differences in the occurrence of motorcycle crashes among mechanical problems (one-way ANOVA Output).

Based on the output of one-way analysis of variance, the difference in the occurrence of motorcycle crashes with the mechanical problem of a motorcycle were shown in the above table 4.32. The result of a one-way analysis of variance (ANOVA) table shows that F (3,384) =6.071, p=0.000) which is much less than (α=0.05). Accordingly, this result allowed that there is significant evidence to rejecting the null hypothesis (H_0) and supporting the conclusion that the variation of the mechanical problem has too much significant difference with the occurrence of motorcycle crashes. this finding is generally consistency with other studies conducted in Iran at which p=0.001 which is much less than p=0.05 (Heydari et al., 2016).

Kind of mechanical problem

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.974	3	2.325	8.645	.000
Within Groups	103.261	384	.269		
Total	110.235	387			

Table 4.33: Differences in the occurrence of motorcycle crashes among kind of mechanical problem (one-way ANOVA Output)

Based on the output of one-way analysis of variance, the difference in the occurrence of motorcycle crashes with kind of mechanical problem of a motorcycle was shown in the above table 4.33. The result of a one-way analysis of variance (ANOVA) table shows that F (3,384) =8.645, p=0.000) which is much less than (α=0.05). Hence, this result allowed that there is significant evidence to reject the null hypothesis(H_0), and supporting the conclusion that the variation of the kind of mechanical problem of a motorcycle has too much significant difference with the occurrence of motorcycle crashes.

Had a crash at the time of riding a motorcycle

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	1.587	3	.529	3.135	.026
Within Groups	64.792	384	.169		
Total	66.379	387			

Table 4.34: Differences in the occurrence of motorcycle crashes had a crash at the time of riding motorcycle (one-way ANOVA Output)

Based on the output of one-way analysis of variance, the difference in the occurrence of motorcycle crashes with a crash at the time of riding motorcycle was shown in the above table 4.34. The result of a one-way analysis of variance (ANOVA) table shows that F (3,384) =3.135, p=0.026) which is less than

(α=0.05). Therefore, this result witnessed that there is significant evidence to reject the null hypothesis (H_0), and supporting the conclusion that the variation of a crash at the time of riding motorcycle has too much significant difference with the occurrence of motorcycle crashes.

4.8.3.Road and environmental factors

These factors are types of surface, weather conditions, light condition and so on.

Types of surface

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	6.670	3	2.223	6.177	.000
Within Groups	138.217	384	.360		
Total	144.887	387			

Table 4.35: Differences in the occurrence of motorcycle crashes among surface type(one-way ANOVA Output)

Based on the output of the one-way analysis of variance, the difference in the occurrence of motorcycle crashes with surface type was shown in the above table 4.35. The result of a one-way analysis of variance (ANOVA) table shows that F (3,384) =6.177, p=0.000) which is much less than (α=0.05). Therefore, this result permitted that there is significant evidence to reject the null hypothesis(H_0), and supporting the conclusion that the variation of surface type has too much significant difference with the occurrence of motorcycle crashes.

weather condition

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	14.274	3	4.758	4.332	.005
Within Groups	421.796	384	1.098		
Total	436.070	387			

Table 4.36: Differences in the occurrence of motorcycle crashes among Types of weather condition (one-way ANOVA Output)

The difference in the occurrence of motorcycle crashes with types of weather condition was shown in the above table 4.36. The result of one-way analysis of variance (ANOVA) table shows that F (3,384) =4.332, p=0.005) which is less than (α=0.05). Thus, this result revealed that there is significant evidence to reject the null hypothesis(H_0), and supporting the conclusion that the variation of weather conditions has too much significant difference with the occurrence of motorcycle crashes.

Light condition

Source	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	5.844	3	1.948	3.391	.018
Within Groups	220.610	384	.575		
Total	226.454	387			

Table 4.37: Differences in occurrence of motorcycle crashes among types of light condition (one-way ANOVA Output)

The difference in the occurrence of motorcycle crashes with types of the light condition was shown in the above table 4.37. The result of one-way analysis of variance (ANOVA) table shows that F (3,384) =3.391, p=0.018) which is less than (α=0.05). Consequently, this result has shown that there is significant evidence to reject the null hypothesis(H_0). And supporting the conclusion that, the variation of the light condition has too much significant difference with the occurrence of motorcycle crashes.

5. CONCLUSION AND RECOMMENDATION

5.1. Conclusion

Based on the findings of the present study, some major conclusions are drawn with regard to the impact of motorcycle crashes in the south Omo zone.

- Overall, the trend of motorcycle crashes from (January 2014 to December 2017) showed increasing patterns for both fatal and non-fatal crashes as the researcher of this study observed from the result but it needs more effort to reduce the problems in the study area.
- However, the finding of the study indicated that motorcycle riders are the primarily responsible factors to cause motorcycle crashes than vehicle (motorcycle) and environmental factors. Most of the motorcycle crashes occurred by motorcycle riders' fault.
- The highly significant factors determined to increase the severity of motorcycle crashes are determined to be male riders with the age of below eighteen and between eighteen to thirty years, education level specifically with five to eight; riding experience of over to two to five years and owners of the motorcycles. In addition to this, Motorcycles served over five to ten years and the sudden mechanical problems on motorcycles are also other factors identified to be increasing the severity of motorcycle crashes.
- Pedestrians were one of vulnerable to motorcycle crashes than other types of victims. As most of the severity of motorcycle crashes happened by motorcycle with pedestrians.
- Saturday and Monday were the two market days of the week that more motorcycle crashes have happened.
- Most of the motorcycle crashes occurred by riders' errors like failure to give priority, careless riding and over speeding were the main cause leads to crashes.
- This study shows that the lack of sufficient skills in motorcycle riding and violation of traffic rules and regulation were the other risk factors for the occurrence of motorcycle crashes.
- Overall, it might be concluded that there is an urgent need to address problems in the study area. Besides, reducing motorcycle crashes in the study area will enhance people's safety and also economic safety eventually.
- Generally, many cases of crash severity types (fatal, serious injury, slight injury and property damages are caused by human errors which are gradually preventable.

5.2. Recommendation

Following the outcome of the above analysis, the following measures are needed to be taken to deal with considerations in an attempt to reduce the problems in the study area as well as other towns in Ethiopia. Therefore, measures that are expected to predict for the stakeholders depend on three main factors like Human, vehicular(motorcycle), and Environmental factors.

- The majority of the contributing factors for the occurrence of motorcycle crashes in the study area could be motorcycle riders' (human factor) and vehicular factors. This is the main issue that needs great attention.so that, the main policymakers collaborating with other concerned authorities work on to address those issues. One of these strategies could be education, properly training of motorcycle riders before riding and getting riding license, could be critical measurements.
- The participants or motorcycle riders of this study noticed that there is a humble controlling system both in giving licenses for the motorcycle riders as well as other motor vehicle drivers and enforcing traffic regulations. Besides, a number of motorcycles are on the road are without having a number plate and helmet worn in the study areas. The author of this study observed different slight injuries up to fatal injuries. Therefore, and ensuring the obedience of riders to traffic rules and regulations and also creating public awareness on road safety needs to be the most critical parts of necessary measurements.
- Moreover, other interventions which include, enforcement of speed limits, helmet wearing, strict traffic police enforcement especially in the market days and public education is the urgent need to be in place to respond to these high losses associated with the problems in the area.
- Overall, road safety is the responsibility of all community but it is not a group of some stakeholders since its occurrence affects all communities. Therefore, the zone administration collaborating with other policymakers should be worked together to reduce the problems and should enforce the important traffic rules and regulations in well-organized means.

Future Research Direction

Findings from this study can be used as a benchmark for the study area as well as other cities in Ethiopia. The problem of motorcycle crashes is a growing concern in most cities in Ethiopia and government efforts to improve road safety by reducing the problems is an important point to enhance motorcycle safety. Provided below are some directions for future research work. The limitations outlined in this thesis are all potential areas to consider in subsequent work to improve motorcycle safety.

- Generally, this study is the first of its kind and needs to be done in further studies in a more organized manner to identify the possible factors associated with motorcycle crashes for the south Omo zone but also for other cities in the country, Ethiopia.

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APPENDIX:

Appendix I: Output of software for police-reported crash data

Model Fitting Information

Model	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood	Chi-Square	df	Sig.
Intercept Only	534.059			
Final	326.566	207.493	114	.000

Likelihood Ratio Tests

Effect	Model Fitting Criteria	Likelihood Ratio Tests		
	-2 Log Likelihood of Reduced Model	Chi-Square	df	Sig.
Intercept	326.566[a]	.000	0	.
Age	348.359	21.794	12	.040
edulev	358.646	32.080	15	.006
exper	375.982	49.416	12	.000
riderrln	341.150	14.584	9	.103
Serviceyr	340.813	14.248	15	.507
motorcledfc	353.200	26.635	3	.000
Rdcondn	329.868	3.302	6	.770
Lightcondn	329.617	3.051	3	.384
wthrcondn	350.145	23.580	6	.001
surfacetyp	334.411	7.845	6	.250
Typofseverty	341.765	15.199	15	.437
causeofcrash	349.515	22.950	12	.028

Parameter estimates

Crashes severity[a]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% Confidence Interval for Exp(B)	
								Lower Bound	Upper Bound
fatal	Intercept	-6.054	5.712	1.123	1	.289			
	[Age=0]	3.105	2.078	2.232	1	.135	22.316	.380	1311.682
	[Age=1]	2.675	1.652	2.622	1	.105	14.517	.570	370.054
	[Age=2]	2.699	2.173	1.543	1	.214	14.872	.210	1052.367
	[Age=3]	2.974	2.215	1.802	1	.179	19.573	.255	1504.431
	[Age=4]	0[b]			0				
	[edulev=0]	1.186	1.478	.643	1	.422	3.274	.181	59.349
	[edulev=1]	-2.030	1.465	1.919	1	.166	.131	.007	2.321
	[edulev=2]	-2.393	2.150	1.239	1	.266	.091	.001	6.179
	[edulev=3]	.735	1.666	.195	1	.659	2.086	.080	54.619
	[edulev=4]	.207	1.859	.012	1	.911	1.230	.032	47.001
	[edulev=5]	0[b]			0				
	[exper=0]	.798	1.418	.316	1	.574	2.221	.138	35.789
	[exper=1]	-3.377	1.636	4.259	1	.039	.034	.001	.844
	[exper=2]	-.433	2.001	.047	1	.829	.649	.013	32.776
	[exper=3]	-1.710	1.782	.921	1	.337	.181	.006	5.946
	[exper=4]	0[b]			0				
	[riderrln=0]	-.959	1.932	.247	1	.619	.383	.009	16.891
	[riderrln=1]	3.516	1.686	4.349	1	.037	33.659	1.235	917.019
	[riderrln=2]	2.690	1.859	2.095	1	.148	14.737	.386	563.155
	[riderrln=3]	0[b]			0				
	[Serviceyr=0]	-1.950	1.625	1.440	1	.230	.142	.006	3.438
	[Serviceyr=1]	-.355	1.173	.092	1	.762	.701	.070	6.989
	[Serviceyr=2]	.751	1.146	.430	1	.512	2.119	.224	20.030
	[Serviceyr=3]	1.809	2.232	.657	1	.418	6.105	.077	484.611
	[Serviceyr=4]	-1.323	2.764	.229	1	.632	.266	.001	59.986
	[Serviceyr=5]	0[b]			0				
	[motorcledfc=0]	1.346	1.206	1.246	1	.264	3.842	.361	40.839
	[motorcledfc=1]	0[b]			0				
	[Rdcondn=0]	-.996	1.940	.264	1	.608	.369	.008	16.544
	[Rdcondn=1]	-.306	2.342	.017	1	.896	.736	.007	72.538
	[Rdcondn=2]	0[b]			0				
	[Lightcondn=0]	1.941	1.235	2.469	1	.116	6.969	.619	78.476
	[Lightcondn=1]	0[b]			0				

	[wthrcondn=0]	2.690	1.517	3.145	1	.076	14.728	.753	287.885
	[wthrcondn=1]	-2.646	1.648	2.579	1	.108	.071	.003	1.792
	[wthrcondn=2]	0[b]			0				
	[surfacetyp=0]	-.665	1.142	.339	1	.560	.514	.055	4.822
	[surfacetyp=1]	.668	1.151	.337	1	.562	1.950	.204	18.595
	[surfacetyp=2]	0[b]			0				
	[Typofseverty=0]	.744	2.782	.072	1	.789	2.105	.009	491.153
	[Typofseverty=1]	-.337	2.998	.013	1	.910	.714	.002	254.233
	[Typofseverty=2]	2.207	2.957	.557	1	.455	9.091	.028	2991.317
	[Typofseverty=3]	1.697	2.819	.362	1	.547	5.455	.022	1369.239
	[Typofseverty=4]	4.532	3.139	2.084	1	.149	92.910	.198	43649.261
	[Typofseverty=5]	0[b]			0				
	[causeofcrash=0]	1.267	2.604	.237	1	.626	3.552	.022	584.308
	[causeofcrash=1]	.739	2.670	.077	1	.782	2.093	.011	392.568
	[causeofcrash=2]	2.158	2.661	.657	1	.418	8.650	.047	1593.924
	[causeofcrash=3]	3.073	3.226	.908	1	.341	21.616	.039	12049.170
	[causeofcrash=4]	0[b]			0				
Serious injury	Intercept	-8.690	3.732	5.421	1	.020			
	[Age=0]	1.056	1.403	.567	1	.451	2.876	.184	44.948
	[Age=1]	1.778	1.236	2.068	1	.150	5.915	.525	66.706
	[Age=2]	2.283	1.484	2.369	1	.124	9.808	.536	179.621
	[Age=3]	-.958	1.567	.374	1	.541	.384	.018	8.277
	[Age=4]	0[b]			0				
	[edulev=0]	1.688	1.142	2.186	1	.139	5.408	.577	50.680
	[edulev=1]	2.195	1.020	4.634	1	.031	8.983	1.217	66.309
	[edulev=2]	-1.082	1.797	.362	1	.547	.339	.010	11.475
	[edulev=3]	2.315	1.484	2.433	1	.119	10.124	.552	185.642
	[edulev=4]	.254	1.557	.027	1	.870	1.289	.061	27.266
	[edulev=5]	0[b]			0				
	[exper=0]	-1.117	1.292	.748	1	.387	.327	.026	4.117
	[exper=1]	1.162	1.020	1.296	1	.255	3.195	.432	23.609
	[exper=2]	.792	1.666	.226	1	.634	2.208	.084	57.875
	[exper=3]	-1.150	1.455	.624	1	.429	.317	.018	5.484
	[exper=4]	0[b]			0				
	[riderrln=0]	1.555	1.241	1.571	1	.210	4.735	.416	53.866
	[riderrln=1]	2.370	1.207	3.857	1	.050	10.700	1.005	113.950
	[riderrln=2]	2.590	1.418	3.335	1	.068	13.326	.827	214.696
	[riderrln=3]	0[b]			0				
	[Serviceyr=0]	-1.115	1.143	.953	1	.329	.328	.035	3.078
	[Serviceyr=1]	.073	.853	.007	1	.931	1.076	.202	5.728

	[Serviceyr=2]	-.206	.882	.055	1	.815	.813	.144	4.582
	[Serviceyr=3]	3.564	1.809	3.880	1	.049	35.313	1.018	1224.976
	[Serviceyr=4]	-.638	1.932	.109	1	.741	.529	.012	23.323
	[Serviceyr=5]	0[b]			0				
	[motorcledfc=0]	-3.227	1.024	9.924	1	.002	.040	.005	.295
	[motorcledfc=1]	0[b]			0				
	[Rdcondn=0]	.539	1.659	.106	1	.745	1.715	.066	44.301
	[Rdcondn=1]	-.439	1.938	.051	1	.821	.645	.014	28.798
	[Rdcondn=2]	0[b]			0				
	[Lightcondn=0]	.810	.921	.775	1	.379	2.249	.370	13.663
	[Lightcondn=1]	0[b]			0				
	[wthrcondn=0]	2.177	1.209	3.244	1	.072	8.817	.825	94.186
	[wthrcondn=1]	1.108	1.182	.878	1	.349	3.028	.298	30.721
	[wthrcondn=2]	0[b]			0				
	[surfacetyp=0]	-.768	.853	.811	1	.368	.464	.087	2.470
	[surfacetyp=1]	1.444	.913	2.504	1	.114	4.239	.708	25.360
	[surfacetyp=2]	0[b]			0				
	[Typofseverty=0]	.920	1.238	.553	1	.457	2.510	.222	28.409
	[Typofseverty=1]	-1.110	1.349	.677	1	.411	.330	.023	4.636
	[Typofseverty=2]	1.925	1.482	1.687	1	.194	6.853	.376	125.079
	[Typofseverty=3]	1.235	1.191	1.075	1	.300	3.439	.333	35.509
	[Typofseverty=4]	.806	1.751	.212	1	.646	2.238	.072	69.296
	[Typofseverty=5]	0[b]			0				
	[causeofcrash=0]	.823	1.920	.184	1	.668	2.278	.053	98.108
	[causeofcrash=1]	.827	1.939	.182	1	.670	2.286	.051	102.257
	[causeofcrash=2]	2.860	1.956	2.138	1	.144	17.465	.378	807.789
	[causeofcrash=3]	1.554	2.104	.546	1	.460	4.732	.077	292.330
	[causeofcrash=4]	0[b]			0				
Slight injury	Intercept	-5.399	3.557	2.304	1	.129			
	[Age=0]	3.189	1.536	4.309	1	.038	24.253	1.195	492.386
	[Age=1]	2.076	1.369	2.298	1	.130	7.971	.544	116.719
	[Age=2]	3.975	1.616	6.050	1	.014	53.251	2.242	1264.605
	[Age=3]	.221	1.893	.014	1	.907	1.247	.031	51.015
	[Age=4]	0[b]			0				
	[edulev=0]	.421	1.128	.140	1	.709	1.524	.167	13.906
	[edulev=1]	.479	.992	.234	1	.629	1.615	.231	11.275
	[edulev=2]	-1.140	1.562	.533	1	.465	.320	.015	6.833
	[edulev=3]	1.220	1.415	.743	1	.389	3.387	.212	54.239
	[edulev=4]	.342	1.461	.055	1	.815	1.407	.080	24.647
	[edulev=5]	0[b]			0				

	[exper=0]	.332	1.174	.080	1	.777	1.393	.140	13.906
	[exper=1]	.762	1.018	.561	1	.454	2.143	.291	15.767
	[exper=2]	2.424	1.612	2.263	1	.132	11.295	.480	265.862
	[exper=3]	.020	1.461	.000	1	.989	1.020	.058	17.878
	[exper=4]	0[b]			0				
	[riderrln=0]	.407	1.175	.120	1	.729	1.503	.150	15.048
	[riderrln=1]	1.480	1.154	1.644	1	.200	4.392	.457	42.180
	[riderrln=2]	1.636	1.347	1.476	1	.224	5.137	.367	71.986
	[riderrln=3]	0[b]			0				
	[Serviceyr=0]	-.579	1.210	.229	1	.632	.561	.052	6.002
	[Serviceyr=1]	.041	.901	.002	1	.964	1.041	.178	6.084
	[Serviceyr=2]	.777	.908	.732	1	.392	2.174	.367	12.883
	[Serviceyr=3]	3.354	1.824	3.383	1	.066	28.619	.802	1020.830
	[Serviceyr=4]	-.366	2.079	.031	1	.860	.693	.012	40.809
	[Serviceyr=5]	0[b]			0				
	[motorcledfc=0]	-.354	.948	.140	1	.709	.702	.110	4.496
	[motorcledfc=1]	0[b]			0				
	[Rdcondn=0]	1.202	1.755	.469	1	.493	3.327	.107	103.768
	[Rdcondn=1]	1.017	2.064	.243	1	.622	2.765	.048	157.950
	[Rdcondn=2]	0[b]			0				
	[Lightcondn=0]	1.266	.930	1.856	1	.173	3.548	.574	21.941
	[Lightcondn=1]	0[b]			0				
	[wthrcondn=0]	1.377	1.185	1.352	1	.245	3.964	.389	40.402
	[wthrcondn=1]	-.386	1.144	.114	1	.736	.680	.072	6.399
	[wthrcondn=2]	0[b]			0				
	[surfacetyp=0]	-.414	.894	.214	1	.643	.661	.115	3.814
	[surfacetyp=1]	1.425	.959	2.207	1	.137	4.158	.634	27.249
	[surfacetyp=2]	0[b]			0				
	[Typofseverty=0]	-.287	1.272	.051	1	.821	.750	.062	9.081
	[Typofseverty=1]	-1.601	1.383	1.341	1	.247	.202	.013	3.032
	[Typofseverty=2]	1.182	1.494	.626	1	.429	3.261	.174	61.015
	[Typofseverty=3]	.090	1.238	.005	1	.942	1.094	.097	12.386
	[Typofseverty=4]	1.253	1.763	.505	1	.477	3.502	.111	110.933
	[Typofseverty=5]	0[b]			0				
	[causeofcrash=0]	-2.279	1.575	2.093	1	.148	.102	.005	2.245
	[causeofcrash=1]	-.646	1.564	.170	1	.680	.524	.024	11.246
	[causeofcrash=2]	-.331	1.578	.044	1	.834	.718	.033	15.815
	[causeofcrash=3]	-.311	1.820	.029	1	.864	.733	.021	25.942
	[causeofcrash=4]	0[b]			0				

a. The reference category is: Property damage.

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

Appendix II: Format of daily motorcycle crash report data record sheet

Appendix III: Output of One-way ANOVA using software for questionnaire data

Test of Homogeneity of Variances

Variables	Levene's Statistic	df1	df2	Sig.
Gender	3.162	3	384	.025
Age of riders in years	2.156	3	384	.093
Level of education	5.055	3	384	.002
Riding experience in years	4.696	3	384	.003
Rider training before ride motorcycle	2.518	3	384	.058
Kind of training that the rider undertook	5.222	3	384	.002
Rider has own motorcycle riding license	43.992	3	384	.000
serviced years of motorcycle riding license	6.376	3	384	.000
when riding motorcycle how often do you use a motorcycle	1.365	3	384	.253
Use safety helmet	5.803	3	384	.001
when riding a motorcycle how do you wear a helmet?	2.922	3	384	.034
Ride above the speed limit	20.427	3	384	.000
when riding motorcycle how often do you ride above the speed limit	20.272	3	384	.000
Ride while under the influence of alcohol/drugs	24.486	3	384	.000
Service of a motorcycle in years	9.643	3	384	.000
Ownership of motorcycle	6.055	3	384	.000
Motorcycle encounter mechanical problem	22.952	3	384	.000
kind of mechanical problem that the motorcycle encounter	36.160	3	384	.000
Have a crash when riding a motorcycle	10.312	3	384	.000
Types of a surface when the crashes happened	15.373	3	384	.000
Types of weather condition when the crashes happened	11.016	3	384	.000
Types of light condition when the crash has happened	10.656	3	384	.000
Recommendations that could be done to reduce motorcycle crashes in the study area	5.126	3	384	.002

One-way ANOVA output

Variables		Sum of Squares	df	Mean Square	F	Sig.
Gender	Between Groups	.206	3	.069	.724	.538
	Within Groups	36.461	384	.095		
	Total	36.668	387			
Age of riders in years	Between Groups	3.214	3	1.071	2.907	.035
	Within Groups	141.556	384	.369		
	Total	144.771	387			
Level of education	Between Groups	8.447	3	2.816	2.187	.089
	Within Groups	494.365	384	1.287		
	Total	502.812	387			
Riding experience in years	Between Groups	16.715	3	5.572	8.425	.000
	Within Groups	253.952	384	.661		
	Total	270.668	387			
Rider training before ride motorcycle	Between Groups	1.219	3	.406	1.676	.172
	Within Groups	93.141	384	.243		
	Total	94.361	387			
Kind of training that the rider undertook	Between Groups	2.682	3	.894	.499	.683
	Within Groups	687.287	384	1.790		
	Total	689.969	387			
A rider has own motorcycle riding license	Between Groups	3.894	3	1.298	5.407	.001
	Within Groups	92.176	384	.240		
	Total	96.070	387			
Serviced years of motorcycle riding license	Between Groups	43.517	3	14.506	6.685	.000
	Within Groups	833.212	384	2.170		
	Total	876.729	387			
when riding motorcycle how often do you use a motorcycle	Between Groups	12.568	3	4.189	2.946	.033
	Within Groups	546.058	384	1.422		
	Total	558.626	387			
Use safety helmet	Between Groups	.594	3	.198	.838	.474
	Within Groups	90.713	384	.236		
	Total	91.307	387			
when riding a motorcycle how do you wear a helmet?	Between Groups	2.033	3	.678	.746	.525
	Within Groups	348.759	384	.908		
	Total	350.791	387			
Ride above the speed limit	Between Groups	2.645	3	.882	6.754	.000
	Within Groups	50.126	384	.131		
	Total	52.771	387			
when riding motorcycle how often do you ride above the speed limit	Between Groups	4.912	3	1.637	6.790	.000
	Within Groups	92.593	384	.241		
	Total	97.505	387			
Ride while under the influence of alcohol/drugs	Between Groups	1.410	3	.470	6.135	.000
	Within Groups	29.422	384	.077		
	Total	30.832	387			
Service of a motorcycle in years	Between Groups	14.510	3	4.837	6.327	.000
	Within Groups	293.559	384	.764		
	Total	308.070	387			
Ownership of motorcycle	Between Groups	2.322	3	.774	1.388	.246
	Within Groups	214.181	384	.558		
	Total	216.503	387			
Motorcycle encounter mechanical problem	Between Groups	.940	3	.313	6.071	.000
	Within Groups	19.813	384	.052		

	Total	20.753	387			
kind of mechanical problem that the motorcycle encounter	Between Groups	6.974	3	2.325	8.645	.000
	Within Groups	103.261	384	.269		
	Total	110.235	387			
Have a crash when riding motorcycle	Between Groups	1.587	3	.529	3.135	.026
	Within Groups	64.792	384	.169		
	Total	66.379	387			
Types of a surface when the crashes happened	Between Groups	6.670	3	2.223	6.177	.000
	Within Groups	138.217	384	.360		
	Total	144.887	387			
Types of weather condition when the crashes happened	Between Groups	14.274	3	4.758	4.332	.005
	Within Groups	421.796	384	1.098		
	Total	436.070	387			
Types of light condition when the crash has happened	Between Groups	5.844	3	1.948	3.391	.018
	Within Groups	220.610	384	.575		
	Total	226.454	387			
Recommendations that could be done to reduce motorcycle crashes in the study area	Between Groups	31.541	3	10.514	19.090	.000
	Within Groups	211.490	384	.551		
	Total	243.031	387			

Appendix IV: Motorcycle safety Questionnaire for motorcycle riders.

Part one: Socio-demographic information of motorcycle riders

For each question, please tick the box which represents your view.

1.Your gender? Male ☐ Female ☐

2.Your age in years? Below 18 ☐ Between 18-30 ☐ Between 31-50 ☐ 50 above ☐

3. What is your level of education? 0 to 4 ☐ 5 to 8 ☐ 9 to10 ☐ 11 to 12 ☐ 12+ ☐

4.Riding experience in years? 0 to 2 ☐ over 2 to 5 ☐ over 5 to10 ☐ 11 and above ☐

Part two: -Motorcycle rider characteristics

5. Do you have taken rider training before you ride a motorcycle? Yes ☐ No ☐

6.If your answer in Q-5 is yes, which kind of motorcycle training have you undertaken?

Formal training ☐ informal training ☐ No training at all ☐

7. If your answer in Q-5 is no, what do you think are the main causes of motorcycle crashes?

a) ----------

b) ----------

c) ----------

8. Do you have your own motorcycle riding license? yes ☐ No ☐

9.If your answer in Q-8 is yes, for how many years have you had a motorcycle riding license?

≤ 2 years ☐ 2 to 5 years ☐ 5 to10 years ☐ Above 10 years ☐

10.If your answer in Q-8 is no, for how often do you use a motorcycle?

Always ☐ sometimes ☐ never ☐

11. Please, read the following list of safety measures for motorcyclists and place a tick in the boxes next to the three you think are the most important?

    Reading road signs ☐ observing the speed limit ☐ not riding while tired ☐

    Properly maintaining your motorcycle ☐

    Correctly positioning your motorcycle according to the road condition ☐

    Wearing protective instruments like a helmet ☐

    An appropriate number of passengers ☐

    Making yourself visible to other road users ☐

    Not riding while under the influence of alcohol or drugs ☐

12. Do you wear a safety helmet? Yes ☐ No ☐

13. If your answer in Q-12 is yes, how often do you wear a motorcycle helmet?

    Always ☐ Occasionally ☐ Never ☐ don't know ☐

14. Do you ride above the speed limit? Yes ☐ No ☐

15. If your answer in Q-14 is yes, how often do you ride above the speed limit?

    Always ☐ occasionally ☐ Never ☐ Don't know ☐

16. When you are riding your motorcycle, how often ride while under the influence of alcohol/drugs?

    Always ☐ occasionally ☐ Never ☐ don't know ☐

17. Listed below are types of crashes that involve motorcyclists. Please tick the boxes next to the two you think motorcyclist is most at risk from. (Please, remember to only tick two boxes)

    Poor riding technique leading to loss of control of the motorcycle ☐

    Over-shooting bends in the road ☐

    Being hit from behind by other road users (rear-end shunt) ☐

    Collision while overtaking other road users ☐

    Collision with right-turning vehicles ☐

    Collision with left-turning vehicles ☐

18. Are there any other types of crashes you think motorcyclists are particularly at risk from?

Part three: -Motorcycle factors condition

19. How many years are the services of your motorcycle?

0 to1 ☐ over 1 to 2 ☐ over 2 to 5 ☐ Above 5 ☐

20. Who is the owner of this motorcycle? Owner ☐ Hired ☐ other ☐

21. Do your motorcycle encounter a mechanical problem? Yes ☐ No ☐

22.If your answer to question number Q.21 is yes, what common mechanical problem does the motorcycle encounter? Brake ☐ steer ☐ lighting ☐ tire ☐ other ☐

Part four: Road and environmental condition of motorcycle crashes

23. Have you ever had a motorcycle crash in the last four years? Yes ☐ No ☐

24.If your answer to question number 23 is yes, what was surface type?

Asphalt ☐ Not Asphalt ☐

25.If your answer to question number 23 is yes, what was the weather condition?

Dry ☐ rainy ☐ other ☐

26.If your answer to question number 23 is yes, what was the light condition?

Day ☐ night ☐

27. Do you think what main factors facilitate the occurrence of motorcycle crashes in the South Omo zone?

In terms of vehicles(motorcycle) factor ☐ In terms of human(rider) factor ☐

In terms of enforcement of legislation and regulations ☐ In terms of (environment) road factor ☐

28.In your opinion what could be done to reduce motorcycle crashes?

Traffic laws are implemented strictly ☐ Create public awareness on road safety ☐

Undergo intensive rider training ☐ Avoid drink riding before working hours ☐