

***JIMMA UNIVERSITY COLLEGE OF SOCIAL SCIENCES AND  
HUMANITIES DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL  
STUDIES***

***SPATIAL AND TEMPORAL ANALYSIS OF ROAD TRAFFIC ACCIDENT USING  
GEOSPATIAL TECHNIQUES: THE CASE OF DURAME TOWN, SNNPRS, ETHIOPIA***

***BY***

***MENGISTU FELEKE***

***A THESIS SUBMITTED TO DEPARTMENT OF GEOGRAPHY AND ENVIRONMENTAL  
STUDIES, JIMMA UNIVERSITY, IN PARTIAL FULFILLMENT OF THE  
REQUIREMENT FOR MASTER OF SCIENCE (M.Sc.) DEGREE IN GIS AND REMOTE  
SENSING***

***MAIN ADVISOR: AJAY BABU (PhD)***

***CO-ADVISOR: SOLOMON CHERU (M.Sc.)***

***April, 2023***

***JIMMA ETHIOPIA***



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# Declaration

I declare that this thesis entitled “*Spatial and Temporal Analysis of Road Traffic Accident Using Geospatial Techniques in Durame Town*” *is originally prepared me in fulfillment of the requirements for award for the degree of Master of Science in Geography and Environmental Studies with specialization in GIS and Remote Sensing at Jimma University. It based on my own work, with acknowledgements of other sources, and has not been submitted in whole or part for any other professional qualification.*

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Signature: \_\_\_\_\_ Date of Submission: \_\_\_\_\_

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*Department of Geography and Environmental Studies*

*Thesis Approval sheet*

*This is certifying that this thesis is prepared by Mengistu Feleke: entitled " Spatial and Temporal Analysis of Road Traffic Accident Using Geospatial Techniques in Durame Town " submitted in fulfillment of the requirements for the Degree of Master of science in Geography and Environmental Studies with specialization in GIS and Remote Sensing at Jimma university and is approved for its contribution to knowledge.*

*Signed By the Examining Committee:*

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*Chairperson \_\_\_\_\_ Signature \_\_\_\_\_ Date \_\_\_\_\_*

## **ACKNOWLEDGEMENT**

*I would like to acknowledge the efforts, support, guidance, cooperation and encouragement of numerous people who directly and indirectly participated in the process and finalization of this Thesis. But first and foremost I would like to give my special Glory and thanks to (almighty God) in the name of Jesus Christ who giving me the health and strength to start and complete my stud. Thank you Lord! I owe many thanks to express my sincere gratitude to my advisor Dr.Ajay Babu and Mr. Solomon Cheru, for his excellent guidance, critical comments and corrections and also encouragement throughout my research time. Your welcoming approach at any time will never be forgotten. Really God bless your Whole life.*

*The data used in this thesis are gathered from cooperative offices in Durame Town. I would like to give thanks to Kambata Tembaro zone traffic police office, Road and transport Authority and Durame Town traffic police Department, road and Transport authority, and municipality for their willing to give available materials. Collaboration in providing me traffic data and for guiding in the field survey. The ultimate cooperation of Jimma University, Geography and Environmental Studies GIS and RS staff members, I would like to thank everyone who has participated in making this thesis successful.*

*I have deep gratitude to my wife Tegessach Lonbaso for her Wonderful thought and kindness, love, respect and support during this research. She had a lot dutiful prayers for my success and I dont t know what could I pay back for you? In this regard I have deepest love and thanks to my beloved dear father and mother for their strong support me by morally, psychologically and prayer; words alone cannot express what I owe them for their continuous encouragement that enable me to complete my study. Finally, I want to extend my regards to all my friends and classmates whose names could not be mentioned, for their cooperation and healthy interaction.*

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## **List of Acronym and Abbreviations**

|                   |  |
|-------------------|--|
| <b>ASUS</b>       | <i>Arts and Science Undergraduate Society</i>                                  |
| <b>DNRGPS</b>     | <i>Department of Natural Recourse Global Positioning System</i>                |
| <b>DTSPRP</b>     | <i>Durame Town Structural Plan Revision Project</i>                            |
|                   | <i>Economic Development Bureau</i>   |
| <b>FAO</b>        | <i>Food and Agriculture Organization</i>                                       |
| <b>FGD</b>        | <i>Focus Group Discussion</i>  |
| <b>GIS</b>        | <i>Geographic Information System</i>   |
| <b>GPS</b>        | <i>Global Positioning System</i>   |
| <b>GRSP</b>       | <i>Global Road Safety Project</i>  |
| <b>HIV/AIDS</b>   | <i>Acquired immunodeficiency syndrome</i>                                      |
| <b>IBFRAD</b>     | <i>International Bank for Reconstruction and Development</i>                   |
| <b>ITS</b>        | <i>Intelligent Transportation System</i>                                       |
| <b>KIIS</b>       | <i>Key Informants' Interviews</i>  |
| <b>KTZ</b>        | <i>Kambata Tembaro Zone</i>  |
| <b>NASA</b>       | <i>National Aeronautics and Space Administration</i>                           |
| <b>NCBE</b>       | <i>New Commercial Bank of Ethiopia</i>   |
| <b>RTA</b>        | <i>Road Traffic Accident</i>   |
| <b>RTAs</b>       | <i>Road traffic accidents</i>  |
| <b>SNNP</b>       | <i>Southern Nation Nationality people region</i>                               |
| <b>SNNPRSFEDB</b> | <i>Southern Nation Nationalities &amp; People"s Regional State Finance and</i> |
| <b>SPSS</b>       | <i>Statistical Package for the Social Sciences</i>                             |
| <b>TB</b>         | <i>Tubercles Bacteria</i>  |
| <b>U.S. DOT</b>   | <i>United States Department of Transportation</i>                              |
| <b>WHO</b>        | <i>World Health Organization</i>   |

## **ABSTRACT**

*All nations in the world are currently affected by Road Traffic Accidents (RTAs). RTAs are the leading causes of death, injury and damage of property at global as well as national level UN(2020). The main aim of this study is to Analysis RTAs related issues of Durame town in terms of time and space from 2016 to 2021. For this purpose, primary data were collected through Focus Group Discussions, Key Informant Interviews, questionnaire survey, observation and GPS. Furthermore, secondary data were obtained from different traffic accident records of Durame town police. In cooperation qualitative and quantitative techniques were employed to analyze the data. Data analysis was made using ArcGIS 10.8 and Excel &SPSS. The results were presented in the form of line graphs, crosstabs, column graphs, pie charts, figures and spatial and spatiotemporal maps. The result of the study revealed that, the general trend of RTAs have shown more severe trend and driver factors were the leading responsible factor than other factors for RTAs in Durame town. The analysis of the study indicated that, 342 RTAs have occurred in the study period. From 342 RTAs occurrences 246 RTAs have occurred in 13 black spots, top 9 as well as 2 consistent RTAs Black Spots have been identified in the town. In addition to this, RTAs are more frequent at Evening time from 6 am - 12 am because of two conditions first one mass commuters return back to their home from different activities as the result this a higher traffic movement and road users and the next condition most controls and traffic policies come back home and the drivers disobey traffic rules. It was concluded that, the distributions and frequencies of RTAs as well as the health, socioeconomic and physical environment impacts of RTAs have shown more severe trend in the study period. Therefore, authorities, stakeholders and different groups concerned with road traffic safety administration and control should give special attention to deliver education and awareness for the whole communities (road users) to change the attitude and behavior, and to develop the sense of responsibility and take actions to prevent or reduce this kind of Road Traffic Accidents in Durame town.*

**Key Terms:** GIS, GPS, Traffic Accident, Spots, Black Spots and Road Traffic Accident Casualties

# **CHAPTER ONE**

## **1 Introduction**

### **1.1 Background of the study**

People for centuries and millennium have been moving from place to place to carry out/complete their day-to-day activities. To facilitate their movement, they use different means of transportation including land (highway and rail), air (domestic and international), water (inland and ocean). It is an accepted fact that of all modes of transportation, road transport is easily accessible and closes to people. Any movement of people for any activity using different means is known as transportation (Sori & Science, 2020). With the development of the global economy, the expansion of roads, and the sharp increase in the number of cars, road traffic accidents have become the most important injury factor that threatens human life and safety. This worldwide public hazard has attracted great attention from the international community and governments of various countries (Science, 2021). RTAs are growing on a worldwide stage because of the improvement of transportation infrastructure fails to hold pace with different sectors (Prasannakumar *et al.*, 2011, Hayidso *et al.*, 2019).

World Health Organization (WHO) (2015) reports; road traffic injuries were among the leading causes of death and lifelong disability among young people aged 15–29 years and the top three causes of mortality among people aged 15–44 years UN (2020) these time reports also show that over 1.35 million people are killed on the world's roads and more than 50 million injured due to traffic crashes every year. Additionally, millions of humans are afflicted by serious accidents with a long time ill-health effects (Khaledur *et al.*, 2017, Rahman & Jamal, 2020). The social and economic consequences of road traffic crashes (RTCs) are enormous, annually costing around 518 billion USD globally (Rahman & Jamal, 2020). According to ( Sorate, 2016, Deme, 2019, Hayidso *et al.*, 2019, Dechkamfoo *et al.*, 2021, Adane, 2021). The most Causes of Road accidents are in the effects of 3 factors, namely, human factors, road and environmental factors. In current years, there is a growing problem in road traffic injuries. Road traffic injuries are one of the main reasons for human demise worldwide (Adane, 2021). The Institute for Health Metrics and Evaluation (IHME) estimated about 0.9 million, 1.3 million, and 1.4 million deaths from road traffic accidents in 1990, 2010, and 2013 respectively (Adeloye *et al.*, 2016). According to WHO (

2018)report; road traffic deaths were the eighth leading cause of death for all age groups killing more people than tuberculosis and HIV/AIDS.

Africa, a continent of people who have long been in a struggle for poverty reduction and for the security of other basic needs, is nowadays seems to face another Headache /challenge that is devastating road traffic accident. African roads are the world's deadliest for many reasons. According to WHO report; additionally assessed 178 international locations over 85% of all deaths and 90% of disability adjusted life years lost from road traffic injuries occurred in low and middle-income countries, which have only 47% of the world's registered vehicles (Naghavi et al., 2015, Hayidso *et al.*, 2019). According to the 2015 Global status report on road safety, the WHO African Region had the highest rate of fatalities from road traffic injuries worldwide at 26.6 per 100 000 population for the year 2013(Naghavi *et al.*, 2015)and( Surfacing, 2021).Sub-Saharan Africa was the global capital for road traffic deaths(WHO 2018).According to(Adane, 2021)the causes of car accidents can seem endless. Every day people die in road collisions.

Various studies have indicated that Ethiopia has one of the highest fatality rates per vehicle in the world(Getahun, 2021). It a major burden on the social, economic and health sectors(Getahun, 2021). According to WHO, (2015) reported to be25.3 people dies per 100,000 populations in Ethiopia amongst the highest in the world. It shows that Ethiopia has not achieved the goal of the United Nations Decade of Action for Road Safety (2011- 2020) to reduce road fatalities and injuries by 50 per cent by 2020.According to official statistics for Ethiopia, road traffic deaths more than doubled in the 12year period between 2007 and 2018, rising from 2,161 to 4,597(united nations geneva, 2020).the size of the vehicle fleet in 2018 was 1,071,345(united nations geneva, 2020). This implies that nearly 43 people were killed per 10,000 vehicles in the country in 2018(united nations geneva, 2020). Viewed from another perspective, Ethiopia loses 13 people per day in road traffic crashes(united nations geneva, 2020) actual fatality figures may in fact be much larger than those reported by the Ethiopian federal police commission as a result of underreporting and misclassification of road traffic fatalities(united nations geneva, 2020)

In Ethiopia, the majority of road safety analysis methodologies employed by transportation authorities and safety specialists are classic descriptive approaches focused on quantifying and

summarizing crash data (Adnan et al., 2013, Tola et al., 2021). Furthermore, at present, in Ethiopia, GIS is not used widely in crash data recording and identifying RTC hot spot locations (Tola et al., 2021). To identify RTC 6pm-12pm hot spots, a GIS-based spatial analysis has been a promising tool and widely used (Adnan et al., 2013). The GIS-based hot spot analysis result is presented accurately on a single map with the related attribute data of each RTC which may advance the understanding of road safety (Tola et al., 2021). Researchers regarding the reasons for each crash occurrence, hence, there is a need to identify the hot spot areas/black spot along the road with high accidents to minimize the risks. Traffic officials aim the identification of safety deficient areas on the road network at a comprehensive safety program. One of the most important problems that traffic officials face is where and how to implement protective measures and provisions so that they can have the most significant impact for traffic safety. GIS is a very important and comprehensive management tool for traffic safety (Erdogan et al., 2008, Adane, 2021). GIS has the ability to hold a vast amount of data that can be easily stored, shared and managed (Adane, 2021). GIS allows Hotspot map to be electronically generated from a well-designed accident database and can produce rankings of high accident locations based on total accident either occurring or accident rates. In addition to promoting linkage between various types of data and maps, GIS is able to visually display the results of analyses thus enabling sophisticated analysis and quick decision-making.

More studies focused on the entire nature and disastrous effect of road traffic accident at a global and national scale. This study is focused on assessing the general characteristic RTA, examine the trend of RTA, Mapping spatio-temporal distribution of RTA Spots and RTA Black Spots, identify major causes of RTAs occurrence and analyze the socio – economic impacts RTAs, propose appropriate interventions which could help to reduce the RTAs occurrences, minimize RTA socio-economic impacts and develop database using ArcGIS for future analysis in Durame town.

## **1.2. Statement of the problem**

All nations in the world are currently affected by road traffic accidents. It constitute major health, social, economic, developmental, and environmental challenges of developing countries,

especially those in Africa (Sori & Science, 2020). According to (Kindaya, 2014, Alebachew, 2019) One of the major challenges of the 21st century, the Road Traffic Accidents are having a worsening effect on our society life and economy. Among all accidents, road traffic injuries declare the largest toll of human existence and have a tendency to be the maximum critical trouble worldwide. Worldwide, the number of humans killed in Road Traffic Accidents (RTAs) every 12 months is expected at nearly 1.5 million people, because of the number of humans injured excessive as 50 million pedestrians account for the highest share of street fatalities in almost all African countries, ranging among 31% in Zimbabwe and 51% in Ethiopia.

Ethiopia's administration is investing heavily in road construction and related infrastructure to increase road satisfaction, ease connectivity, and increase import and export distribution. In Ethiopia, the wide variety of loss because of traffic accident is reported to be among the highest in the world. According to WHO, 25.3 human beings die per 100,000 population in Ethiopia (WHO, 2015). According to the present day WHO (2018) information posted in, Road Traffic Accident Deaths in Ethiopia reached 27.140 or 4.27 % of overall deaths. The age adjusted loss of life charge is 36.67 per 100,000 of population ranks Ethiopia #24 in the global. And, in line with global Life Expectancy; Road Traffic Accident ranks 6th in main reasons of loss of life in Ethiopia (*RTAs in Ethiopia*, 2021)

In, Ethiopia the rate of traffic accidents is very high; because of road transport is the major transportation mechanism along with Poor road network; driver-related problems, absence of knowledge on road traffic safety; mixed traffic flow system; poor legislation and failure of enforcement; poor conditions of vehicles; poor emergency medical services; and absence of traffic accident compulsory insurance law are key determinants of the problem in Ethiopia this day (Ayano. M, 2018). Although the situation of RTAs is getting worse from time to time, in many developing countries including Ethiopia, evidence is scarce regarding the incidence of RTA-related injuries and fatalities. In Ethiopia, RTA information is collected through the accident report forms, which are finished by the Traffic Police (Getahun, 2021). According to an unpublished document (2021) of the Kembata Tambaro Zone Transport Office, Durame City is one of the zones with the highest road traffic accidents, resulting in loss of life and property. Therefore, since the road safety movement began over the past decade, there has been a need to

optimize RTA resources by identifying priority areas in Durham City. This aims to provide significant information about road traffic accident patterns and trends in the study area. It is also important to identify hotspots to improve road safety by allocating assets to high-priority areas.

Prior to this study, some studies have been conducted by Ayano (2018) on the risk of traffic accidents on the road from Durame to Mudulla, Southern Region, and Ethiopia. This study used geospatial technology to consider the spatial temporal assessment of issues related to road traffic accidents in time and space. However, this research generally does not use any geospatial technologies, it is not possible to develop a database of RTA events that cannot be mapped and spatially analyzed. Vulnerability areas have not been selected and mapped to take care of the identified road areas, not well organized, and little attention given to recent events. This study did not include all the streets of the city; only one major road crossing from Durame to Mudulla (KTZ level) was considered. In addition, the study lacked an adequate and reliable data collection system. It also gave less attention to pedestrians, road size, and the increased number of two-wheelers and three-wheelers. It failed in identifying major factors of RTAs. This study does not indicate spatial distribution in each district, no priorities (ranking) are based on various factors and the recommendations passed are insufficient for the current number of road users.

Also, there is a gap in identifying the main contributing factors of RTAs such as knowledge to identify vulnerable road sections, time gap, and inadequacy of current road infrastructure with current road users, increasing road traffic accidents, and inadequate work partnership culture of traffic police with school, broadcast media, and other organization. Therefore, this study fills the gaps listed above by exploring the characteristics of RTA, identifying frequent RTA or road traffic accident-prone areas (black spots or point areas) and mapping them, investigating the current trends of RTA, identifying the main causes of RTA, assessing the social and economic impacts of RTA, and providing suggestions that can reduce the risk of RTA in the study area.

This study was carried out in Durham town using geospatial technologies as a tool for road traffic accidents and identifying road traffic accident black spots using input data from areas, vehicle drivers, road traffic offices, and health facilities. Therefore, this study will help to further implement road safety measures and other measures to reduce the risks associated with RTA.

### **1.3 Objective of the study**

#### **1.3.1 General objective**

The overall objective of this study is to analyze road traffic accident hotspots in Durham town in time and space using geospatial technologies

#### **1.3.2 Specific objectives**

The specific objectives of the study are:

- To identify the Underlying causes and characteristics of road traffic accidents in Durame Town.
- To map the spatio-temporal distribution of road traffic accident sites and road traffic accident black spots in Durame Town.
- To assess the main health, socio-economic and environmental impacts of road traffic accidents in Durame Town.
- Forward possible recommendations to reduce road traffic accident in Durame Town.

### **1.4 Research Questions**

This study was conducted to answer the following basic questions:-

- What are the causes and characteristics of RTA incidence in Durame Town?
- Where do frequent Road Traffic Accidents occur in Durame Town?
- What are the socio-economic and environmental impacts of RTAs in Durame Town?
- What measures should be taken to prevent or reduce Road traffic accidents in Durame Town?

### **1, 5 Scope of the Study**

This study dealt with the Spatio – Temporal Road Traffic Accident analysis and their implication on the health, and socio-economic situations of Durame Town. This study mainly used six years of RTA data based on problem severity in these years higher (2016 - 2021) of the study area. The

data were collected from the RTA archives of the Durame Town Traffic Office, and other stakeholders concerned with the issues of RTA and road safety.

### **1.6 Limitation of the Study**

The main limitations of the study were; the lack of fully completed data related to RTA, the existence of some irregularities in the data, shortage of finance, the lack of sot copy data, the lack of Global Positioning System (GPS) coordinate data, lack of data related to the accurate location of RTA sites (the data contained names of the approximate location of the RTA), and lack of access to secondary data from concerned government organizations. To solve those problems I was need different mechanizes such as money from family, GPS from Angacha agricultural office and in addition to this using mobile Application and additional exist recorded data from D.c Bogelach Gabire Matasabt General Hospital

### **1.7 Significance of the Study**

This study was helpful mainly concerned with the assessment of RTA in Durame Town. The primary benefit of this study is to provide a tool that enables the user to make a better decision while planning to make any movement so that either the risk of being victimized with a road accident or trapped traffic jamming was minimized. Accident information is useful to different stakeholders. The results of this study provide the Kambata Tambaro zone Municipality Transport Authority, Durame Town Transport Authority, Kambata Tambaro zone Municipality Engineers, Town Planners, Traffic Police, and drivers, with the spatial distribution of risky road segments and in particular, the location of road traffic accidents hotspots with their magnitudes in Durame Town.

Generally, this study is significant for the following reasons:

- Even though the study was limited to a single Town in the country, the results to be obtained from this study was helpful in launching initiations in studying the complex problems of road transport in general and RTA in particular.
- The judgments attained from the study was helpful to gain valuable data and information about the RTA black spots, trend, cause and impact of RTA in the Town, which in turn,

can help to develop counter measures that can reduce the frequency and severity of road traffic accidents.

- The study was having dominant importance to the government, municipal authorities and the community in the zone and town to determine the need for road improvements and vehicle checkups.
- It can be used as one source of information for those institutions concerned with road safety management and helps to improve the quality of decision-making in road transport safety planning.
- The study was used as benchmark information to those scholars who want to conduct future detailed studies on RTA, road safety, and other related issues.

### **1.8 Organization of the Thesis**

This Study was comprised in to five chapters. The first chapter introduces the study with general introduction, statement of the problem, objective of the study, basic research questions, significance of the study, scope of the study, and limitation of the study The second chapter highlights the related literature on worldwide and Ethiopian perspective regarding there definition and concepts of RTA, global and regional trend of RTA causes of RTA occurrences, economic and social impacts of RTA, RTA black spot definition and treatment and an overview of RTA in Ethiopia. The third chapter encompasses description of the study area in terms of location and administrative setup, demographics characteristics, topography, climate and road network and infrastructure and materials used and methods applied in steering the entire work. The fourth chapter presents detailed results and discussions of the study while the Fifth chapter embraces conclusion and recommendations.

### **1.9 Standard Definition of Basic Terms**

The definitions of some basic terms are varying from one country to another. Because of the variety of context and concept of basic terms/ words should be clearly defined in the first chapter to avoid incomprehensibility of their usage in the study. Accordingly, the researcher clearly defines those terms in the lines of this research context and the United Nations (UN) standard ( WHO, 2019, Yilmaz, 2018)

**Accident:** Involves personal injury occurring on the public highway (including footways) involving at least one road vehicle or a vehicle in collision with a pedestrian and which becomes known to the police within 30 days

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

**Disability Adjusted Life Years:** The years lost by an individual because he or she is disabled as a result of being involved in a Traffic Accident.

**Fatal accident:** Accident involving at least one fatal casualty.

**Fatal injury/ casualty:** a death occurring within 30 days of the road traffic crash

**Injury:** Physical damage that results when a human body is suddenly or briefly subjected to intolerable levels of energy. It can be a bodily lesion resulting from acute exposure to excessive energy or impairment of function resulting from lack of vital elements.

**Road motor vehicle:** A road vehicle fitted with an engine providing its sole means of propulsion, which is normally used for carrying persons or goods, or for drawing (on the road), vehicles used for the carriage of persons or goods.

**Road network:** Totally roads in a given area

**Road infrastructure:** road network facilities and equipment which including the network, parking spaces, stopping places, draining system, bridges, and footpaths

**Road traffic accident black spots:** Places or cites where frequent road traffic accidents occur.

**Road traffic accident spots:** Places or cites where even a single RTA has occurred regardless of its frequency or severity level of its consequence in a given specified period.

**Road traffic accident:** any accident involves personal injury occurring on the public highway (including footways) involving at least one road vehicle or a vehicle in collision with a pedestrian or infrastructure item and which becomes known to the police within 30 days

**Road traffic crash:** A collision or occurrence involving at least one road vehicle in motion, on a public road or private road to which the public has right of access. Included are: collisions among road vehicles; between road vehicles and walkers; among road vehicles and wildlife or fixed obstacles and with one road vehicle alone. Included are collisions between road and rail vehicles. Multi-vehicle collisions are counted as only one crash provided that any successive collisions happen within a very short time period

**.Road traffic injury (or casualty):** A person who has sustained physical damage (i.e. injury) as a end result of a road traffic crash.

**Road traffic:** Every movement of a road vehicle on a given road network.

**Road transport:** a type of transport that used to move goods and/or passengers using a road vehicle on a given road network.( (Loo & Anderson, 2020,Aychew.R, 2020)

**Road user:** a person using every part of the road system as a non-motorized or motorized transport user.

**Road vehicle:** A vehicle running or drawn on wheels intended for use on roads.

**Road:** Line of communication (travelled way) open to public traffic, primarily for the use of road motor vehicles, using a stabilized base other than rails or air strips. Included are paved roads and other roads with a stabilized base, e.g. gravel roads. Roads also cover streets, bridges, tunnels, supporting structures, junctions, crossings and interchanges.

**Serious accident:** Accident in which no one is fatally injured, but at least one casualty received serious injuries.

**Serious injury/ casualty:** Injury does not cause death within 30 days of the accident and either outcomes in the casualty being detained in hospital as an in-patient, or any of the following wounds: fractures, concussion, internal injuries, crushing's, severe cuts and lacerations, severe general shock requiring treatment, or any injury which causes death more than 30 days after the accident.

**Slight accident:** Accident in which at least one casualty receives minor injuries but no fatal or serious injuries.

**Slight injury/ casualty:** Injury of a slight character such as a sprain (including whiplash neck injury), bruise or cut which are not judged to be severe or slight shock requiring roadside attention. Injuries not needing medical treatment are included. In addition to the above terms related to RTA, main economic terms are used in this study to brand countries based on their economic status. The economic relations used in this study are taken on the basis of their definition given by( (IBFRAD, 2019, Sori & Science, 2020) and are stated as follows.

**High-income countries:** Are nations whose Gross National Income Per capita is US\$ 12,616 or more.

**Low-income countries:** Are nations whose Gross National Income Per capita is US\$ 1,035 or less.

**Middle-income countries:** Are nations whose Gross National Income Per capita is among US\$ 1,036 to 12,615.

**Durame Town:** Durame Town in this research refers to the administrative boundary of Kambata Tambaro zone as per 2021.

**A buffer** is a tool that Creates buffer polygons around input feature to a specified distance.

## ***CHAPTER TWO***

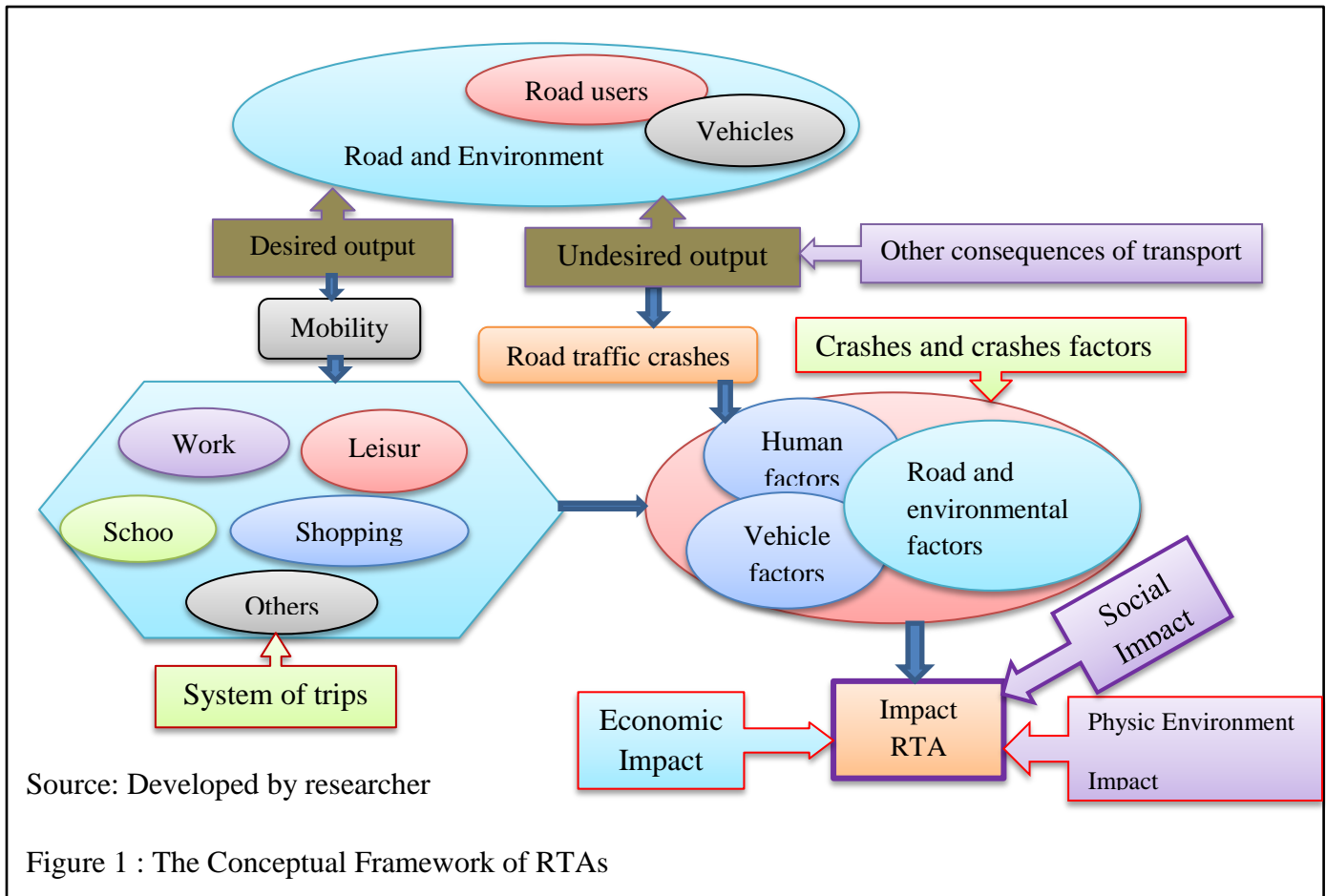
### ***2. Review of Related Literature***

#### ***2.1 Conceptual Framework Road Traffic Accident***

Road Traffic Accident is an unfortunate incident that happens unexpectedly and unintentional (Khaledur et al., 2017)ally between two or more vehicles, a vehicle and a train, a vehicle and a cyclist, a vehicle and a pedestrian, a vehicle and an animal, a vehicle and a fixed object such as a bridge, building, tree, post or a single vehicle that overturned on or near a public road(Adane, 2021). In a similar manner (Kindaya, 2014), have mentioned that an Accident is an occasion, occurs abruptly, Unpredictably and inadvertently under unforeseen circumstances. In this regard, RTA can be defined as an accident that occurred on a way or street open to public traffic; resulted in one or more persons being killed or wounded, and at least one stirring vehicle was intricate. Therefore, RTA is a smash between vehicles; between vehicles and pedestrians; between vehicles and animals; or between vehicles and geographical or architectural obstacles.(Alebachew, 2019)

##### ***2.1.1 Concepts***

Transport is the movement of people and goods from one place to another .The type of transport, which exhibits accident that drastically affects the wellbeing of the people, and economy of the nations is the one that involves the movement of people and or goods from one place to the other. Several RTA incidences occur throughout the world at every fraction of times in a day. Whatever the reason, where ever the scene and whoever the victim is, RTAs remain as the headache of everyone(Kindaya,et al., 2014).



## 2.2. Dynamics of Road Traffic Accidents

### 2.2.1 Globally trends of road traffic accidents

Road traffic accidents-the leading cause of death by injury and ninth-leading cause of death by injury and the ninth-leading cause of all deaths globally- now make up a surprisingly significant portion of the worldwide burden of ill health. Annually, 1.35 million people are estimated to die from road traffic injuries (RTI), and 93% of these deaths occur in low and middle-income countries.(Ochieng et al., 2022).(RTI), between 20-50 million people disabled and about 518 billion US\$ largest annually at global level (Hayidso et al., 2019a).Internationally, road traffic injuries are the leading cause of death in young people aged 9-25 years, and more people die from road traffic injuries than from HIV/AIDS, tuberculosis or diarrheal diseases. The low-income countries (LIC), which include countries with a GDP per capita of less than 1006 USD, have 9% of the worlds' population, 1% of the world's vehicles and 13 % of the world's road traffic deaths(Sundet et al., 2021) According to(WHO, 2019,and 2021 ) the increased rate of

fatal road traffic accidents worldwide has been attributed to population explosion and increased motorization especially in the developing countries

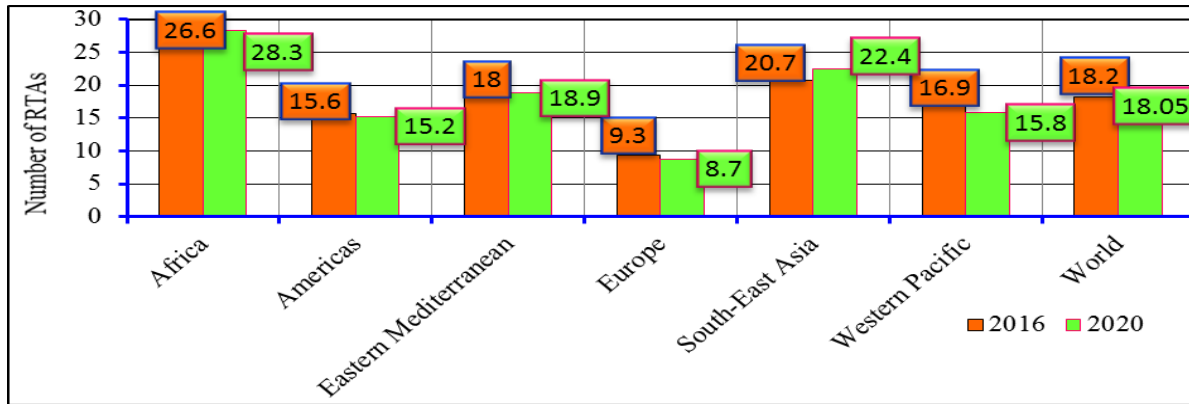


Figure 3: Rates of road traffic death per in world in 2016, 2020 per 100,000 population by who regions: 2016, 2020.Source,(WHO, 2021)

### 2.2.2 Ten leading causes of the global burden of disease from 1990 to 2020

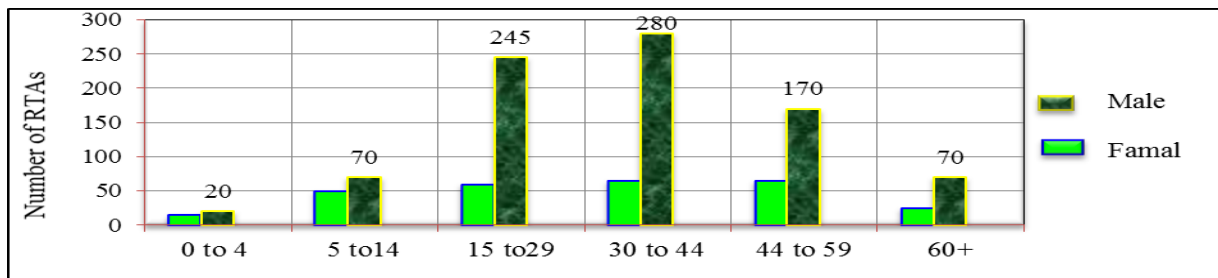
Based on many studies indicated that RTAs in 2020 is to be the third major killer and largest leading cause of death and disabilities after human immunodeficiency virus infection and acquired immune deficiency syndrome (HIV/AIDS) and Tuberculosis (TB), which will replace the current third ranking disease perinatal (WHO, 2019).Table1.Rank order of disease burden of disability adjusted life years (DALYs) for the ten leading causes of the global burden of disease from 1990 to 2020.

Table 1 Rank order of disease burden

| Rank     | Leading cause of disease or injury in 1990 | Rank     | Leading cause of disease or injury by 2020 |
|----------|--|----------|--|
| 1        | Lower respiratory infections               | 1        | Ischemic heart                             |
| 2        | Diarrhea                                   | 2        | Unpopular major depression                 |
| 3        | Perinatal                                  | <b>3</b> | <b>Road traffic crashes</b>                |
| 4        | Unpopular major depression                 | 4        | Cerebrovascular                            |
| 5        | Ischemic heart                             | 5        | Pulmonary                                  |
| 6        | Cerebrovascular                            | 6        | Lower respiratory infections               |
| 7        | Tuberculosis                               | 7        | Tuberculosis                               |
| 8        | Measles                                    | 8        | War  |
| <b>9</b> | <b>Road traffic crashes</b>                | 9        | Diarrhea                                   |
| 10       | Congenital Anomalies                       | 10       | HIV  |

Source: WHO (2013) report on road traffic injury prevention, Geneva

According to the (IBFRAD, 2019) estimation, road traffic injuries cost 1 percent to 2 percent of the Gross National Product (GNP) of developing countries, or twice the total amount of development aid received worldwide by developing countries. As in developed countries, driver impairment component of road traffic accidents in developing countries. Driving at excess speeds, while under the influence of alcohol or drugs, while sleepy or tired, when visibility is composed, or without protective gear for all vehicle occupants are major factors in crashes, deaths and serious injuries.



Source: WHO, Global Burden of Disease Project, Version 1, 20019\*Number of deaths in thousand

Figure 4 Traffic Accident Deaths Worldwide By Sex and Age Group

In general, pedestrians, cyclists, moped, and motor cycle riders are the most vulnerable road users as well as the heaviest users of roads in poor countries. Most people who use public transportation, bicycles, or mopeds and motor cycles or who habitually walk are poor, illuminating the higher risk bores by those from less privilege. In Asia, for instance, motorized two-and three-wheelers (such as motorized rickshaws) will make up the anticipated growth in numbers of motor vehicles ((Aklweg Et Al., 2011,IBFRAD, 2019)

### 2.3 Africa Trends of Road Traffic Accidents

According to (Abegaz & Gebremedhin, 2019) RTAs kill more people around the world than malaria, and are the leading cause of death for young and youth aged 5 to 29 especially in developing countries. In Africa, for example, the severity of RTAs is higher than rest of the world. According to the(WHO, 2022) Africa has shared the world’s highest death rate per population that is, 24.1 per 100,000 of the population, even though data are not correctly reported. This is because, many vulnerable road users are involved, poor transport conditions such as failure to use seat belts, overcrowding, and hazardous vehicle environments. The lack of pre-hospital and hospital emergency care after accidents makes the outcome of

car accidents in Africa the worst (Advisor, 2015). Furthermore, the poor reporting system has also masked the magnitude of the problem in the continent.

However, Africa accounts for nearly 20% of global road deaths, while having less than 2% of all vehicles. On the other hand, high-income countries have more than half of all registered vehicles but face only 8.5% of all fatalities annually(UNECA, 2009). Moreover, in Africa road users, which are pedestrians, pedal cyclists and public transport passengers are the most vulnerable and affected groups of road accidents. This is due to their high participation in traffic systems. Pedestrians account for the highest and prime proportion of road fatalities in nearly all African countries, for example, ranging between 31% in Zimbabwe and 51% in Ethiopia ,(Advisor, 2015). Passengers ranked second, which accounting for 32 to 46%. Pedestrians and passengers altogether represent over 90% of all road deaths in Africa. Drivers account for a small share of fatalities of less than 10 per cent, except in South Africa, which has the largest share of driver fatalities, which is 22%(Advisor, 2015)

The lack of pre-hospital and hospital emergency care after accidents makes the outcome of car accidents in Africa road deaths (48.4 per- 100,000 people), Egypt (41.6), Libya (40.5), Ethiopia (35.0), Sudan (34.7), Guinea-Bissau (34.4), South Africa (33.2) (WHO, 2009). RTAs in Africa are expected to rapidly increase over the next four decades, becoming a major public health challenge across the continent. Currently, RTAs worldwide is estimated to claim the lives of 1.4 million people per year and injure an additional 20-50 million. By 2050 the international futures for casting model anticipates that global traffic deaths will surpass 3 million people per year. This forecast shows that Africa will be particularly hard hit and will account for over 1 million of these deaths, or 35 percent of the global total. To put this in perspective, by 2050, traffic accidents in Africa will kill almost the same number of people annually as now die from HIV/AIDS in east and Southern Africa combined. And, for every 20 Africans who die in 2050, one will be killed in a traffic accident. However, despite the significant numbers of Africans being injured or killed in this way, RTAs do not receive the same coverage as other public health issues such as HIV/AIDS, tuberculosis and malaria. African countries experience a dramatic increase in the number of vehicles on the road. Very often, such increases in RTAs are not matched by adequate improvements in infrastructure and road safety legislation. This results in lag between private expenditure on vehicles and the public expenditure necessary to accommodate increased motorization(Akloweg et al., 2011)

### **2.3.1 Top 13 nations by road traffic accident**

Table 2 Top 13 Nations by Road traffic Accident

| Rank | Top African, Middle East and Asian Nations by RTAs |                          |                      | Remark  |
|------|--|--------------------------|----------------------|---|
|      | Nations  | Reported Number of death | Estimated Death Rate |   |
| 1    | Eritrea  | 81                       | 48.4                 | This figure ranks the countries based on estimated road deaths per 100,000 populations. |
| 2    | Cook islands                                       | 6                        | 45.0                 |   |
| 3    | Egypt  | 15,983                   | 41.6                 |   |
| 4    | Libya  | 2,138                    | 40.5                 |   |
| 5    | Afghanistan  | 1,179                    | 39.0                 |   |
| 6    | Iraq   | 1,932                    | 38.1                 |   |
| 7    | Angola   | 2,358                    | 37.7                 |   |
| 8    | Niger  | 570                      | 37.7                 |   |
| 9    | United-Arab Emirates                               | 1,056                    | 37.1                 |   |
| 10   | Gambia   | 54                       | 36.6                 |   |
| 11   | Iran   | 22,918                   | 35.8                 |   |
| 12   | Mauritania   | 262                      | 35.5                 |   |
| 13   | Ethiopia   | 2,441                    | 35.0                 |   |

Source: Allianz/WHO Status Report, 20019.

## 2.4 Road Traffic Accident Trends in Ethiopia

Ethiopia is one of the worst countries in the world where road transportation kills and injuries are in large number of road users every year. In Ethiopia, traffic police reports are the official sources of data for road-related incidents. In Ethiopia, the rate of RTAs is very high; because of road transport is the major transportation mechanism along with poor road network, absence of knowledge on road traffic safety, mixed traffic flow system, poor legislation and failure of enforcement, poor conditions of vehicle, poor emergency medical services and, absence of traffic accident compulsory insurance law have been identified as key determinants of the problem (Deme, 2019).

In Ethiopia each year more than two thousand people die and ten thousand people injured in road traffic clashes (Deme, 2019). RTAs, the 3rd most important killer globally, ranked 13<sup>th</sup>... According to a study of the Swedish medical university, fatalities related to traffic accident in the country have a proportion of 70 to 100 for every 10,000 vehicles, which means in every 5 accidents kill 1 person on average (WHO, 2019) Like other low-income countries, the traffic controlling system is not that much supported by modern technological instruments in Ethiopia. Currently, the country is almost using relatively simple and outdated controlling methods which had been applicable before several decades. It seems that more sophisticated optimization methods are failed for networks. Modern instruments such as traffic speed enforcement hand-held radar and alcohol breath tester, among others, is still not introduced in the country. of course, according to studies most traffic accidents are the result of speed, lack of road signs and driver's impairment of judgment. Many say that speed, drunk driving and lack of enforcement are said to be the causes of the major failures of the traffic system in Ethiopia. In a report issued late last week, the

Commission said the country experienced 15,034 road accidents during the fiscal year that ended on July 7, 2021, leaving 4,161 people dead. The accidents also inflicted serious physical injuries on 5,763 people while 5,110 others also sustained minor injuries. Police also recorded 31,643 accidents that caused damages on properties worth more than 2.28 million birr. Incompetence among drivers, speeding, technical inefficiency of vehicles, inappropriate use of roads by pedestrians mentioned by the police as reasons for the majority of accidents. The latest statistics from the police shows that road accidents have remained to be a major burden on the social, economic and health sectors.

It is also highly likely that these vehicles travel more kilometers per annum, which contributes, to both a high number of crashes and high rate. The observed trends in Ethiopia road crashes provide guidance on their current road safety problems and the challenges, and point to possible areas of counter measures, policies, and program will need to represent low-cost solutions, green economic constraints with in the country(By: & Abiye, 2020)

Most importantly, Oromiya regional state is one of the traffic flow is usually high because of its location obviously vehicles from the 8 states and Dire Dawa City Administration pass through this region to come to the capital city of Addis Ababa (Advisor, 2015). Behind the wheel, driving without using a seat belt and not using motorcycle helmet and the amendment of an existing road safety laws (excessive speeding, impaired driving with alcohol and chat and unsafe loading) by introducing higher penalty rate including suspension of the driver license. Seat belt wearing, helmet use and phoning while driving were enforced by using a road side random check up on regular bases; however, speed and alcohol were not well enforced due to lack of radar and breath analyzer(By: & Abiye, 2020).Ethiopians are more likely to make use of commercial vehicles, minibuses, buses, three tire vehicles (Bajaj) to support mobility needs. Commercial vehicles have a high involvement in crashes, although there is need for exposure data to determine whether they are overrepresented

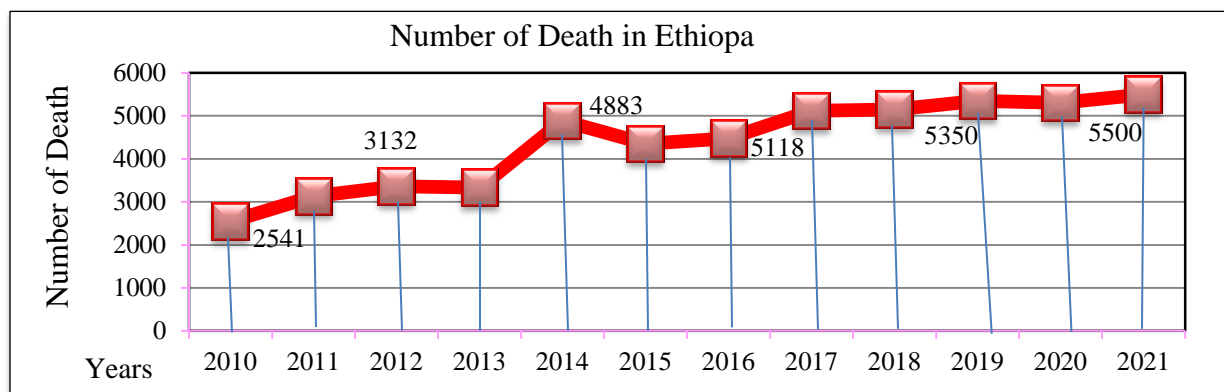
Plate 1: Accidents of Vehicles in Ethiopia 2021.



Source. Mengistu. F, 2022, Ethiopia

#### 2.4.1 Death Rate and Trend of Road Safety in Ethiopia

The analysis to figure out the trends of fatalities that occurred due to (RTCs) in Ethiopia was done based on 12 consecutive years (2010–2021). The crash history from Ethiopian Traffic Police Commission has shown that in 2010, 2541 fatalities occurred because of traffic collisions (see Figure 2). There was a slight increase in fatalities until 2013, then a significant increase in 2014, when the number of people killed in crashes shockingly reached 4883. Even if a slight decrease was seen in 2015, it increased again from year to year and finally, 5500 deaths were recorded in 2021. According to the data from the Ethiopian Roads Authority (ERA) , from 2009 to 2017, 79,790 kilometers of road networks were newly constructed total highways (asphalt and gravel), with an annual growth rate of 13.08%. Despite the Ethiopian government’s efforts to improve access and mobility for road users, the significant growth of motor vehicles was a contributing factor to the increase in traffic fatalities. The motor vehicle registration record of the Ethiopian Federal Transport Authority disclosed that in 2009 the number of vehicles in Ethiopia was about 276,794 in which had exceeded 927,847 motor vehicles in 2021 with an annual average growth rate of 29.8%. The Ethiopian Police Commission-Department of Traffic Police reported that the day-to-day increase of RTC fatalities caused by alcohol use has become their main concern. As previously stated, the reasons for the increase of fatalities may be attributed to a significant growth rate of motor vehicles relative to road networks (the road network’s growth rate is 13.08%, while motor vehicles’ growth rate is 29.8%) and alcohol consumptions of drivers.



Source: Source: Federal Police Commission Of Ethiopia, Ethiopia 2022

Figure 5 Number Of Deaths Recorded In Ethiopia From 2010–2021.

### 2.4.2 Number of Registered Vehicles in Ethiopia

Table 4: Number of vehicles in the regions ( up to September 26,2020) Registered vehicles (By: & Abiye, 2020).

Table 3: Number of Registered vehicles in Ethiopia

| ER      | AA      | Amhara  | AF    | BN     | DD     | SO     | TG     | GM    | HA     | SNNP    | OR      | Total     |
|---------|---------|---------|-------|--------|--------|--------|--------|-------|--------|---------|---------|-----------|
| Numbers | 630,440 | 106,434 | 8,277 | 10,655 | 24,510 | 19,579 | 60,800 | 6,237 | 10,728 | 118,424 | 204,026 | 1,200,110 |
| Ranks   | 1       | 3       | 10    | 9      | 6      | 7      | 5      | 11    | 8      | 4       | 2       |           |

NB: ER =Ethiopia regions AA =Addis Ababa, AF= Afar, BN= Benishangul, DD=Dire Dawa, SO= Somali, TG= Tigray, GM= Gambella, SNNP= Southern Nations, Nationalities People, HA= Harari, OR= Oromia

### 2.4.3 Road Traffic Accident Causalities in Region of Ethiopia.

Table 4 Accidents of Region in Ethiopia \*Ranking was done on the total number of Accident performance.

Table 4 Road Traffic Accident Causalities in Region of Ethiopia.

| Region Name | Accident Type and Year |                |               |       |                |               |       |                |               | Total | Rank |
|-------------|------------------------|----------------|---------------|-------|----------------|---------------|-------|----------------|---------------|-------|------|
|             | 2019                   |                |               | 2018  |                |               | 2017  |                |               |       |      |
|             | Death                  | Serious Injury | Slight Injury | Death | Serious Injury | Slight Injury | Death | Serious Injury | Slight Injury |       |      |
| Tigray      | 386                    | 854            | 381           | 374   | 858            | 584           | 371   | 664            | 356           | 4828  | 5    |
| Amhara      | 1104                   | 1032           | 1252          | 1152  | 1181           | 1924          | 1035  | 1190           | 1990          | 11860 | 2    |
| Afar        | 56                     | 73             | 20            | 72    | 49             | 31            | 131   | 164            | 79            | 675   | 10   |
| Oromia      | 1 478                  | 1 448          | 1 386         | 1 882 | 1 710          | 1 586         | 1 541 | 1 459          | 1 485         | 12516 | 1    |
| Somalia     | 132                    | 127            | 134           | 204   | 533            | 447           | 157   | 408            | 396           | 2538  | 6    |

|             |       |       |       |       |       |       |       |       |       |        |    |
|-------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|--------|----|
| Benishangul | 91    | 136   | 266   | 36    | 126   | 215   | 33    | 224   | 395   | 1522   | 8  |
| SNNPR       | 712   | 1152  | 725   | 720   | 1121  | 922   | 634   | 990   | 939   | 7915   | 4  |
| Gambella    | 19    | 43    | 81    | 18    | 20    | 48    | 16    | 38    | 101   | 384    | 11 |
| Harari      | 55    | 203   | 188   | 34    | 224   | 507   | 53    | 123   | 284   | 1671   | 7  |
| Addis Ababa | 528   | 2210  | 1274  | 585   | 1804  | 1232  | 477   | 2085  | 1232  | 11427  | 3  |
| Dire Dawa   | 36    | 127   | 242   | 41    | 128   | 279   | 31    | 141   | 180   | 1205   | 9  |
| Total       | 4 597 | 7 407 | 5 949 | 5 118 | 7 754 | 7 775 | 4 479 | 7 486 | 7 435 | 56,519 |    |

Source: Source: Federal Police Commission of Ethiopia, statistics Division, Addis Ababa, Ethiopia 2020

The distribution of road traffic crashes in the country is uneven, with road fatalities and injuries concentrated on roads in the central part of the country (see Table4). For instance, four out of 12 Regional States, namely the Oromia Regional State (ORS), Amhara Regional State (ARS), South Nations Nationality People (SNNP) and the Addis Ababa City Administration accounted for almost 85 per cent of the fatalities in the country. Serious injuries have a similar spatial variation among the Regional States, even though the credibility of existing data is compromised by concerns of underreporting and misclassification across the regions. Crash data for three years (2017–2019) shows that consolidated efforts are required in these regions, particularly ORS and ARS. Then, SNNP and Addis Ababa City Administration could be considered to curb the current high level of road death in the country. Countryside for primary and secondary trips in their daily lives. Many fatalities and serious injuries are recorded as crashes on interstate highways, often involving public transport vehicles (By: & Abiye, 2020). In terms of road user age, the age group between 18 and 50, which is the active working force in the country is overrepresented in passenger deaths and accounted for nearly 60 per cent of passenger deaths in 2018(By: & Abiye, 2020)

#### **2.4.4 Road Traffic Accident Causalities in Kambata Tembaro Zone**

According to Kambata Tembaro Zone traffic safety department unpublished training manual 2022, RTAs has destructive influence in human life and development of economy of the zone. A lot of reducing measurements were tried to be taken by regional and zonal government but it impossible reduce and in contrary the situation becoming higher from time to time. Table 3 shows nine years RTAs statistic data of Kambata Tembaro Zone (2016-2021).

Table 5 Road Traffic Accident Causalities in Kambata Tembaro Zone

| Years | Death | Serious injuries | Light injuries | Number of property accidents | Total | Ranks |
|-------|-------|------------------|----------------|------------------------------|-------|-------|
| 2016  | 33    | 38               | 43             | 91                           | 205   | 6     |
| 2017  | 40    | 45               | 67             | 115                          | 267   | 4     |
| 2018  | 38    | 34               | 57             | 107                          | 236   | 5     |
| 2019  | 55    | 60               | 71             | 132                          | 318   | 3     |
| 2020  | 53    | 67               | 67             | 166                          | 353   | 2     |
| 2021  | 57    | 64               | 65             | 191                          | 377   | 1     |
| Total | 276   | 308              | 372            | 802                          | 1756  |       |

Source: Kambata Tembaro Zone road traffic safety training manual (2022).

## 2.5 Causes/Factors of Road Traffic Accident

Road traffic crash results from a combination of factors related to the components of the system including roads, the setting, vehicles and road users, and the way they interact. Some factors contribute to the occurrence of a collision and are therefore part of crash causation. Other factors aggravate the effects of the collision and thus contribute to shock severity. Some factors may not appear to be directly related to road traffic injuries. Some causes are immediate, but they may be underpinned by medium-term and long-term structural causes. Identifying the risk factors that contribute to road traffic crashes is important in identifying interventions that can reduce the risks associated with those factors (Kindaya, 2014). Extensive human and material losses, many temporary and permanent injuries and enormous damages to the public and private properties are the ultimate results of road traffic accidents. (Kasimani & Sivaprakash, 2020). According to (Lakshmi et al., 2019) traffic accident is influenced by factors which are grouped into three categories namely, Human Error, Road and Environmental factors, and Vehicle characteristics. (Dechkamfoo et al., 2022)

### 2.5.1. Human Factors

According to (Watson & Austin, 2021, WHO, 2004, WHO, 2010, Alebachew, 2019 WHO, 18, Kasimani & Sivaprakash, 2020, Uhegbu & Tight, 2021, Sebos et al., 2010, Rahman & Jamal, 2020, Stanley et al., 2022 Solberg et al., 2011, Science 2021).

- ❖ Some of the human related causes of RTA are as follows:- Driver's skill performance, Blood alcohol level, Carelessness, Non-Use of Helmets, The Use of Hand-Held Mobile Telephone, Lack of Road User Information Choice of Less Safe Forms of Travel, and Campaign, Hazardous materials, Non-

Use of Seat Belts, Insufficiently experienced, Age of Drivers, Overloading, Land-use planning, Over speeding, Population density, Economic development Lack of sensitivity and responsibility, Land-use planning drink Driving.

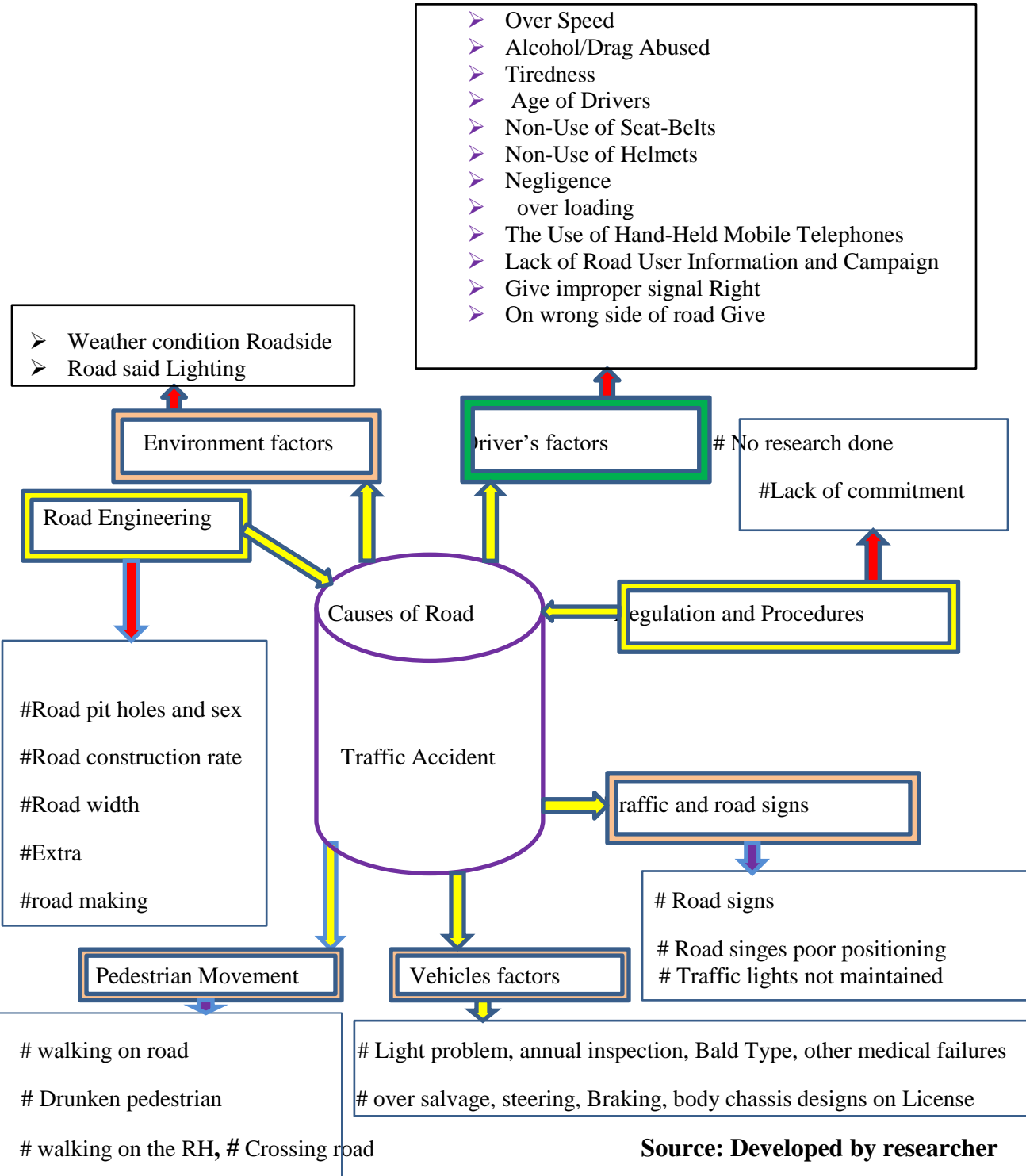
### **2.5.2 Road and Environmental Factors**

- ❖ According to (Sandhyavitri & Wiyono, 2017, Pagany & Dorner, 2019, Abraham et al. 2020, Better, 2020, Roadside et al., 2022 Roadside et al., 2022).) Some of the Road and environment related causes of RTA are discussed as follows:
  - Weather and lighting conditions, road design, planning, designing, road condition, signals, bridge width, traffic control devices and intersections, curved bridge, approach roadway arrangement, Signals, operation stage ,road surface that become slippery from rainfall, adverse surface condition, Road lights, roadside devices, activities, shielding devices, surface deposits, activities, Flooding and Climate change, Rainfall and Landslide ,and Wildlife

### **2.5.3 Vehicle Factors**

- ❖ According to (WHO, 18, Bokaba et al., 2022) Some of the Vehicle related causes of RTA are as follows:-
  - Braking performance increased stopping distance, vehicle defects, tire blowout, power steering failure, and headlight failure overloaded or poorly loaded vehicle or trailer, defective lights or indicators, defective steering or suspension and defective or missing mirrors, are the major factors for the frequent occurrence.

Figure 6 general frame work road traffic accidents cause



## **2.6 Impacts of Road Traffic Accident**

RTA currently affects all nations in the world. Although the effects of RTA vary from one nation to the other, from country to country, it should be every body's scholars are conversed in the following sub-sections, 1, Economic Impact 2. Social Impact 3. Physical Environment Impacts

### **2.6.1 Economic Impact**

RTAs are currently deteriorating the financial wealth of many nations. In this regard, urges that, in economic terms, the cost of (Prasannakumar et al., 2011). If road crash injuries is estimated at roughly 1% of Gross National Product (GNP) in low-income countries, 1.5% in middle-income countries and 2% in high income countries. The direct economic costs of global road crashes have been estimated at US\$ 518 billion, with the costs in low-income countries – estimated at US\$ 65 billion – exceeding the total annual amount received in development assistance. (Alebachew, 2019)

In addition to this, in terms of regional disparities of cost of RTA (Kindaya, 2014) indicated that, the economic cost of road crashes have been estimated to be as much as US\$ 24.5 Billion in Asia, US\$ 19 Billion in Latin America and Caribbean, US\$ 9.9 Billion in Central and East Europe, US\$ 7.4 Billion in the Middle East and US\$ 3.7 Billion in Africa. When we come to Ethiopia, RTA's economic impact is even worse. As far as the economic impact of RTA in Ethiopia is concerned, have discussed that, the economic impact of RTAs is substantial for Ethiopians as the annual cost is estimated to be around £40 million. (Prasannakumar et al., 2011 and Gebru, 2020)

### **2.6.2 Social Impact**

The social impact of RTAs is also widespread. The RTA impacts are also shown with their influence on the social aspects of the livelihood. To this regard, WHO (2004) claims that, over 50% of the global mortality due to road traffic injury occurs among young adults aged between 15 and 44 years, and the rates for this age group are higher in developing world. In 2002, males accounted for 73% of all road traffic deaths, with an overall rate almost three times that for females: 27.6 per 100, 000 population and 10.4 per 100, 000 population, correspondingly. Road traffic mortality rates are higher in men than in women in all regions regardless of income level, and across all age groups. On average, males in the low-income and middle-income countries of the WHO Africa Region and the WHO Eastern Mediterranean Region have the highest road traffic injury mortality rates worldwide (Kindaya, 2014 and Alebachew, 2019).

The report of (WHO, 2019) added that people with road traffic injuries accounted for 13-31% of all injury-related attendees and 48% of bed occupancy in surgical wards and were the most frequent users of operating theatres and intensive care units. The increased workload in radiology departments and increased demand for physiotherapy and rehabilitation services were largely attributed to road traffic injuries. Regardless of the costs of healthcare and rehabilitation, injured people bear additional costs. Permanent disability, such as paraplegia, quadriplegia, loss of eyesight or brain damage, can deprive an individual the ability to achieve even minor goals and can result in dependence on others for financial support and routine physical care. Less serious injuries can result in chronic physical pain and limit the injured person's physical activity for lengthy periods. Serious burns, contusions or lacerations can lead to emotional trauma associated with permanent disfigurement(WHO, 2019)

(WHO, 2019) States that, over 90% of the world's fatalities on the roads occur in low and middle income countries, although these countries only have about 48% of the world's registered vehicles. This report also urges that, given these numbers, road traffic injuries have to be seen in developing world as one of the most important health problems along with diseases such diarrhea, malaria, HIV/AIDS and tuberculosis(Kindaya, 2014,Gebbru, 2020,Angelevska et al., 2021)).

## **2.7 Black Spots of Road Traffic Accident**

### **2.7.1 Black Spot Definition**

Black spot areas in RTA are defined in different ways by different scholar's .An accident black spot is a term used in road safety management to denote a place where road traffic accidents have historically been concentrated. Black spot methods are designed to identify the prone spots in particular stretch and reduce the crash risk in that area by providing remedial measures. The process is sometimes known as black spot identification or hazardous identification location. Generally black spot are termed to define the location where many accidents have occurred and risk (severe, major, and minor) is involved in that accident(Sorate, 2016)

Thus, a black spot in the UK may well have only five injury accidents in three years, whereas city in Bangladesh may have black spot defined as having more than 10 injury accidents in a year ( Geurts and Wets(2003)). In most developed states, black spots are defined as the locations where there are 12 accidents in 3 years per 0.3 kilometers. In Czech Republic, the black spot criterion is that junctions or 250m long road sections that are considered as black spots on condition that at least 3 road accidents with injuries occurred within 1 year or at least 3 road accidents with injuries of the same type occurred within

3 years or at least 5 road accidents of the same type occurred within 1 year. Study on single carriage way trunk road revealed that the criterion used to delineate road sections for accident analysis are age of opening, carriageway width, curbs, hard strips, and speed of the road section(Rokytova2000.)(Alebachew, 2019)

Show three alternative methods of ranking black spots. These are number of accident with personal injury or serious personal injury, accident rates (accident per million-vehicle kilometer) and potential for accident reduction(David et al., 2009) In addition to this, Kindaya, 2014)stated that Black spot areas are sites that have had more than one fatal crash, sites with multiple crashes within a mile from one another(Kindaya, 2014).

### **2.7.2 Criteria for Black Spot Analysis**

Different country can use expected time coverage for black spot analysis in respect to amount of accident exist repeatedly with the specified number and relative severity at specified period. As a result; accident data for the most recent 1 to 3-year period is normally used and is generally sufficient. 2 or 3-year analysis periods are more appropriate at locations with low traffic volumes, where a 1-year period may not provide sufficient information for location with low traffic volume. Accident data should only be used when there are no major changes in facility characteristics or land use. Simple methods for identifying unsafe locations, where the number of crashes or the crash rate per unit exposure exceeds a given threshold, are routine and straightforward ( Rokytova2000, David et al., 2009,Geurts et al., 2012,Alebachew, 2019)

### **2.7.3 Application of GIS for Road Traffic Accident Black Spot**

Accordingly, the owner of GIS software ESRI (2011) also described GIS as an integrated hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information. GIS technology allows you to view, query, and understand data in many ways. Now a day GIS is applied in the transportation as the backbone for Intelligent Transportation System (ITS). ITS, utilizes advanced technologies frequently GIS, to improve both the efficiency and safety of transportation system. GIS-based ITS applications are fed with data from GPS units, video cameras, and road monitoring units( D et al., 2013,Alebachew, 2019). Geographic database as such consist of spatial and non-spatial data with complex data structures used to analysis(Taylor et al., 2000). According to)(Alebachew, 2019), transport data are spatial in a number of aspects. All spatial data is geographically referenced to a map projection in an earth coordinate system and can be "re-projected" from one

coordinate system into another, thus data from various sources can be brought together into a common database and integrated using GIS software(Mustaffa et al., 2014).

The role of GIS as an analytical tool provides a major influence in providing solutions to solve RTAs problems. This capability makes it easier for planners to make decisions more effectively and efficiently (Hayidso et al., 2019b). Geographic data usage plays an important role in several fields. In our day to day studies, we used several data that have spatial information. Usage of spatial data required data clarity and manipulation of them correctly. In this way, GIS has a critical role. The occurrence of accidents at the same place or nearby places is the indicator of the location of accidents. Traffic accidents should be analyzed with their coordinates. With the help of spatial analysis tools, high crash occurrence areas will be clearly identified. In order to understand the causes of accidents and improve traffic safety, hot spot analyses have an important role(Kyaw Zin Htut, Ei Ei Mon, Leonard Johnstone, Rattaphol Pueboobpaphan, Vatanavongs Ratanavaraha, 2016). Traffic management and planning operators may apply the application of GIS in many ways to locate the optional route to road users, for effective traffic signal control, to give specific information to drivers and passengers, to generate databases on traffic accident-prone areas, and to compute accident severity index. It is also used for accident mapping and reporting systems.

This system may be used in actual-time traffic accident recording, analyzing, visualization, and finally apply the report and management system of the accidents through delineations of the nearest suitable facilities and emergency services(Muthoni Njeru & Imwati, 2016). To prepare the data as much as suitable for the GIS environment the concerned body or traffic police should be reporting the geo referenced data and all things that happened there(accidents and incidents). Then the GIS experts may store the recorded data in a database. The database may contain datasets like district, accident types, clinic/hospital access, and road networks. After preparing all observed data it is possible to apply GIS applications for a further advanced process like trend analysis, modeling, and overall visualization(S Liang et al., 2005,tudy et al., 2022). The final map may help to locate and visualize the issues for the concerned bodies like traffic managers to properly decide decisions. It is also used to understand the hot spot areas for a traffic accident and ultimately the planners and decision-makers may select the appropriate suitable location for service sectors in relation to road networks. This system is also very important to do web GIS for traffic accident problems. With the aid of geospatial technologies like global positioning systems we can record the location for web mapping purposes and this is very crucial for data sharing among different government sectors(Muthoni Njeru & Imwati, 2016)

## **2. 7.4 Road Traffic Crash Databases in Ethiopia**

The road traffic crash database in Ethiopia is not computerized and data are collected and handled manually in most police stations in the country. In the country as a whole, the existing crash database system provides little information on the number of crashes and casualties. Moreover, there are questions related to the uniformity, relevance and reliability of available data. An effort is being made, however, to computerize the management of road crash data in Addis Ababa.(By: & Abiye, 2020)

## **2.8 Global positioning system (GPS) for field survey**

GPS is a satellite navigation system used to determine the ground position of an entity. GPS technology was first used by the United States army in the 1960s and expanded into civilian use over the next few decades. Today, GPS receivers are incorporated in many commercial products, such as automobiles, smartphones, exercise watches, and GIS device. GPS receiver associations the broadcasts from multiple satellites to calculate its exact position using a process called triangulation. Three satellites are required in order to determine a receiver's location, though association to four satellites is ideal since it provides greater accuracy. In order for a GPS device to work appropriately, it must first establish a connection to the required number of satellites (Muthoni Njeru & Imwati, 2016).

GPS receivers provide a fast and convenient method for obtaining position information that can be collected in actual time and is easily employed within a GIS. This is because the basic GPS position information is provided in the form of latitude and longitude on the surface of the Earth, which is compatible with common GIS location speculations. Differential GPS corrections can be used to enhance positional accuracy to about 5 m (with 95% condense) under almost all conditions. In addition, instantaneous speed accuracy to 2 km/h (with 95% condense) can be achieved, with vehicle speed being observed directly and recorded independently of the GPS position data, using commonly available GPS receivers explain the use of GPS in traffic studies and the theory of and methods for instantaneous speed observation using GPS and describe a series of experiments which validated the above results for both position and the independent speed observation(Taylor et al., 2000).

## **2.9 Preventive Measures for Road Traffic Accidents or Road Traffic Management Techniques**

Evangeline and Andrew, 2016 presented that road traffic accidents are the major cause of mortality among people aged 15–30 years in the world. World Health Organization (WHO) and the World Bank

launched decadal action for road safety in 2011 with the goal of halving the number of injuries and deaths on the roads. Some of the preventive measures are listed below.

- ✓ **Implement safety-oriented infrastructures:** - Infrastructure is the primary task to prevent road traffic accidents, especially for developing countries. Continuous improvement of hotspot locations and hazardous road areas. Implementation of safety facilities including roundabouts, bus stops and terminals, and rest areas.
- ✓ **Establish traffic culture:** - Safety awareness should begin from childhood because childhood is a better way to impart awareness than adults are. Enforce road safety campaigns and education; enhance road safety advertisement by promoting cooperation of diverse road safety-related institutions.
- ✓ **Strengthen Traffic National Policy:** - Enforce control of illegal, non-registered vehicles and investigate repetitive accident cased vehicles. Strengthen local government authority traffic safety capacities; conduct road safety training and workshops to local government officers to share road safety-related policies.
- ✓ **Enhance safety regulations for transport service enterprise and upgrade accident response systems:** -conduct traffic safety assessment to transport service enterprises both government and private enterprises that have caused traffic accidents and fatalities. Reward and provide incentives to high-performance enterprises.
- ✓ **Increasing parking supply:** On-street parking is a major problem for traffic congestion and accidents. Strengthening public parking is important to minimize on-street parking that affects traffic flow and safety (Aychew.R, 2020)

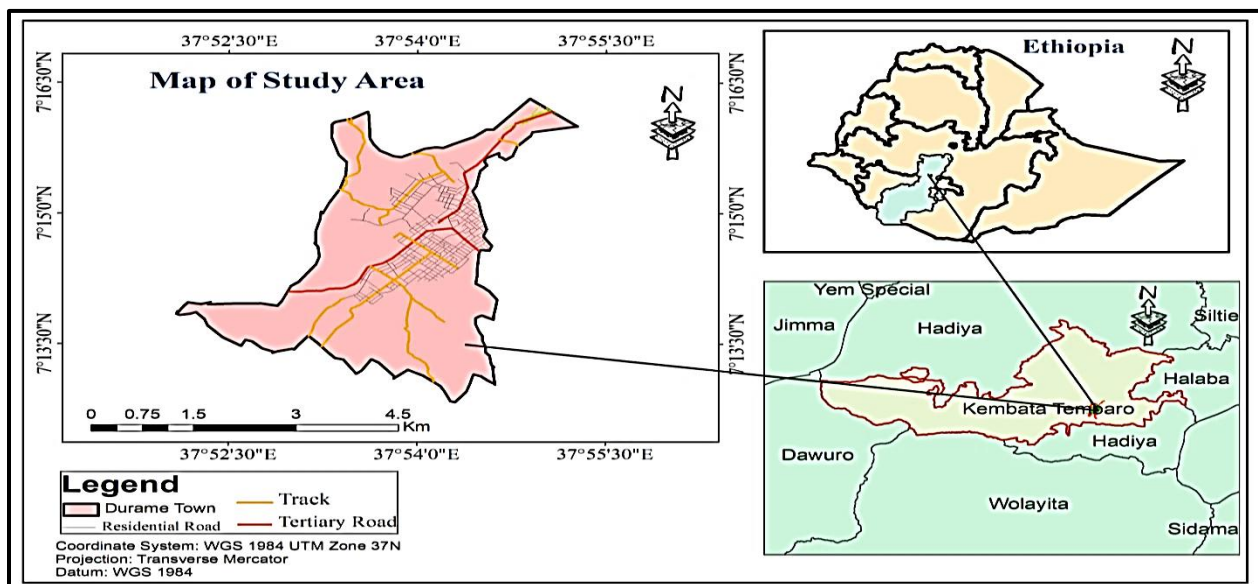
## CHAPTER THREE

### 3. Materials and Methods

#### 3.1 Description of the Study Area

##### 3.1.1 Geographical Profile of the Study Area

This study was carried out in Durame Town. Durame Town the Capital of the Kambata Tembaro zone, it is located almost at the center of the zone. Durame town is found in Kembata Tembaro zone in SNNPRS at a distance of 125km west of the regional capital, Hawassa, 350 km south of Addis Ababa. Astronomically, the town lies at the coordinate of  $7^{\circ}11'0''$  to  $17^{\circ}17'0''$  north latitude and  $37^{\circ}52'30''$   $37^{\circ}55'0''$  east longitudes. Durame lies between Hossana, Wolaita sodo and Halaba the asphalt road connect Durame with Addis Ababa, Hossana, Butajira, Wolikete, Halaba,shashamene, Hawassa, Wolaita sodo Arbamimich, Hadaro,mudulla, shinshicho and sona. Because of its strategically position the town is the center for trade, transportation, truism, and others economic activity. Durame is the administrative canter of both Kambata Tembaro zone and kedida Gamelaworeda



. Figure 7 Location Map of the study area

### 3.1.2. Topography and Land Form

The topography of Durame town is mixed consisting of gently sloping area at about the center following the main road, which falls to the west and east and rises again. In general, the town has rolling topography bounded by Ambericho Mountain in the north and consists of small hills and elevated areas. The elevation of the town ranges from 1990-2240 m.a.s.l showing a difference of 250m within the boundary. The topography of the town has a higher elevated area at about the geographic center of the town and then falls down and rises to the boundaries of the town in the northeast and southwest and west. The land falls from the center of the town to the exits to Mazoria, Hosaina and Damboya.

#### 3.1.2.1 Slope of Durame Town

Slope indications the upward or downward inclination of a natural or non-natural surface. It is a deviation of the surface from the straight. The surface of Durame Town shows varied slope characteristics. According to the slope classification criteria set by FAO (2006). Regard to slope 0-2 % of the town is flat , 2-4% is straight with very gently sloping, 4-8% gentle sloping, 8-16% is sloping,16-30% strong sloping, 30-50% moderate steepy and >-50% very steepy .

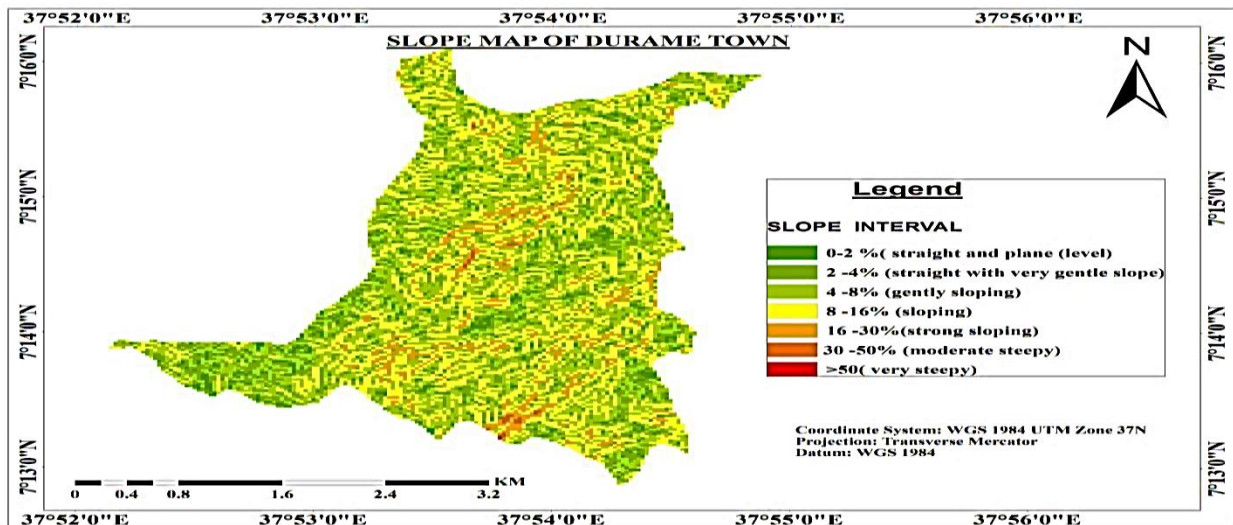


Figure 8 Slope Map of Durame Town

### 3.1.2, 2 Aspect of Durame Town.

Aspect shows the position (face) of the area. From the total surface Durame Town (16%) and (15%) faces to North to south direction respectively. In addition, 14% of the surface of the town is inclined towards west, west-south and south-west direction respectively, and 12% and 11% is inclined toward east, northeast and east north. Generally, the town is inclined from North to south, so that the drainage pattern of the town is north to south (Amare Feleke, 2015)

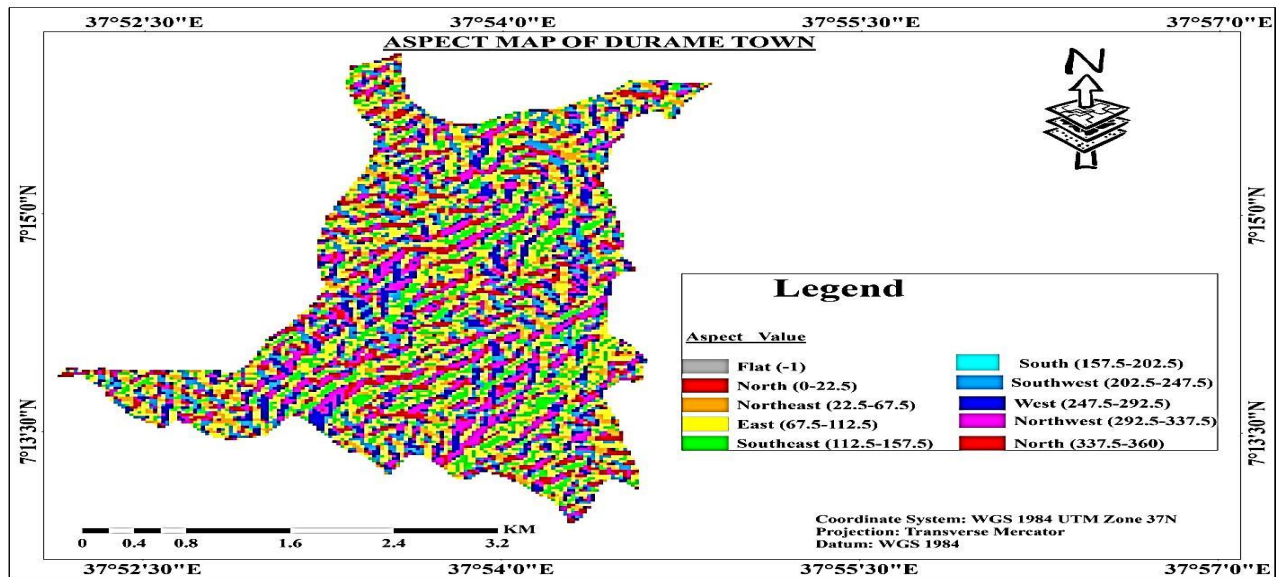


Figure 9 Aspect Map of Durame Town

### 3.1.3. Climate

#### 3.1.3.1 Temperature

The whole study area is lying within a temperate climate as a cool region (Tulu, 2021). The climate of Durame town is characterized by four distinct seasonal weather patterns; that are the main wet season “kiremt” which extends from June to August, a minor rainy season-mehir| extends from September to October, a little rainy season -belg| extends from March to May and more likely no rainy season - begal| extends from December to February. More specifically, the highest and the lowest temperatures in the town are recorded during March and August respectively (Amare Feleke, 2015). In general based on local climatic classification, Durame Town is grouped under —woeina-degal| climatic zones. As meteorological data has shown that the annual mean average temperature of the town for consecutive 34 years is around 22.74<sup>0</sup>c in year 2013 and the maximum temperature reaches up to 36.01 <sup>0</sup>c by the year 2005 as indicated in the following graph

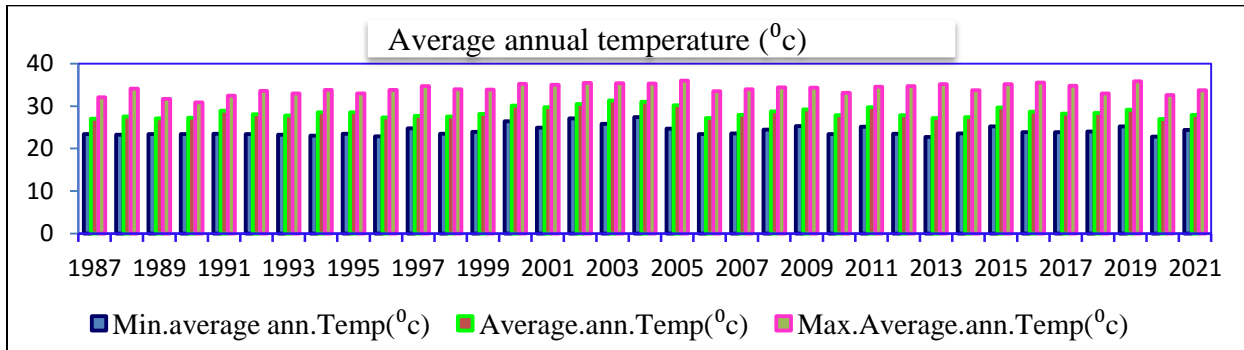
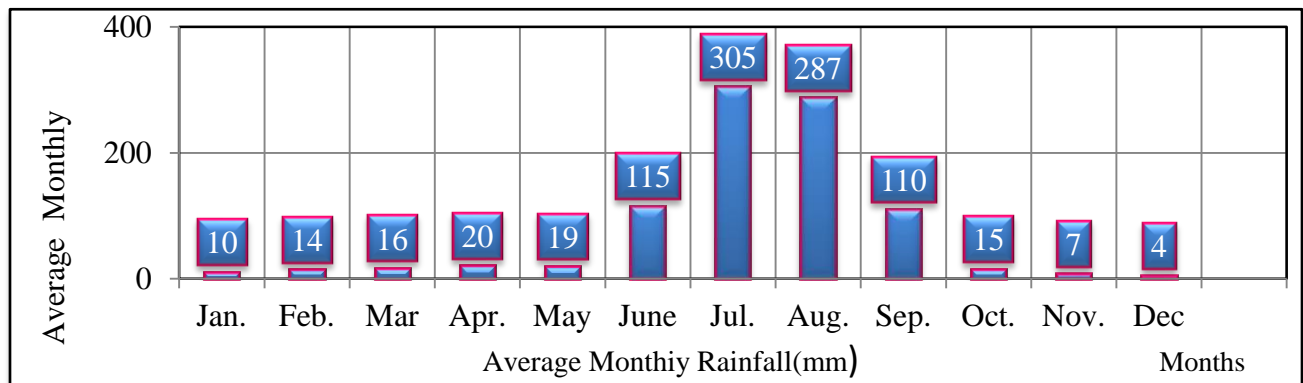


Figure 10: average monthly maximum and minimum temperature of study area.

Source: Ethiopian meteorological agency, 2022

### 3.1. 3.2 Rainfall

The air is usually humid because of abundant vegetation cover and enough rainfall. Durame gets rainfall almost throughout the year. The annual rainfall is 554.44-1357.611mm and reaches up to 2330.86mm. The highest rainfall is recorded between June and September and the lowest rainfall occurs between December and February which are relatively dry months of the year. Likewise, July is the wettest while December is the driest months of Durame Town.



Source: Ethiopian Meteorological Agency, 2022

Figure 11 Average Monthly Rainfall of (NMA 2021)

### 3.1.3.3. Wind Speed and Direction

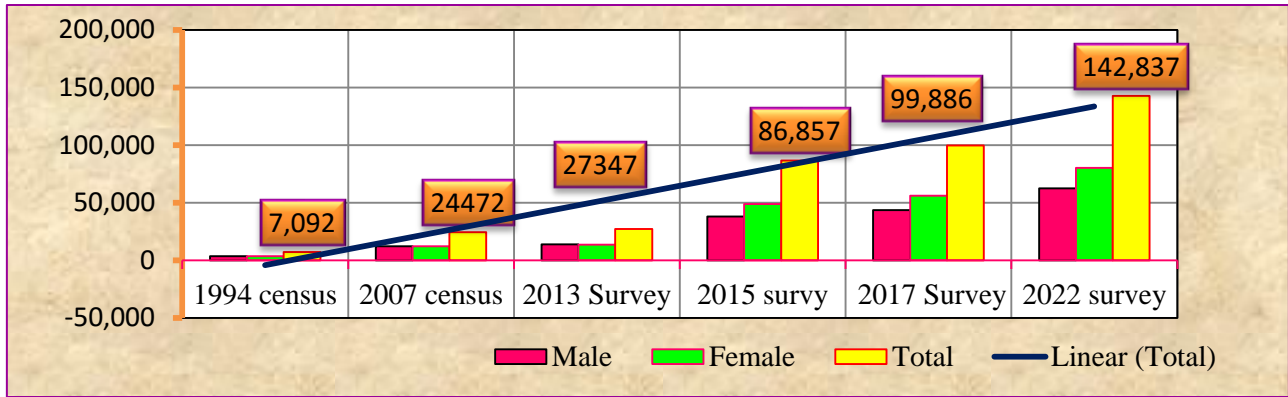
The available wind speed measured five times a day at Durame Town station indicates that wind with minimum speed occurs during February (1.65m/s), while the wind with high velocity occurs during September, October, and November (3.05-3.2 m/s). The values calculated over 10 years

(20010 to 2020) indicate that mean is 2.31 m/s. Generally, the wind speed at Durame Town is high. During summer month the wind speed portrays decreasing trend .In ten years period (2010-2020), the maximum wind speed recorded was about 10m/s. The prevailing wind direction of the woreda is Northeasterly (DTMA, 2021).

### **3.1.4 Socio-Economic Profile**

#### ***3.1.4.1 Trend in Population Size***

According to the 1994 Population & Housing Census of Ethiopia, which was conducted for the second time in the history of the country, the total population of Durame Town was 7,092 out of which 3,577 (50.4%) were males and 3,515 (49.6%) were females. 13 years later on the year 2007, the FDRE Central Statistics Agency conducted the third Population & Housing Census survey and by then the total population of Durame town reached to 24,472, out of which 12,173 (49.7%) were males and 12,299 (50.3%) were females. Based on the request made from Durame Town Administration, the SNNPRSFEDB conduct a population survey in the year 2016. During this time the town's population, including 3 additional rural Kebeles from Durame Zuria, happened to be 86,857 out of which 38,014 (43.8%) were males and 48,843 (56.2%) were females on 2015. During the socio-economic study of the town, i.e. 2017 the total population of Durame town stood at 99,886 out of which 43,720 (43.77%) were males and 56,166 (56.23%) were females. The current (the socio-economic study period) ,in 2022 the total population of Durame town is 142,837 out of which is 62,520 males and 80,317 were females



Source: CSA 1994 To 2022 Survey, SNNPRS Finance & Economic Development Bureau 2022

Figure 12 Population Characteristics by Gender

The rapid urbanization in Durame pressure on urban services and facilities has become a serious problem. Road traffics are not matched by adequate improvements in infrastructure and road safety legislation. This exposed to high risk for traffic accident of the urban population (Tulu, 2021)

### 3.1 .4.2 Socio-Economic Aspect

The economic activities in Durame town are diverse. Durame is an economic center for trade and products that are paid for by ways that radiate from it and the necessary transaction involved in this exchange are proved by it. Economically, the town has been serving as a major focal point for trade and small scale industries. The major business sectors in Durame are hotels, trade and industry. The town is pulling migrants, who came following the trade route in search of jobs and livelihood. The town is an important center of distribution of goods. It is still a relay point for goods produced and manufactured in the country and imported from abroad to the small towns and rural areas in the region. As a result, it seems the two primary market places namely “Aroge market area ” and “Adisu market area” are characterized by whole sale trade side by side the retail for the town dwellers (Durame Town Administration, 2022). In a nut shell, Durame is a growing capital and its strategic importance as an intersection point between economically important regions. It has always been full of travelers. Recently, there are a lot of hotels, big and small, restaurants, bars and cafes and the majority of population gets its livelihood from commercial activities and services. There are also factory and office workers whose number is increasing lately.

Trade and Industry, Durame has one industrial zone with adequate site and service, whereas small sized industries have been scattered all over the town. The service sector, on the other

hand, is dominated by hotels followed by bars and restaurant. The main reason for such attraction of private investment is the availability of market, infrastructure, and cheap labor force in the town. The investment opportunities in and around the town are: Manufacturing and storage, Hotels and Tourism, Social Service Provision (Education and Health facilities), Real-estate development and Urban Agriculture (Durame Town Administration, 2021).

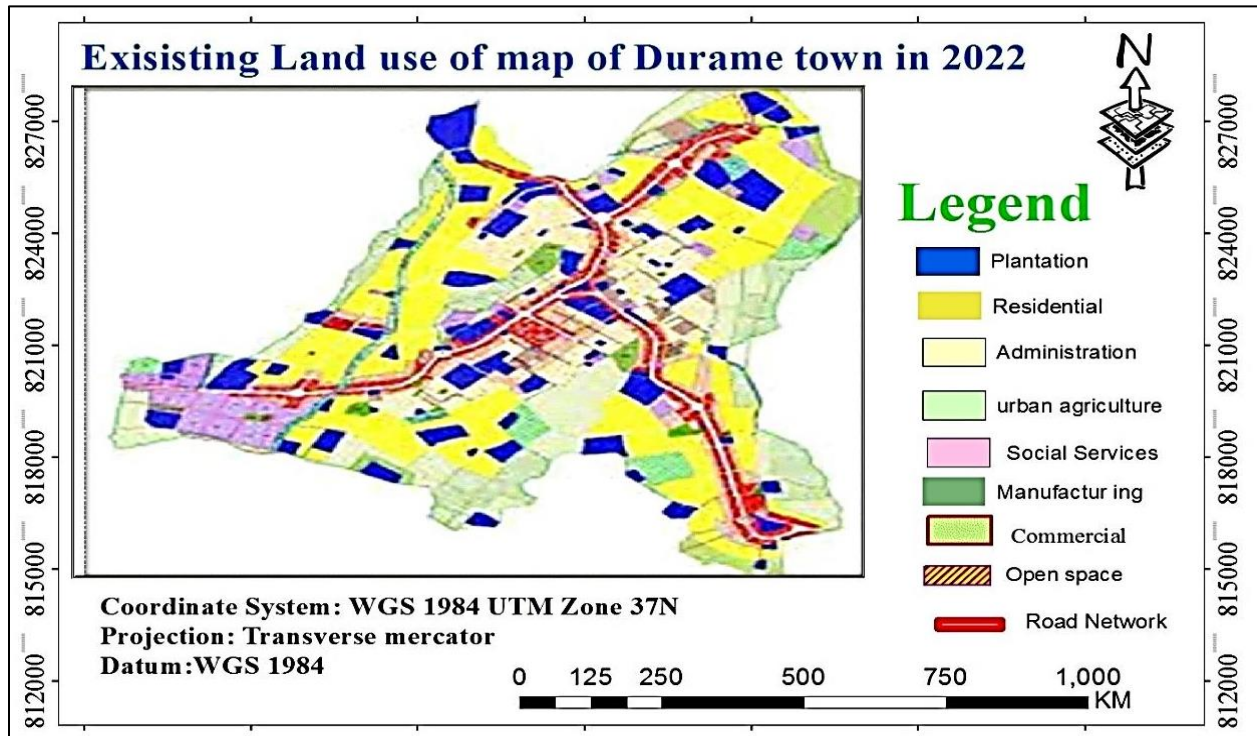
### 3.1.5 Land Use Land Coverage

The study area has different land uses. Its total municipal area is approximately 7502 hectares or 75.02 km<sup>2</sup> (Amare Feleke, 2021).

Table 6 Land use type and Areal Coverage of Durame town

| Land Use Type |                           | Area Covered in km <sup>2</sup> | Land Use Type |                             | Area Covered in km <sup>2</sup> |
|---------------|---------------------------|---------------------------------|---------------|-----------------------------|---------------------------------|
| 1             | Residential               | 27                              | 10            | Cultural and Social welfare | 1.5                             |
| 2             | Open space                | 0.45                            | 11            | Mixed Residential           | 8.5                             |
| 3             | Administration            | 4.8                             | 12            | Infrastructure and Utility  | 0.18                            |
| 4             | urban agriculture         | 7.3                             | 13            | Health                      | 3.3                             |
| 5             | River and riverine        | 0.49                            | 14            | Under Construction          | 0.52                            |
|               | Road Network              | 3.02                            | 15            | Stadium                     | 1.3                             |
| 6             | Manufacturing and Storage | 0.78                            | 16            | Transport terminal          | 1.2                             |
| 7             | Municipal Services        | 2.1                             | 17            | Religious Institution       | 3.1                             |
| 8             | Commercial                | 6.5                             | 18            | Plantation                  | 2.3                             |
| 9             | Special use               | 0.38                            | 19            | Recreation                  | 0.75                            |

Source: Durame town Administration, 2022



Source: Durame town Land Management Office, 2022

Figure 13 Land use Map of Durame town

The land use distribution as identified in table 3.2 and figure 3.2 shows that most of the land use characteristics of Durame town is mixed with residential, commercial, educational and administration areas.

### 3.1.6 Soil

According to DTANRO the major soils of the area include Vertisols or black basaltic soils “locally named as Gambalabucha” and Nitosols (red basaltic) “locally named as Bishabucha” soils. In some parts of the district, alluvial and clay, soils are common. The soil it has high water holding capacity in those parts of the district where the slope is steep, the soil is highly eroded due to high torrential rainfall and the place where lack of drainage accessibility and vegetation cover absence. The shrinking and swelling of Vertisols can also damage buildings and roads leading to extensive subsidence FAO (2006). The roads leading from Durame town to Angacha and Danboya are damaged and in need of repair. This may be the area

covered by Vertisoils as mentioned earlier. A road on Vertisoils requires a deep structure between 2 and 4 meters to minimize damage.

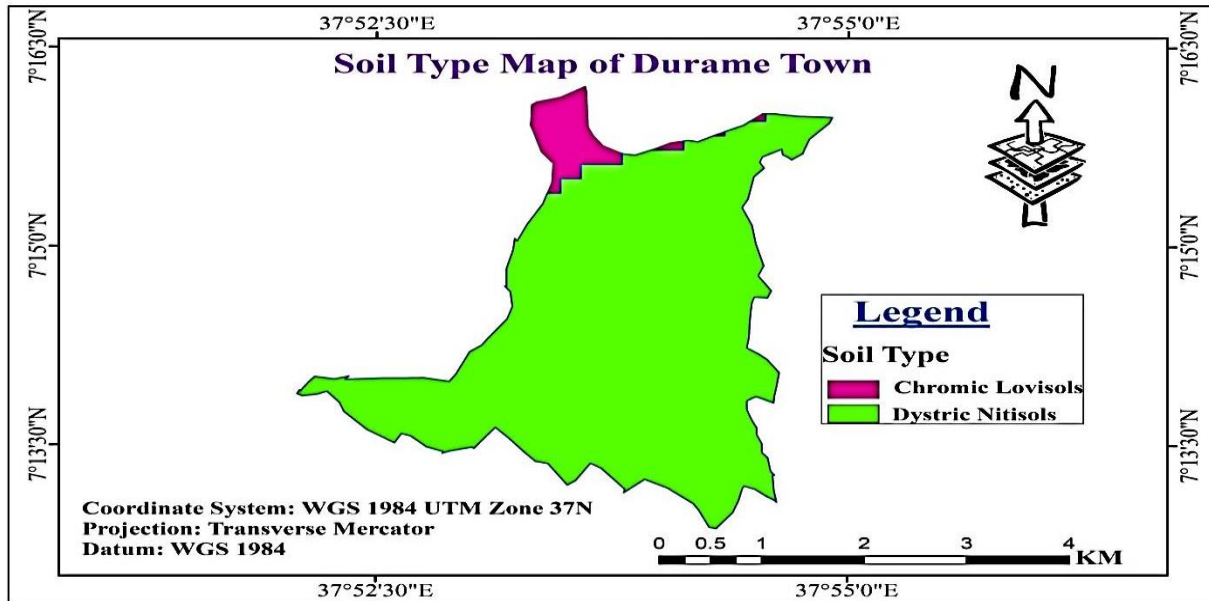


Figure 14 Soil Map of Durame Town

### 3.1.7 Road Network Infrastructure and Transport

Durame Town like many other towns in Ethiopia has the transportation infrastructure that was initially designed for largely non-motorized travel. However, the quality, length and purpose of roads in the Town have shown a significant progress with time. According to DTSPRP Spatial Study Report of 2018; Road Network, Transportation & Utilities accounts about 12% of the general existing land use of the town. DurameTown is a busy transportation center.

#### 3.1.7.1 Classification of Roads

According to the classification of Durame Town planning division and plan project officers, Durame roads are divided into two groups: major arterial roads and minor arterial roads. Main roads are designed in such a way as to ensure the connection of major centers with the city. The minor roads are important and form a link between the main and collector roads. The criteria for roads in the city are local importance, width, and tonnage allowed on the roads.

As shown in Table 7, the city roads are under construction and they spent a lot of money to build the asphalt road. The road infrastructure has deteriorated over the past few years. In my view, in

most parts of the city, asphalt roads, cobblestones, and red ash roads are not wide enough that many vehicles pass by using the edge of the asphalt.

Table 7 Road Types and cost of computation

| Types of Road | Number of Lanes Road for Asphalt | Width in Meter | Total Length of in Km |
|---------------|----------------------------------|----------------|-----------------------|
| Asphalt       | Dual                             | 10-11          | 6.56                  |
|               | Single                           | 11-12          |                       |
| Gravel        |                                  | -              | 3.29                  |
| Red ash       |                                  | -              | 6.97                  |
| Cobble stone  |                                  | -              | 39.77                 |
| Earthen       |                                  | -              | 48.03                 |

Source: Durame Town Municipality, 2022

### 3.1.7.2 Transportation Characteristics

The number of vehicles in the town is increasing from time to time, the same will happen to the congestion and accident size. Today, according to the Durame Transport Agency, the total number of vehicles in the Town is over 3000.

Table 8: Transportation Characteristics in Durame Town.

| Type of vehicle       | Purpose of Vehicle | Numbers and Years |              | Rate of increment in (%) |
|-----------------------|--------------------|-------------------|--------------|--------------------------|
|                       |                    | 2016/2017         | 2020/2021    |                          |
| Automobile            | Private use        | 420               | 625          | 67.2                     |
| Tricycle              | Commercial         | 572               | 765          | 74.8                     |
| Bicycle               | Private use        | Unregistered      | Unregistered |                          |
| Government Vehicles   | Service            | 35                | 78           | 44.9                     |
| Heavy truck           | Construction       | 250               | 375          | 66.7                     |
| Horse cart            | Commercial         | 28                | 51           | 54.9                     |
| Mini -bus(12-26seats) | Commercial         | 45                | 82           | 54.9                     |
| Motor cycle           | Private use        | 761               | 1053         | 72.3                     |
| bus                   | Service            | 184               | 256          | 71.9                     |
| Total                 |                    | 2260              | 3203         | 70.6                     |

Source: Durame town Transport Agency, 2020/21

As shown in Table 8, the number of vehicles in Durame town increased by 2260 or 70.6% in the last 4 years. In particular, the transport of tricycles and motorcycles has increased significantly. Hence, Road accidents are increasing because of a combination of factors such as road deterioration, vehicular congestion, use of footpaths, and speeding of vehicles, especially motorbikes, and tricycles.(U.S. Bureau of Transportation Statistics, 2021)

## **4.2 Materials and Methods**

### **4.2.1 Research Approach**

In order to systematically solve the problems, (mixed) both the qualitative and quantitative research methodology was used in the survey. The qualitative research methodology has helped the writer to explore the behavior and attitudes of the pedestrians and drivers, while the quantitative research methodology has helped to generate the road accident statistics from the traffic police and part from the respondents. Interviews and review of secondary data was making to assess the socio-economic impacts of RTAs black spots in Durame Town. Primary sources of data were collected, especially GPS data was used to create geospatial information using road accident information in the GIS database, and field observation data was also used.

### **3.2.2 Research Design**

The Concurrent Case Study Research Design has been employed to analyze, and map road accident black spots, and to explore the cause and consequences of RTAs in the study area. A concurrent case study is a study that looks at the background of a person or groups of people and uses a concurrent narrative about how they deal with problems. A concurrent case study is a story about a real-world situation facing people or groups and how they addressed it. It includes a concise but thorough account of the facts of the situation and expert commentary to help the audience understand the causes of the problem, the forces behind the solution, the outcomes of implementation, lessons learned, and connections to theories, concepts, policies, and tools relevant to the situation.

The researcher employed a concurrent case study research design because it is suitable for detailed scientific analysis and explanation about different issues RTA, it is useful to capture the best of both qualitative and quantitative data, and it provides the opportunity to investigate many specific details in the selected case and specific geographical area, institutions, organizations or individuals and which generalized all other similar cases in the study area

### **3.2.3 Data Types and Sources**

In order to achieve the objectives of the study. The study was used both primary and secondary data type and collected from both primary and secondary sources. The primary data was

collected from the selected population groups such as key informants, focus group discussion and questionnaire survey members, and observation. The primary data was collected by using GPS instruments for taking x, y and z coordinate of accident location, Google Earth was used to extract road data of the Town, field observation to check road design of accident, interviewed with key informants and focus group discussion to know magnitude of RTAs in Town and to gather solution data. Secondary data was obtained from different RTAs records of Durame Town police office, traffic accident statistics and reports of four years (2016 to 2021) such as: Accident Record (AR), compliant format, annual accident report and different published and unpublished related materials from various organizations such as: Central Statistical Agency, National Meteorological Agency and Durame Town Administration. Different journal articles, books reports, and researches documents etc.

### **3.2.4 Sampling Techniques and Sample Size**

A purposive (judgmental) and random sampling techniques was used for this study. Purposive sampling technique was employed due to the issue of the research (i.e. road traffic accident). This means the study issue needs professional knowledge and awareness about the problem. A purposive (judgmental) sampling technique was employed for the selection of key informant interviews and focus group discussions participants.

The number of key informants usually ranges from 15 to 35 (USAID, 2011.).Based on information, the total key informants, which hold 26 members, was selected by using purposive selecting methods and interviewed in each of them independently. These was 13 police members (5 from Durame Town traffic police department (1 office manager and 4 traffic police officers), 4 from Durame Town traffic accidents investigators),4 from Kambata Tembaro zone traffic police department (1 office manager and 3 traffic police officers), and 4 Transport Authority (3 from Kambata Tembaro zone Transport Authority particularly from road security department(1 office manager and 2 experts ),2 from Durame Town Transport office particularly 1 office manager and 1 experts from safety department), and 2 from town dwellers, 2 from persons who faced the accident (victims), ,from health service experts 4 (2 from Durame hospital,2 from Bogelach hospital),from educational office KTZ 2 ( 1 office manager and 1 experts)

The number of FGDs participants usually ranges from 6 to 12. Based on information one focus group discussion was selected by using purposive selecting methods which contain (10) members. The participants of the focus group discussion was selected from Durame Town prosecution police (1), from traffic police members(2), Durame Town road and construction office(2), from Ethiopian insurance company Durame branch members(1), from Bajaj Association (1), from motor Association(1), Taxi Association(1), and from country Travel bus Association(1) was selected. All the focus groups discussions was hold with the help of guidelines and the same open-ended questions administer for each individual to facilitating the discussion. The questions was focused on socio economic impacts of the RTAs in Durame Town from 2016-2021. All the discussion questioners was translated into Amharic language; the researcher was serve mediator to smooth the progress of the discussion.

Simple random sampling technique was employed to select samples from traffic police members and drivers to conduct questionnaire survey for quantitative data collection and analysis. From the town, from town Pedestrians 50 Pedestrians, police stations traffic police members 30 traffic police and from 200 drivers in the Town 40 drivers was selected for questionnaire survey.

### **3.2.5 Instruments of Data Collection**

The Instruments of Data Collection was through Questionnaire survey, key informants' interviews, focus group discussion, and field observation. so as to get reliable Information the study was tried to make smooth relationship and friendly social chain with the interviewees in the study area. In addition to this, the study was observed RTAs prone location of all Durame Towns to check design of roads, vehicles movements and congestion. Questionnaire survey was used to quantify variables of road traffic accident, and key informant interviews, focus group discussions and observations was used to for collection of the qualitative data.

#### **3.2.5.1. Questionnaire Survey**

Both close-ended and open-ended questions was used to collected information from selected samples of 50 Pedestrians, 30 traffic police officers and 40 drivers. In this survey, participants demographic characteristics, the general trend of RTAs, the major factors of RTAs the impacts of RTAs on health, socioeconomic, and physical environment and the types of measures to be

taken to prevent or reduce RTAs in Durame Towns was collected. Therefore, for effective collection of questionnaire survey data, two enumerators was assigned from Durame Towns road transport and construction office (i.e. road transport supervisors).

### 3.2.5.2 Key Informants' Interviews (KIIs)

The key informants used to collect primary data (i.e. qualitative data) on the existing major causes and consequences of RTAs, and the frequent RTAs places or black spots as well as the types of measures to be taken to prevent or reduce RTAs in the study area. As explained above, 26 key informants were selected for key informant interview. In- depth and face-to-face interviews was employed with intention of getting better information about RTAs in the study area. The researcher conducted interviews in a very suitable environment to allow the informants to feel free and imagine that they are in a natural interaction rather than in a stressful situation. The questions were prepared and translated into the official language (Amharic) and the same open question was presented to the respondents. This approach facilitated quick interviews that could be analyzed more easily.

### 3.2. 5.3 Focus Group Discussion (FGD)

In addition to questionnaire survey, focus group discussion was used to collect qualitative RTAs data because it is important for data generation especially on distributions and frequencies of, major causes and consequences of RTAs and the major places/spots and time of RTAs.

Plate 2 : KIIS & FGD Being Conducted with Different stockholders of Durame Town



### 3.2.5.4 Field Observation

Observation was made as supportive or supplementary technique to collect data that can complement or set in perspective the data obtained by other means. The observation was acted as across check mechanism of primary and secondary data. During the field observation of the study area, the researcher was observed road design, vehicles types and speed, traffic congestion and traffic law enforcement in all study area. The researcher was used checklist during filed observation.

### 3.2.5. 5 Global Positioning System (GPS)

The use of Global Positioning Systems (GPS) is the fastest and most accurate way of obtaining reliable data about road traffic accident places/black spots. Global positioning systems recorder was used as tool for collection of the quantitative data.

### 3.2.6 Material and Tools Description

The lists of materials used for the accomplishment of the study are tabulated as follows in table. Shown below.

Table 9 List of Materials was used for the Study

| A | Data used                                    | Purpose  | Source   |
|---|--|--|--|
| 1 | Topographic Map of Durame Town               | For Extraction of Digital Road Network To know topography and others data classification                 | Ethiopian Geo-spatial Institute                                |
| 2 | Rectified Google Earth Image                 | To update road networks which may not exist on Topographic Map   | Google Earth Explorer  |
| 3 | Land use Land cover data,                    | For land use Land cover classification of Durame Town  | Durame town Land Management Office                             |
| 4 | Geographic Coordinates of Accident Locations | Hotspot Location Identification  | GPS and Digital camera   |
| 5 | 2015 to 2021 RTA data                        | Used as non-spatial data for identification of hotspots location and to determine magnitude of hotspots. | Durame Town Traffic Police Station                             |
| 6 | Transport data                               | To know data contains information about number of vehicle.   | KTZ and Durame Town Road Transport office, KTZ and Durame Town |

|                    |   |  |   |
|--------------------|---|--|---|
|                    |   |  | adminterative town<br>Road Transport Office   |
| 7                  | Road Network<br>Infrastructure Data   | For Identifies Road Type and length      | Durame Town<br>Construction and<br>Design Office and<br>Google Earth  |
| 8                  | climate data  | To know climate condition of Durame Town | National<br>Meteorological<br>Agency  |
| 9                  | Soil type   | For Soil type map                        | FAO   |
| B. Softwares' used |   |  |   |
|                    | Name  | Version                                  | Purpose   |
| 1                  | ArcGIS Desktop<br>SPSS  | 10.8<br>26                               | Database creation Extraction of Road network<br>Overlay Spatial and non-spatial data hotspot analysis<br>To display map showing hotspot locations and magnitude |
| 2                  | Microsoft office word<br>Excel  | 2016                                     | Writing the research<br>Collecting road traffic accident data   |
| 3                  | GPS   | 3.2                                      | To collect X,Y and z coordinate of accident location  |
| C. Equipments used |   |  |   |
| 1                  | Hand Held GPS with High<br>accuracy (ASUS5)<br>Mobile Application<br>Digital camera | AndoiTS<br>GPS .apk                      | Collection of geographic coordinates of accident<br>location/filed survey<br>To take a photographic view of RTAs  |

### 3.2.6.1 Satellite Image

Remote sensing is an effective method for collecting data without direct communication, and it is particularly useful for obtaining information about land uses such as urban areas ,agricultural land, water bodies, , and slopes are obtained by analyzing and interpreting satellite images and maps covering the entire study area at various scales. One satellite images DEM with 30m spatial resolution was used for the, slope and aspect of the study area. Details of the image characteristics are tabulated in Table 10.

Table 10 Source and type of data

| Image     | Path | Row | Resolution | Sources | Application   |
|-----------|------|-----|------------|---------|---------------|
| ASTER DEM | 169  | 55  | 30M        | NASA    | Aspect, slope |

Same parameter was extracted from ArcGIS 10.3 package. All of the data's coordinate systems were combined using the UTM-WGS84 Zone 37 N projection

### **3.2.7 Data Preparation**

To the RTAs sites prone location, GIS program plays a very important role because GIS is computer based system that enable user to collect, store, and process, analyze and present spatial data (David et al., 2009). Before analysis data, all data was prepared in spatial and non-spatial form Recorded file.

Then the accident location was surveyed by GPS to determine latitude, longitude and elevation of accident locations. After GPS surveyed all accident data was Geocoded with its accident locations by using code number and location name/ RTA Spot name/ID, RTA year, x, y and z coord in Excel for spatial analysis. Geocoded RTAs data of Durame Town was exported into ArcGIS10.8 as a point shape file. Vector data (road data of town) was extracted from Google Earth and stored separately. After arrangement of RTAs, data linked to the above-mentioned shape file in to the Arc Map using the joins and relates function. Finally, the GPS data was added to road network of Durame Town with the help of Arc Map10.8, so to know the number of RTAs hotspots in study area within each year.

### **3.2.8 Data Analysis Techniques**

Different types of data was utilized to achieve the objectives in this paper, Then the collected data was passing through different processing, analysis technique to make more consistent, and accurate data interns of quality and interpretability.

Analysis of the data was made in five sections. The first part was tried to analyze the general characteristics of RTAs in Durame Town using the collected RTA incidences of the town in the past six years. The second part was conversed about the spatiotemporal variation and distribution of RTAs across the Durame Town in general and amongst the surrounded area in particular. Spatio-temporal maps of RTA Spots and RTA Black Spots of Durame Town was generated using the spatially referenced known places for RTA incidences out of the total. The third part was discussed about the trend of occurrence of RTAs in the whole town in general and in the

RTA Black Spots in particular. The fourth part was specifies the major causes and the last about socio-economic impacts of RTA in Durame Town the RTA data of Durame Town from 2010 to 2015 was also useto analyze the frequency, trend and socio-economic impact of road crashes comparing to the RTA occurrences in the town between 2016 and 2021

Quantitative research method was employed to analyze the data collected through survey questionnaire by Excel and SPSS and the data collected through GPS analyze by ArcGIS. The qualitative research method was employed by descriptive to analyze the qualitative data (i.e. KII, FGD and observation).Descriptive statistics like crosstabs, frequencies, averages, totals and percentages in the Statistical Package for the Social Sciences (SPSS) version26 software. Accordingly, to this, the data was organized and presented in the form of tables, pie charts, column bar charts and line graphs. The difference and trend in the frequency of RTAs was presented on maps using graduated symbols and bar charts of Spatio–Temporal Assessment of Road Traffic Accident analysis will requires a good and adequate data to assess RTAs. The information gathered from the key informants was analyzed in line with each associated characteristics of RTA of the town. After all above mentioned process have finished, the RTAs black spots ranking processes was undergo depending on(Geurts et al., 203)

### 3.2.9 Prioritization of RTA Black Spots/Hotspots

With the help of a "join" function in ArcGIS, GPS point data was automatically combine with RTAs data such as number of fatalities, serious injuries and minor injuries related to RTAs points located within each site. For this research, ( Geurts and Wets(2003)) ranking schemes was

u Where:  $S=x+3y+5z$  (2)

s= severity

X=total numbers of minor injury within each RTAs hotspots

Y=total number of major injury each RTAs hotspots

Z= total number fatalities within each RTAs hotspots

### **3.2.10 Ethical Consideration**

An ethical concern is one of the most important things in research. It is related mostly with confidentiality as well as with efforts to assurance and to reduce possible risks and dangers for the participants in the time of field work and interview respondents. All the study participants was informed about the purpose of the study and finally their permission was obtained before the actual data collection process started. The researcher also was tried to make the respondents at ease when they feel stress and did not want to answer questions by omit the question for later time consumption, these stances played a significant role to the development of trustful relationships and to the collection of rich and meaningful data from the field. Above all, researcher was made an attempt to develop a sense of trust and gain the genuine permission of all of the participants of the study including confidentiality of their information, the information provided by each respondent was kept confidential in order to safeguard them from differ

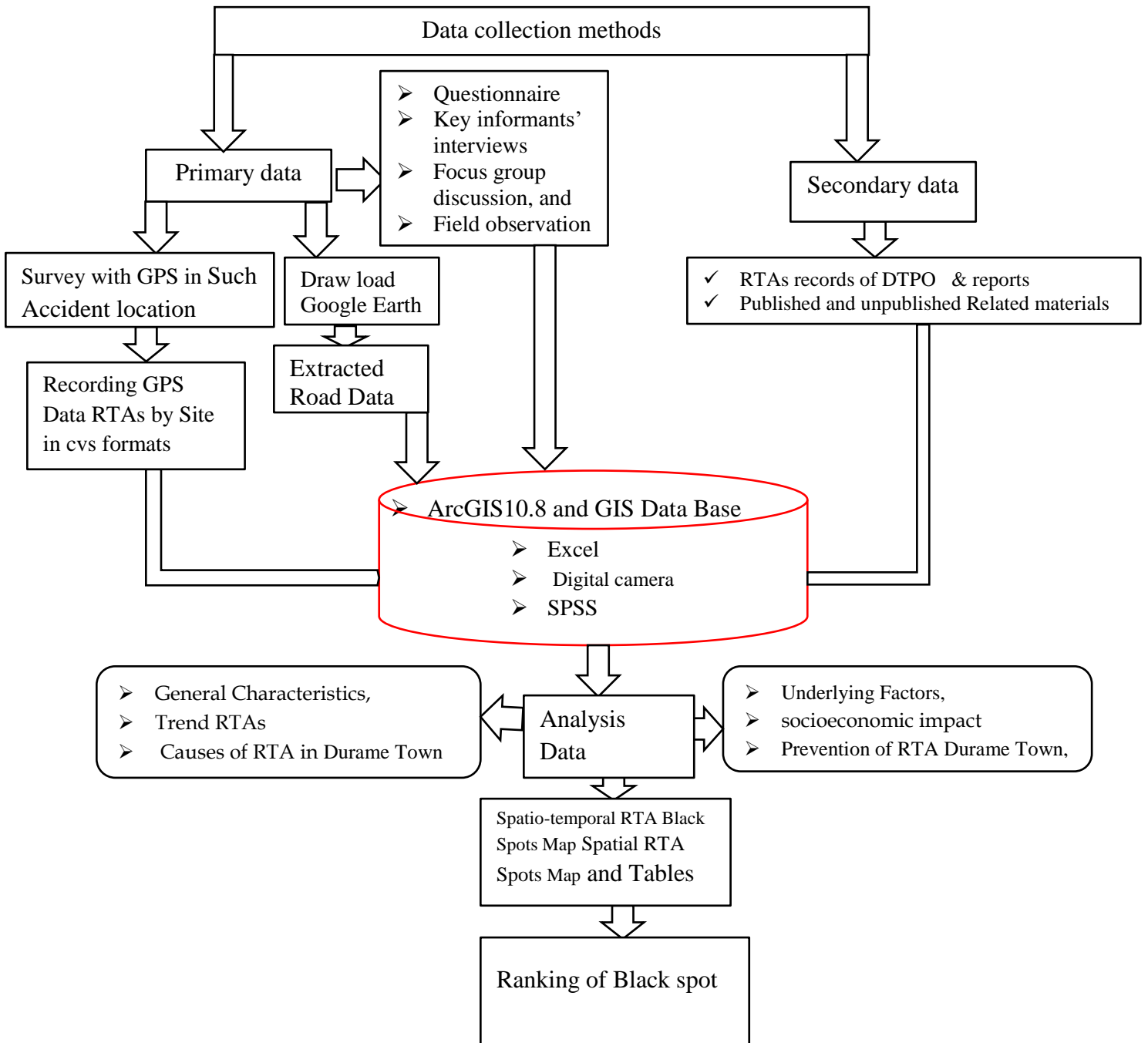


Figure 15 Data Collection and Analysis Method

## **CHAPTER FOUR**

### **4. Result and Discussion**

#### **4.1 Introduction**

This chapter presents the empirical finding of this study and it incorporates statistical and spatial analysis (presented in tables, figures, and maps). For this study, 52 fatal, 88 Serious injuries, 93 Slight injury, 109 property case road traffic accidents were collected and included in the database from the year 2016 to 2021 in the Durame Town. The data collected through focus group discussions, key informant interviews, questionnaire survey, observations, and secondary data derived from Durame town administration police to show the trends of RTAs from 2016 – 2021. In this chapter, analysis is made on the general trend of RTAs, the major factors of RTAs, the impacts of RTAs on health, socioeconomic, and physical environment. The chapter also attempts to display maps of frequent RTAs places or black spots in Durame town. Moreover, the types of measures to be taken to prevent or reduce RTAs in Durame town administration are discussed.

#### **4.2 Background of Respondents**

As shown in Table 11 the background of the research participants shows that respondents (50%) were male and 50% female. The age distribution of the research participants, 18-25 years, 26-35 years and 36-45 years accounted for 36 (23.08%), 68 (43.6%) and 52 (33.3%) respectively and the majority of respondents were between 26 and 35 years.

Table 11: Background of Respondents

| Research Respondents | Respondents background |        |             |             |             |                |         |                   |           |       |                |             |           |
|----------------------|------------------------|--------|-------------|-------------|-------------|----------------|---------|-------------------|-----------|-------|----------------|-------------|-----------|
|                      | Sex                    |        | Age         |             |             | Marital status |         | Educational level |           |       | Job experience |             |           |
|                      | Male                   | Female | 18-25 years | 26-35 years | 36-45 years | Single         | Married | 1-10              | 10+1-10+2 | >10+2 | 4-9 years      | 10-20 years | >20 years |
| Questionnaire        | 120                    | Male   | 15          | 25          | 20          | 15             | 45      | 36                | 32        | 20    | 18             | 35          | 7         |
|                      |                        | Female | 15          | 25          | 20          | 15             | 45      | 18                | 32        | 20    | 18             | 35          | 7         |
| KIIs                 | 26                     | Male   | 2           | 7           | 4           | 4              | 9       | 2                 | 7         | 4     | 3              | 6           | 4         |
|                      |                        | Female | 2           | 7           | 4           | 4              | 9       | 2                 | 7         | 4     | 3              | 6           | 4         |
| FGDs                 | 10                     | Male   | 1           | 2           | 2           | 1              | 4       | 1                 | 1         | 3     | 1              | 2           | 2         |
|                      |                        | Female | 1           | 2           | 2           | 1              | 4       | 1                 | 1         | 3     | 1              | 2           | 2         |
| Total                | 156                    |        | 36          | 68          | 52          | 40             | 116     | 41                | 80        | 35    | 45             | 86          | 26        |

Source: Computed by the Author, 2022

The marital status of the research participants reveals that, single and married accounted for 40 (25.6%) and 116 (74.4) respectively and the majority of participants were married. The educational level of the research participants indicates that, 1 to 10, 10+1 to 10+2 and above 10+2 accounted for 41(26.3%), 80(51.3%) and 35 (22.4%) respectively and 10+1 to 10+2 educational level respondents were the majority participants of the research. The job experience of the research participants points out that, 4-9 years, 10 to 20 years and more than 20 years accounted for 45 (28.8%), 86 (55.1%) and 26(16.7%) respectively and therefore, the majority respondents were between 10 and 20 years job experience. This is provided more information concerning the RTAs based on their experiences and perceptions for this study.

#### **4.3 Trend of Road Traffic Accident in Durame Town**

The distributions and frequencies of RTAs have shown dangerous trend and it claims the largest toll of human life, injuries, and properties and tends to be the most serious problem in the study period. In all interviews participants said that RTAs is a serious problem. During interview, one police member justified the distributions and frequencies of RTAs based on his experiences and perceptions and said that the distributions and frequencies of RTAs have shown dangerous trend regarding to accident severity i.e. fatal accident, serious injury, slight injury and property damage; from year to year, therefore, RTAs is a serious problem in Durame Town. The victims of RTAs describe that not only the distributions and frequencies of RTAs but also the health, socioeconomic and physical environment impacts of RTAs have shown stern trend from year to year in Durame Town and therefore, RTAs is a serious problem. The offenders of RTAs pointed out that the situation has been worsened as the number of vehicles has increased and consequently there is increased traffic flow and conflicts between vehicles and pedestrians.. Every year many lives are lost and much property is destroyed due to RTAs and therefore, RTAs is a serious problem in Durame town.

In FGDs with Ethiopian insurance company Durame branch, members provided more information concerning the economic impacts of RTAs based on their experiences and perceptions. They said that the economic impacts of RTAs are more serious in Durame Town.

RTAs are currently deteriorating the economic wealth of the town regarding to the direct economic costs and the cost of road crash injuries, and therefore, it is a serious problem. The other FGD participant from traffic police members pointed out that the distributions and frequencies of RTAs as well as the health, socioeconomic and physical environment impacts of RTAs have shown an alarming trend from year to year.

During discussions one participant from Durame Town road transport office member justified that RTAs put its impacts on the social aspects of the livelihood. Mortality due to road traffic injury occurs among young adults and productive aged and the rates for this age group are higher. According to the observations of the researcher, the findings from KIIs and FGDs participants and questionnaire survey not only the distributions and frequencies of RTAs but also the health, socioeconomic and physical environment impacts of RTAs have shown extremely bad trend from year to year in Durame Town. As shown the data from questionnaire survey show that all respondents (100%) agreed that RTAs a problem in the study area. In all questionnaire survey, respondents answered the same as KIIs and FGDs participants that RTAs is the main a problem in Durame town. The secondary data derived from Durame Town police to show the trends of RTAs from 2016 – 2021 and accident investigation record reviews prove that RTAs is a serious problem in Durame town.

Generally, the findings based on primary and secondary data justify that the distributions and frequencies of RTAs as well as the health, socioeconomic and physical environment impacts of RTAs have shown more severe trend in the study period and therefore, RTAs is a serious problem in study area.

The police member key informant provided more information concerning the problems of road safety remain unresolved despite efforts made to reduce through appropriate road designing methods and legal enactment. Consequently, RTAs are claiming the lives of people and cause destruction of property and leading to social and economic crises. It was added by another respondent (offenders of RTA key informant) point out RTAs can be said to be an unplanned occurrence of auto crash and have shown dangerous trend in Durame Town. The police member key informant notable that the distributions and frequencies of RTAs have shown more severe

trend regarding to accident severity i.e. fatal accident, serious injury, slight injury and property accident (damage) from year to year in Durame Town. It was added by another respondent (offender of RTA key informant) that RTAs can be said to be an unexpected occurrence of auto crash and have shown dangerous trend in Durame Town.

All FGDs participants agree and point out the distributions and frequencies of RTAs have shown extremely harsh trend in the study area. The impact of RTAs over the socioeconomic aspects and the magnitude of the RTAs problem of Durame are even much worse. Generally, all FGDs participants agreed and concluded the discussion by saying “Durame town contributes much to the misery of RTAs in SNNPR as well as in Ethiopia.

Table 12: Distribution of RTAs in Durame town.

| In your experience, the distribution of RTAs | Respondents |      |                |    |        |      |       |     |
|--|-------------|------|----------------|----|--------|------|-------|-----|
|  | Pedestrians |      | Traffic police |    | Driver |      | Total |     |
|  | Count       | %    | Count          | %  | Count  | %    | Count | %   |
| More severe                                  | 50          | 41.7 | 30             | 25 | 40     | 33.3 | 120   | 100 |
| Severe                                       | -           | -    | -              | -  | -      | -    | -     | -   |
| Less severe                                  | -           | -    | -              | -  | -      | -    | -     | -   |

Source: Field survey Computed by the Author, 2022

As shown in Table 12, the data from questionnaire survey show that all respondents (100%) agreed that the distribution of RTAs have shown more severe trend in the study period.

As shown in figure 23, more than 496 RTA occurrences have been recorded on the roads of Durame town from 2010 to 2021. According to DTPTO (2015), the first six years from 2010 to 2015 show only 154 road crashes in the town. However, according to our findings, the years from 2016 to 2021 revealed the incidence of 342 road crashes. This means the occurrence of RTAs in Durame town in the last six years from 2016 to 2021 is 2.22 times much higher than the RTAs occurred in the first six years from 2010 to 2015. The RTA incidences of the town have shown an increasing trend in the last decade except in 2013, 2015, 2018 and 2020 because in this year’s strong Traffic Law and Legislation Enforcement. At an average, about 25.7 RTAs have happened every year in the town between 2010 and 2015 but the occurrence of RTAs have increased to an average of 57 incidences per year from 2016 to 2021. The regular growth the

numbers of vehicle and number human population in the town contributed much to the increasing trend of RTA frequency in Durame town mainly from the year 2016 to 2021.

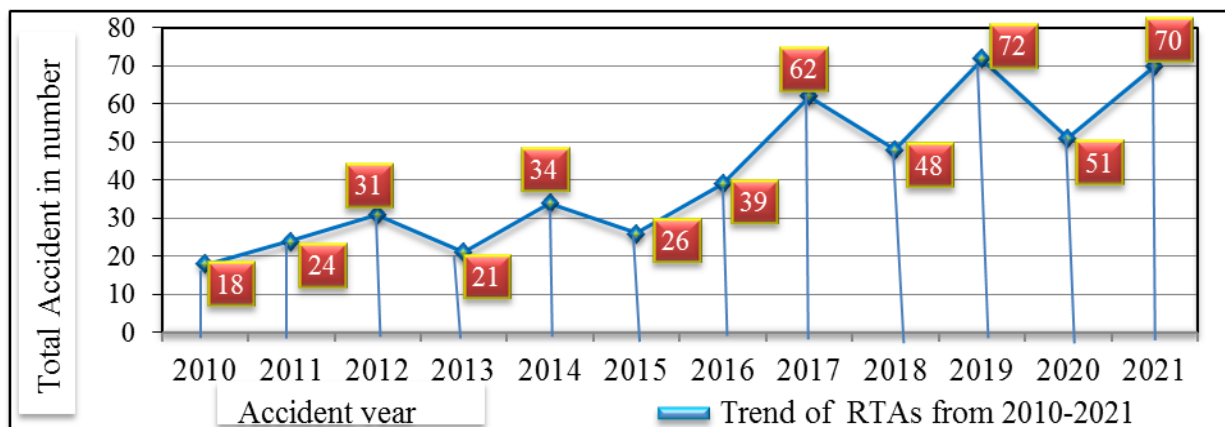


Figure 16 Trend of RTA Occurrences in Durame town (2010-2022)

Source: Compiled from DTPTO RTAs data (2015) and DTPTO RTAs data (2022).

The study shows that the RTAs trend has increased from 18 accidents in 2010 to 70 accidents in 2021. Over all, accidents have increased from year to year.

Table 13: Distribution of RTAs trends in Durame Town (2016– 2021)

| Types of Accident        | Accident year |           |           |           |           |           | Total      | %          |
|--------------------------|---------------|-----------|-----------|-----------|-----------|-----------|------------|------------|
|                          | 2016          | 2017      | 2018      | 2019      | 2020      | 2021      |            |            |
| Fatal accidents          | 7             | 10        | 8         | 6         | 6         | 15        | 52         | 15.2       |
| Serious injury accidents | 8             | 13        | 12        | 25        | 22        | 8         | 88         | 25.73      |
| Slight injury accidents  | 11            | 18        | 11        | 20        | 14        | 19        | 93         | 27.2       |
| Property accidents       | 13            | 21        | 17        | 21        | 9         | 28        | 109        | 31.87      |
| <b>Total</b>             | <b>39</b>     | <b>62</b> | <b>48</b> | <b>72</b> | <b>51</b> | <b>70</b> | <b>342</b> | <b>100</b> |

Source: Computed from Data obtained from DTP by the Author, 2022

As indicated in Table 13 that, the available police accident statistics show that from the total RTAs, fatal accidents, serious injury accidents, slight injury accidents and property accidents accounted for 52 (15.2%), 88 (25.73%), 93 (27.2%) and 109(31.87%), respectively. Based on the available police accident statistics and police accident investigation record reviews, the distributions of RTAs have shown more severe trend in the study area.

#### 4.4 Spatio-Temporal Variation and Distributions of Road Traffic Accidents (RTAs)

##### 4.4.1 Hourly Temporal Variation of Road Traffic Accidents (RTA) In Durame Town.

The occurrences of RTAs vary within 24 hours of the day due to various factors such as light availability, traffic congestion, and pedestrian traffic that vary over the course of 24 hours. According to the responses of key informants, the distributions and frequencies of RTAs are more frequent in the evening time (i.e. 6pm-12pm). The main reasons for these are higher traffic movement in the evening, the absence of traffic police (they go back to their home in the evening time), some of the pedestrians as well as drivers are too drunk, and drivers deriving beyond speed.

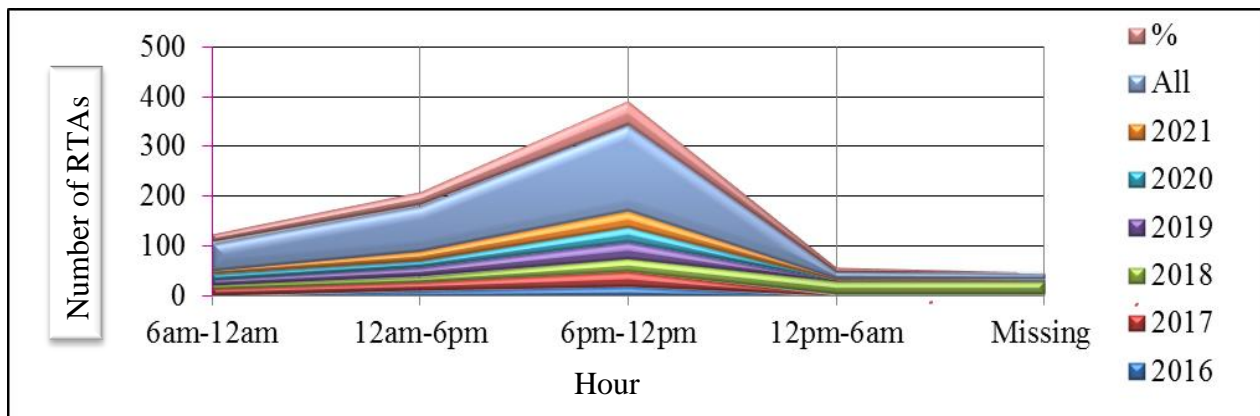
In addition, the police member key informant provided more information concerning the time of the accident based on his experience and perception and said that in addition to the evening time the RTAs are more frequent in the daytime (12 am -6 pm) in Durame Town. According to his justification, the reason is due to a higher traffic movement and road users for different purposes such as marketing, transportation, conference, and recreational activities. Similarly, it was added by other participants (victims and offenders of RTA) that RTAs are more frequent in the daytime (i.e.12am-6 am) in Durame town. On the other hand, All FGDs participants agreed that RTAs are more frequent in the evening time from 12 pm-6 pm and day time from 6 am-12 pm local time) because of higher traffic movement and road users. According to the observation of the author of this research, the findings from the majority KIIs and all FGDs participant RTAs are more frequent in the evening time from 6pm-12pm and at day time 12am-6pm

Table 14: Distribution of RTA in Durame Town within 24 hours

| In your experience, when in the town of Durame does RTA most often occur in a 24-hour period? |          | Respondents |      |                |      |        |      |       |      |
|---|----------|-------------|------|----------------|------|--------|------|-------|------|
|   |          | Pedestrians |      | Traffic police |      | Driver |      | Total |      |
|   |          | Count       | %    | Count          | %    | Count  | %    | Count | %    |
| Day time  | 6am-12am | 7           | 5.8  | 4              | 3.3  | 5      | 4.2  | 16    | 13.3 |
|   | 12am-6pm | 18          | 15   | 12             | 10   | 14     | 11.7 | 44    | 36.7 |
| Evening time  | 6pm-12pm | 23          | 19.2 | 14             | 11.7 | 18     | 15   | 55    | 45.8 |
|   | 12pm-6am | 2           | 1.7  | -              | -    | 3      | 2.5  | 5     | 4.2  |
| Total   |          | 50          | 41.7 | 30             | 25   | 40     | 33.3 | 120   | 100  |

Source: Field survey Computed by the Author, 2022

Furthermore, available police accident statistics show that the highest numbers of RTAs in the study area's road network occur during the nighttime.



Source: Compiled from Durame Town Traffic Police Commission RTAs data (2016-2021)

Figure 17 Temporal variation road traffic accident (RTA) in Durame Town

As Figure 17 shows, the peak time for RTAs in Durame town is 6 pm-12 pm or 12 LT-6 LT (evening), which is shared by 171 (50%) of the 342 RTAs. This is mainly due to two factors; the first is during this time many commuters (urban and rural residents) return home, shopping activities along the main roads are held, and in various areas of the town ritual conferences and recreational activities are held. Due to this, congestion of vehicles and pedestrians results in the town and it caused traffic accidents.

The second reason is that most of the inspectors and traffic policemen go to their homes at night and drivers use this gap to violate the traffic rules, causing traffic accidents. On the other hand, the second peak hour from 12 am - 6 pm or 6 LT-12 LT (afternoon) shares 91 (26.6%) because it is a day, and human movement is high for business and other purposes. Durame town has relatively low RTAs (54 (15.8%) between 6 am-12 am or 12 LT-6 LT (morning) since there is low congestion. Similarly, the lowest number of accidents 14(4.1%) occurred between 12:00 - 6 am and 6 LT-12 LT (after midnight). Because during this period, there is almost no movement of people or vehicles in the town.

#### 4.4.2 Weekly Temporal Variation Of RTA in Durame Town

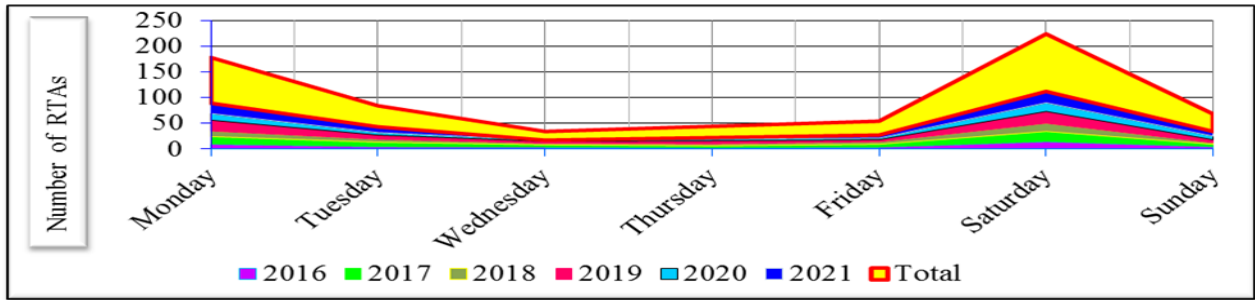
The weekly temporal variation of RTA is the variation in the number of accidents during the seven days of the week. Accordingly, in Durame Town RTAs are more frequent on Saturdays. Based on their experience and perspective, the interviewees and FGDs participants confirmed that Saturday is the most dangerous day of the week in Durame town because it is the trading day, so many rural residents, city dwellers, and businessmen go to the market to sell and purchase goods and services and this creates congestion of vehicles and pedestrians that caused traffic accidents.

Table 15: Distribution of RTA by days of week in Durame Town

| In your experience, the distribution of RTA more frequent on | Respondents |      |                |      |        |      |       |       |
|--|-------------|------|----------------|------|--------|------|-------|-------|
|  | Pedestrians |      | Traffic police |      | Driver |      | Total |       |
|  | Count       | %    | Count          | %    | Count  | %    | Count | %     |
| Monday   | 12          | 10   | 5              | 4.2  | 7      | 5.8  | 24    | 20    |
| Tuesday  | 5           | 4.2  | 2              | 1.7  | 3      | 2.5  | 5     | 8.4   |
| Wednesday  | 3           | 2.5  | 1              | 0.83 | -      | -    | 4     | 3.3   |
| Thursday   | 2           | 1.7  | 3              | 2.5  | -      | -    | 5     | 4.2   |
| Friday   | 4           | 3.3  | -              | -    | -      | -    | 4     | 3.3   |
| Saturday   | 22          | 18.3 | 17             | 15   | 28     | 23.3 | 67    | 55.81 |
| Sunday   | 2           | 1.7  | 2              | 1.7  | 2      | 1.7  | 6     | 5     |
| Total  | 50          | 41.7 | 30             | 25   | 40     | 33.3 | 120   | 100   |

Source: Field survey Computed by the Author, 2022

As the results of the questionnaire survey confirm in Table 15, RTAs occur mostly on Saturdays followed by Mondays, with 67 (55.81%) and 24(20%) responses respectively. As it is the beginning of the working day, Monday is ranked second as many government employees, students, non-government employees, private workers, and drivers go to their workplaces to perform their duties, indirectly causing congestion which is responsible for the RTAs in the town.

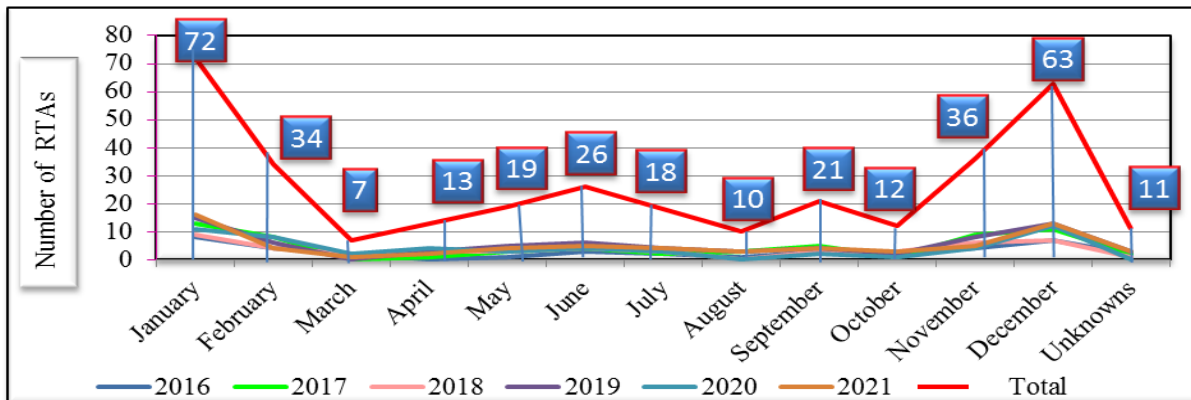


Source: Compiled from Durame Town Traffic Police Commission RTAs data (2016-2021).

In general, as the available police accident statistics shown in Figure 18 that RTA indicates highest rates of RTAs occurred on Saturday accounted 112(32.75%) and Monday 89(26%).

#### 4.4.3 Monthly Temporal Variation Of RTAs in Durame Town

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



Source: Compiled from Durame town Traffic Office (2022)

Figure 18 Temporal Variation of RTAs in a Year by Month in Durame Town (2016-2021).

Figure 18 suggests that there is considerable variation in the incidence of RTAs across months in Durame town. Comparatively, January and December recorded the highest RTA in the town from 2016 to 2021 with 72 (21%) and 63 (18.4%) of the total crashes respectively. This can be mainly influenced by Human related factors (Durame town the highest trading activity take place in January and December) and issues related to congestion of Vehicles and pedestrians (due to supply cache crop such as ziigible and others) ,driving improperly distance & overtaking from wrong side, drivers not respecting pedestrian priority, over speeding, drivers not respecting

vehicle priority and misuse of the scarce footways by service giving enterprises such as Garages, Wood and Metal works, Groceries, Restaurants, street peddlers or hawkers. In addition this aggregate of, Road and weather related issue such as road damage (due to of heavy rains and lack of protection).

#### 4.5 Determinant (Underlying causes) for Road Traffic Accident in Durame town

There are several reasons why even one traffic accident occurs on all the roads in the world. According to Mekonen,(2016), the main causes of RTAs in Ethiopian cities are driver factors, vehicle factors, and road condition factors. The common and frequent causes of RTAs in Durame town are also similar to the above. Based on the responses of respondents of this study the main reasons for RTAs were prioritized as follows: driver related factors, road related factors, vehicle related factors, and weather condition related factors. The town's road traffic accident statistics for the period 2016-2021 also revealed that the above-mentioned factors are the main causes of RTA. The analysis below describes the main reasons for RTAs in Durame town.

Table 16: Underlying factors for road traffic accident in Durame town

| If you have ranked as the first responsible factors of RTAs | Respondents |      |                |      |        |      |       |      |
|---|-------------|------|----------------|------|--------|------|-------|------|
|   | Pedestrians |      | Traffic police |      | Driver |      | Total |      |
|   | Count       | %    | Count          | %    | Count  | %    | Count | %    |
| Human related factors                                       | 15          | 12.5 | 20             | 16.7 | 20     | 16.7 | 55    | 45.8 |
| Road related factors  | 30          | 25   | 10             | 8.3  | 10     | 8.3  | 50    | 41.7 |
| Vehicle related factors                                     | 3           | 2.5  | -              | -    | 5      | 4.2  | 8     | 6.7  |
| Weather condition related factors                           | 2           | 1.7  | -              | -    | 5      | 4.2  | 7     | 5.8  |
| Total   | 50          | 41.7 | 30             | 25   | 40     | 33.3 | 120   | 100  |

Source: Field survey Computed by the Author, 2022

As the results of the questionnaire survey show in Table 16, out of the total responses about RTAs, drivers, road conditions, vehicle, weather condition related factors share 55(45.8%), 50(41.7%), 8(6.7%), and 7(5.8%) respectively. The victim of RTA and key informants also said that currently in Durame town the most shocking fatal accidents, serious injury, and property accidents of road crashes occur by fault of drivers. Therefore, driver-related factors are the leading cause of RTAs in Durame town. According to FGD and, KIIs participants driver-related factors include; driving at an inappropriate distance and passing from the wrong direction, not

giving priority to pedestrians, speeding, not respecting vehicle priority, poor driving skills, unethical behavior, lack of experience, driving without knowing the car, not taking proper protection, illegal driving license, and negligence are the main reasons. On the other hand, the second factor, road-related actors, are damaged roads (road potholes or damage), illegal road construction, major defects in the road network, lack of maintenance, and lack of road safety planning and management. Vehicle factors are technical condition on the vehicle itself that is brake failure, flat tires or tires blowing out, poor vehicle conditions, and poor maintenance of vehicles.

Table 17: Underlying factors for RTAs in Durame town (2016 – 2021)

| Underlying factors for RTA        | Accident year |      |      |      |      |      | Total | (%)   |
|-----------------------------------|---------------|------|------|------|------|------|-------|-------|
|                                   | 2016          | 2017 | 2018 | 2019 | 2020 | 2021 |       |       |
| Human related factors             | 23            | 31   | 25   | 38   | 21   | 31   | 169   | 49.4  |
| Road related factors              | 7             | 13   | 10   | 16   | 9    | 16   | 71    | 20.76 |
| Vehicle related factors           | 5             | 11   | 8    | 11   | 13   | 12   | 60    | 17.54 |
| Weather condition related factors | 4             | 7    | 5    | 7    | 8    | 11   | 42    | 12.3  |
| Total                             | 39            | 62   | 48   | 72   | 51   | 70   | 342   | 100   |

Source: Computed from Data obtained from DTPO by the Author, 2022

As shown in Table 17, the current police accident statistics indicate that the total causes of RTA, driver-related conditions, road-related conditions, vehicle-related conditions, and weather conditions are 169 (49.4%), 71(20.76) %, 60 (17.54 %) and 42 (12.3%) respectively.

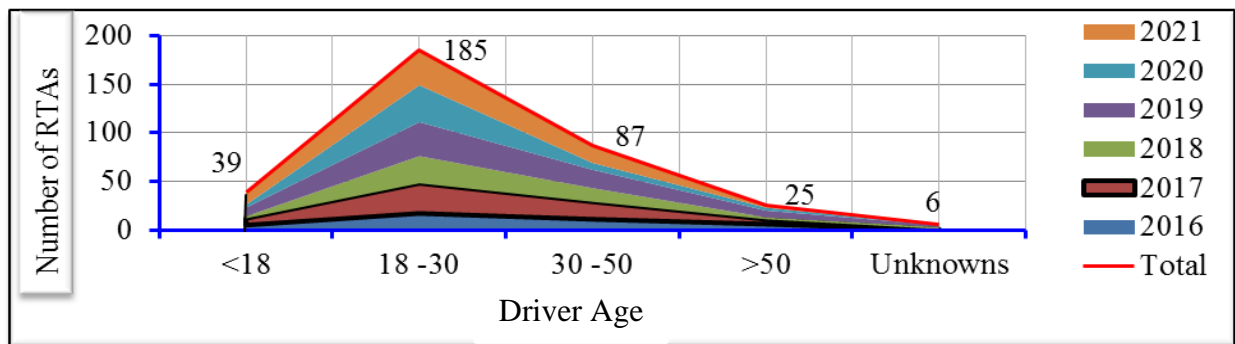
#### **4 .5.1 Human (Driver) Related Factors**

Driver factors are depend on the individuals unique characteristics like age, sex, education and training level, as well as the living environment has an impact on the occurrence of RTAs.

##### **4.5.1.1 Drivers Age and RTAs**

Several studies have witnessed that the age of drivers have a greater impact over the occurrence of RTA scenes. This is due to the fact that, the age of drivers affects their driving behavior, concentration, sense of responsibility and patience. The traffic Police data of Durame town

showed that, Drivers among the ages of 18 and 30 are more frequently involved in road crashes than drivers in the other age groups (fig 20). Drivers aged 18 to 30 contribute 185 (54.1%) of all the RTA crashes in the study period followed by age groups between 31 and 50 which contributes 87 (25.43%) to the sadness. Driver age group above 50 years contributes only 25 (7.31%) road crashes in Durame during the study period. The underage car drivers/riders contribute for 39 (11.4%) of total crashes during the study period. Drivers found in the age group between 18 and 30 (young drivers) in the town are 2.13 times more frequently involved in RTAs than drivers aged 31 to 50 in Durame town. Similarly; a study conducted by (Aychew, 2020) indicated that the magnitude of drivers' sufferers in RTAs reached maximum levels between 18-30 years. In addition to this, a study on drivers killed in road crashes estimated that young drivers are five times prone to the risk of crash accidents compared to the drivers aged above 30. This is mainly due to the fact that many exhibit behaviors, attitudes, lack of skill and have low driving experience can place young drivers in more hazardous situations than other road users. Aged drivers are more careful about traffic safety than youth below 50 years old. It is possible that aged drivers have more experience and probably much more responsibility than youths. In addition, it is also possible to say that youth behaviors towards traffic safety are poor due to peer groups' suggestions and influence on driving style.



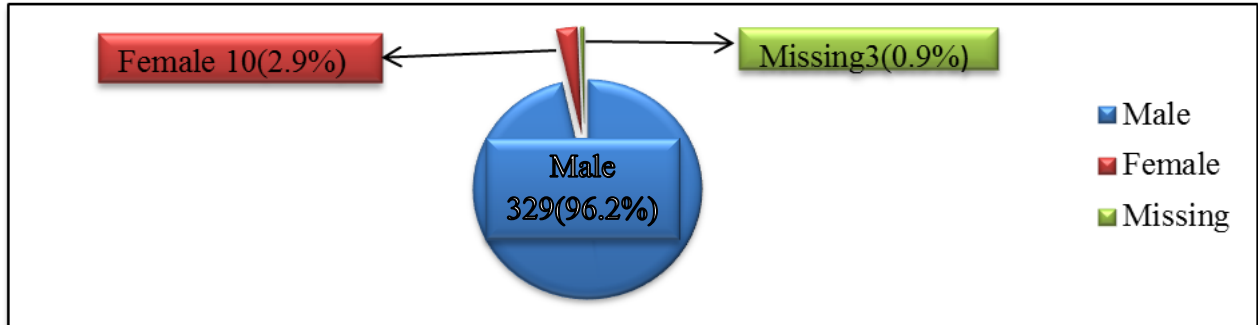
Source: Compiled from Durame Town Traffic Police Commission RTAs data (2016-2021)

Figure 19 Driver age and RTA

#### 4.5.1.2 Driver Gender and RTAs Condition

Even though there are a higher proportion of male drivers than female drivers, male drivers are involved more in RTAs in Durame town as 96.2% of all traffic accidents are registered by male

drivers. This is because most time males may participate in drinking alcohol and other drugs or substance. In a very similar result Aychew.R. (2020) has concluded that male drivers are the main contributors to RTAs more than females in Yeka Sub-city, Addis Ababa.



Source: Compiled from Durame Town Traffic Police Commission RTAs data (2016-2021).

Figure 20 Drivers sex and their contribution to RTA in Durame Town (2016-2021)

#### 4.5.1.3 Drivers' Educational Levels and RTAs Condition

Education is a basic necessity for drivers to easily understand what is to be trained. The driver's educational levels are a fundamental factor in the occurrence of RTAs. The Traffic Police data of Durame town showed that educational level also makes a great variation in the occurrences of RTAs. Accident data reveals that as educational level increases, the level of accidents decreases. This is illustrated in Table 18; drivers who completed elementary school and junior high school were more repeatedly involved in RTAs than those who completed high school and above educational level. For instance, drivers who completed elementary school and junior high school were the most vulnerable to RTAs which contain 139 (22.8%) and 78 (22.8%) respectively. While high school and above high school education level drivers contributed 44(12.9%) and 11(3.2% RTAs respectively. Thus, we can conclude that the more educated drivers have fewer records while the less educated have more participation in RTAs.

Table 18: RTAs data by Drivers' educational levels

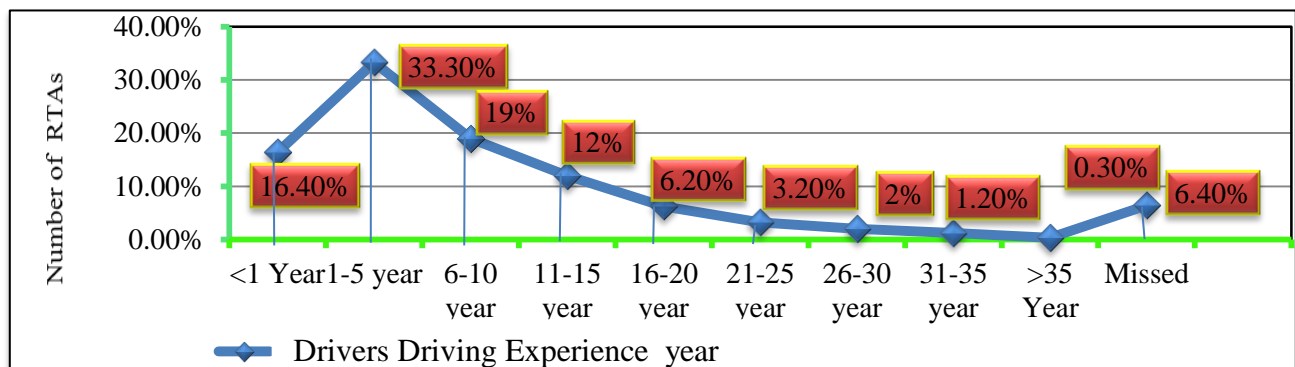
| Educational level | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | Total | %    |
|-------------------|------|------|------|------|------|------|-------|------|
| Non Educated      | 0    | 0    | 0    | 0    | 0    | 0    | 0     | 0    |
| Adult Education   | 5    | 10   | 6    | 9    | 7    | 11   | 48    | 14   |
| Elementary school | 15   | 23   | 19   | 31   | 22   | 29   | 139   | 40.7 |

|                    |    |    |    |    |    |    |     |      |
|--------------------|----|----|----|----|----|----|-----|------|
| Junior high school | 7  | 11 | 14 | 16 | 13 | 17 | 78  | 22.8 |
| High school        | 4  | 7  | 8  | 9  | 6  | 10 | 44  | 12.9 |
| Above high school  | 2  | 3  | 1  | 3  | 0  | 2  | 11  | 3.2  |
| Unknown            | 6  | 8  | 0  | 4  | 3  | 1  | 22  | 6.4  |
| Total              | 39 | 62 | 48 | 72 | 51 | 70 | 342 | 100  |

Source: Compiled from Durame Town Traffic Police Commission RTAs data (2016-2021).

#### 4.5.1.4 Drivers Driving Experience and RTAs

Driving experience increases the driver’s skills because they learn from different mistakes and built practical knowledge. It is to understood that the experience of drivers play a leading role in



road crashes.

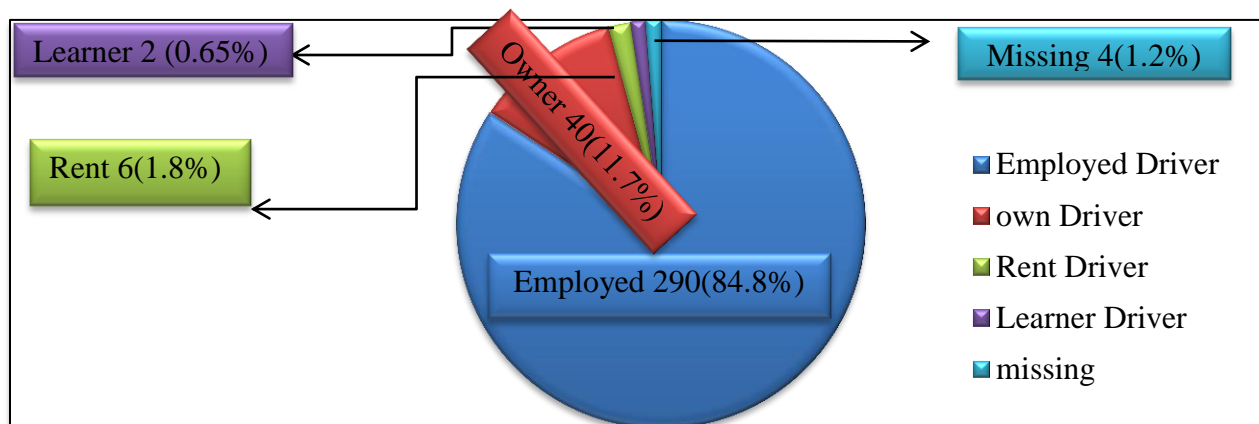
Source: Computed from Durame town Traffic Police Commission RTAs data (2016-2021)

It is clear that experience makes man perfect. Fig 21 explains 114 (33.3%) RTA incidences have been showed by drivers whose driving experience is between 1 to 5 years. The drivers with driving experience between 6 and 10 years have caused 65 (19%) road accidents in the study period. In addition to this, with the rejection of the drivers in their first year experience, the result shows that the frequencies of RTA happenings decrease with increasing in driving experience in

Figure 21 summarizes the change in RTA incidences in relation to driving experience in (2016-2021) Durame town. Drivers with an experience of 1 to 5 years cause 1.75 times more road accident than drivers with driving experience between 6 and 10 years from 2016-2017. Lesser driving experiences might be one of the main causes for the accident in Durame town.

#### 4.5.1.5 Vehicles Driver Relationship

Vehicle driver relationship defines the property/ownership conditions of the vehicles. In this study, there are five main vehicle-driver relations. These are owner-driver, chauffeur, member of the family, rent /borrowed (from friends), and unknown. The result shows that Employed/chauffeur drivers were engaged in frequent RTA in the study area. The vehicle driver relationship with RTA conditions in Durame town Administration shows that 290(84.8%) chauffeur/ Employed drivers, 40(11.7%) owner-drivers, 6(1.8%) Rents, Learner 2 (0.65%), and Missing 4(1.2%) are primarily attributed to RTAs. To understand the reason behind this the researcher asked the traffic police and one of the traffic police of Durame Town states that the low incidence of accidents caused by family member drivers and own drivers is mainly related to a strong sense of ownership feeling, belongingness, and responsibility. Whereas the Employed /chauffeur is young and requires additional business after completing their duty and is very hurry for that but unfortunately they trigger RTAs



Source: Computed from Durame Town Traffic Police Commission RTAs data (2016-2021)

Figure 22 Vehicles driver relationship

Actually, accidents occurred by owners were not small which is a large number (40) next to Employed. Similar results of the Durame Town transport office (2022) report show that the majority of RTAs have occurred by Employed /chauffeur followed by to owners.

#### 4.6.2 Vehicle Characteristics and Road Traffic Accident

Table 19: Vehicle factors as causes of RTA in Durame town (2016 – 2021).

| Vehicle factors          | Respondents |             |                |           |           |             |            |            |
|--------------------------|-------------|-------------|----------------|-----------|-----------|-------------|------------|------------|
|                          | Pedestrians |             | Traffic police |           | Driver    |             | Total      |            |
|                          | Count       | %           | Count          | %         | Count     | %           | Count      | %          |
| Vehicle Service Age      | 22          | 18.3        | 13             | 10.83     | 16        | 13.3        | 51         | 42.5       |
| Poor technical condition | 15          | 12.5        | 11             | 9.2       | 14        | 11.7        | 40         | 33.3       |
| Vehicle type             | 13          | 10.8        | 6              | 5         | 10        | 8.3         | 29         | 24.2       |
| Vehicle design           | 0           | 0           | 0              | 0         | 0         | 0           | 0          | 0          |
| <b>Total</b>             | <b>50</b>   | <b>41.7</b> | <b>30</b>      | <b>25</b> | <b>40</b> | <b>33.3</b> | <b>120</b> | <b>100</b> |

Source: Field survey Computed by the Author, 2022

As shown in Table 19, the available police accident statistics show that from vehicle factors, Vehicle Service Age, Poor technical condition, and Vehicle type accounted for 51(42.5%), 40(33.3),and 29(24.2%) respectively.

#### 4.6.2.1 Vehicle Service Age on RTA

Table 20: RTAs data by Vehicle service age

| Vehicle service age in years | Accident year |           |           |           |           |           | Total      | %         |
|------------------------------|---------------|-----------|-----------|-----------|-----------|-----------|------------|-----------|
|                              | 2016          | 2017      | 2018      | 2019      | 2020      | 2021      |            |           |
| 0 – 7                        | 3             | 5         | 2         | 9         | 7         | 4         | 30         | 8.8       |
| 8 – 15                       | 6             | 9         | 8         | 10        | 11        | 15        | 59         | 17.2      |
| 16 – 30                      | 11            | 17        | 20        | 23        | 17        | 21        | 109        | 31.9      |
| Old                          | 13            | 21        | 18        | 26        | 13        | 29        | 120        | 35.1      |
| Unknown                      | 6             | 10        | 0         | 4         | 3         | 1         | 24         | 7         |
| <b>Total</b>                 | <b>39</b>     | <b>62</b> | <b>48</b> | <b>72</b> | <b>51</b> | <b>70</b> | <b>342</b> | <b>10</b> |

Source: Compiled from Durame town Traffic Police Commission RTAs data (2016-2021)

Vehicle Service Age is the one of the responsible factors of RTAs in Durame town. The vehicle service age (period) determines the outcome of the vehicle to be involved in RTA accidents. As shown in Table 20, the police accident statistics show that vehicles with service age above 30, and 16 to 30 years caused RTA 120 (35.1%) and 109 (31.9%) respectively. This is because it is not simple to control vehicle than the new ones

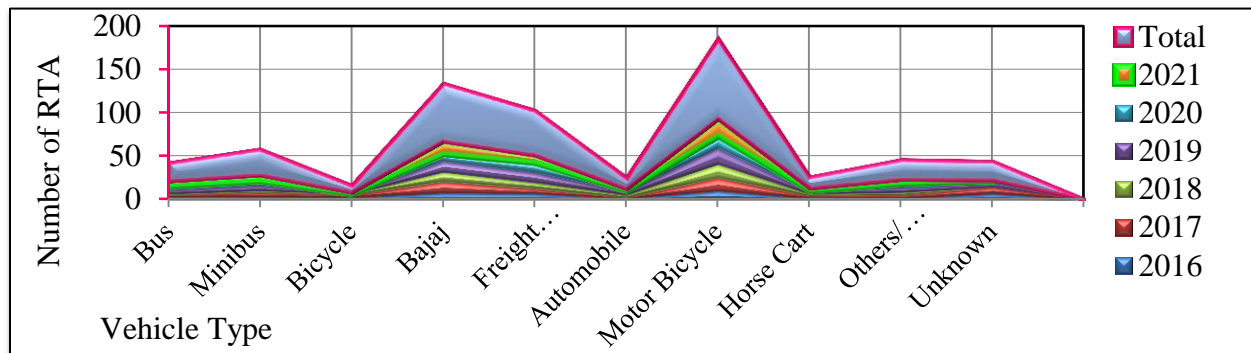
#### 4.4.2.2 Vehicle Type and RTAs

Several vehicle types have been involved in RTA scenes in the town in the last six years but Motor Bicycle and three wheels motor (Bajaj) is more regularly involved in RTAs than other vehicle types (Fig 23). Motor Bicycle and Three wheels motor (Bajaj) at an average cause 93

(27.2%) and 67 (19.6%) road accidents every year. This is attributed to frequent journeys to transport passengers, lack of driving skills, and tiredness from driving long hours.

Table 21: RTAs data vehicle involvements

| Vehicle Type              | Accident Years |           |           |           |           |           | Total      | %          |
|---------------------------|----------------|-----------|-----------|-----------|-----------|-----------|------------|------------|
|                           | 2016           | 2017      | 2018      | 2019      | 2020      | 2021      |            |            |
| Minibus                   | 3              | 5         | 4         | 6         | 5         | 7         | 30         | 8.8        |
| Three Wheel Motor (Bajaj) | 7              | 13        | 11        | 13        | 8         | 15        | 67         | 19.6       |
| Bus                       | 3              | 2         | 1         | 5         | 4         | 6         | 21         | 6.2        |
| Freight Transport         | 6              | 7         | 7         | 12        | 11        | 9         | 52         | 15.2       |
| Automobile                | 1              | 2         | 3         | 4         | 1         | 2         | 13         | 3.8        |
| Bicycle                   | 2              | 3         | 1         | 0         | 0         | 2         | 8          | 2.3        |
| Motor Bicycle             | 9              | 15        | 16        | 19        | 14        | 20        | 93         | 27.2       |
| Horse Cart                | 1              | 3         | 2         | 3         | 1         | 3         | 13         | 3.8        |
| Others/ unclassified      | 1              | 4         | 3         | 6         | 4         | 5         | 23         | 6.7        |
| Unknown                   | 6              | 8         | 0         | 4         | 3         | 1         | 22         | 6.4        |
| <b>Total</b>              | <b>39</b>      | <b>62</b> | <b>48</b> | <b>72</b> | <b>51</b> | <b>70</b> | <b>342</b> | <b>100</b> |



Source: Compiled from Durame town Traffic Police Commission RTAs data (2016-2021)

Figure 23: Type of vehicles involved in RTAs in Durame town (2016-2021)

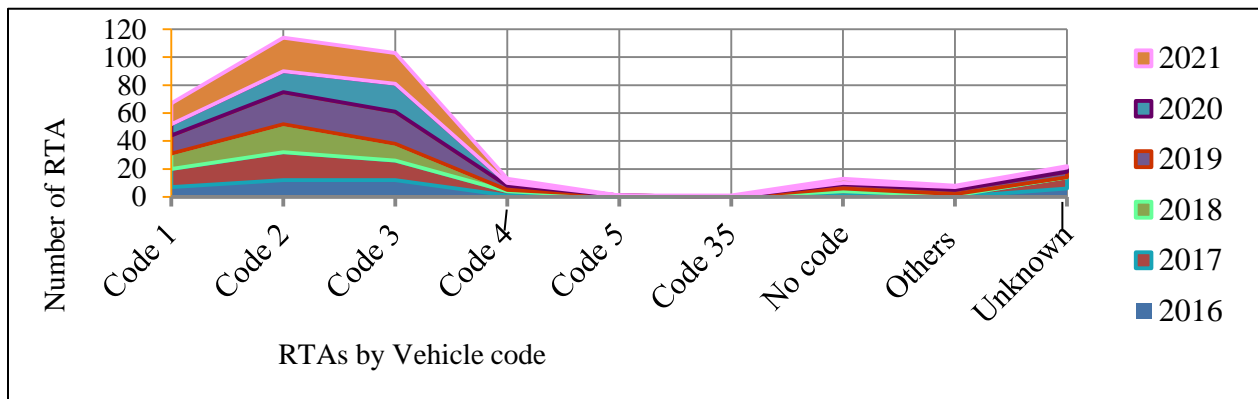
#### 4.4.2.3 RTAs by Vehicles Code

On the other hand, road traffic crashes in Durame Town are mainly caused by vehicles that have code two or private vehicles (114(33.3%)) as it is shown in figure 25 below. Code 3 ranked 2nd and code 1 stood 3rd by accident frequency with a share of share 103(30.1 %) and 67(19.6%) respectively. Code 2, code 3, and code 1 generate a high number of trips within one day, this maneuver results in driver tiredness, and then RTA may occur; hence, the more the trip distance the more incidents may happen. The representations of codes are as follows code1 = Taxi, code

2= private vehicles, code 3 = business vehicle, code 4 government vehicles, code 5= Red Cross vehicles, code 35= aid organization vehicles, and others (AU= Africa Union, UN = .United Nation, CD=Diplomat and transit code vehicle).

Table 22: RTAs data Vehicle code

| Vehicle code | Accident Year |           |           |           |           |           | Total      | %          |
|--------------|---------------|-----------|-----------|-----------|-----------|-----------|------------|------------|
|              | 2016          | 2017      | 2018      | 2019      | 2020      | 2021      |            |            |
| Code 1       | 7             | 13        | 11        | 13        | 8         | 15        | 67         | 19.6       |
| Code 2       | 12            | 20        | 20        | 23        | 15        | 24        | 114        | 33.3       |
| Code 3       | 12            | 14        | 12        | 23        | 20        | 22        | 103        | 30.1       |
| Code 4       | 1             | 3         | 1         | 3         | 2         | 3         | 13         | 4.1        |
| Code 5       | 0             | 0         | 1         | 0         | 0         | 0         | 1          | 0.3        |
| Code 35      | 0             | 0         | 0         | 0         | 0         | 1         | 1          | 0.3        |
| No code      | 1             | 3         | 2         | 3         | 1         | 3         | 13         | 3.8        |
| Others       | 0             | 1         | 1         | 3         | 2         | 1         | 8          | 2.4        |
| Unknown      | 6             | 8         | 0         | 4         | 3         | 1         | 22         | 6.4        |
| <b>Total</b> | <b>39</b>     | <b>62</b> | <b>48</b> | <b>72</b> | <b>51</b> | <b>70</b> | <b>342</b> | <b>100</b> |



Source: Compiled from Durame town police commission traffic accident data (2016-2021)

Figure 24 RTAs by vehicles code

#### 4.6.2.4 Accident Situation Based On Collision

When the accident situations is evaluated, of the total accidents are resulted from a Vehicle to Vehicle (148(43.3%)) collision which is the leading accident collision type followed by vehicle to pedestrian (85(24.9%)), Vehicle to Infrastructure (48(14%)), Inverts (27(7.9%)), Vehicle to passenger (12(3.5%)), and Unknown (22(6.4%)).

Table 23: RTA Data Based On Collision

| Accident Condition | Accident Year |  |  |
|--------------------|---------------|--|--|
|--------------------|---------------|--|--|

|                           | 2016      | 2017      | 2018      | 2019      | 2020      | 2021      | Total      | %          |
|---------------------------|-----------|-----------|-----------|-----------|-----------|-----------|------------|------------|
| Vehicle to Infrastructure | 5         | 8         | 7         | 10        | 6         | 12        | 48         | 14         |
| Vehicle to Vehicle        | 16        | 27        | 22        | 32        | 20        | 31        | 148        | 43.3       |
| Vehicle to Pedestrian     | 9         | 12        | 14        | 16        | 15        | 19        | 85         | 24.9       |
| Inverts                   | 2         | 5         | 4         | 7         | 5         | 4         | 27         | 7.9        |
| Vehicle to passenger      | 1         | 2         | 1         | 3         | 2         | 3         | 12         | 3.5        |
| Unknown                   | 6         | 8         | 0         | 4         | 3         | 1         | 22         | 6.4        |
| <b>Total</b>              | <b>39</b> | <b>62</b> | <b>48</b> | <b>72</b> | <b>51</b> | <b>70</b> | <b>342</b> | <b>100</b> |

Source: Compiled from Durame town police commission traffic accident data (2016-2021)

#### 4.6.3 The Relationship between Road Traffic Accidents and Road-Related Factors

Variation of road characteristics has a significant factor in determining the occurrences of RTA in a given place.

Table 24: Road related factors as causes of RTA in Durame town

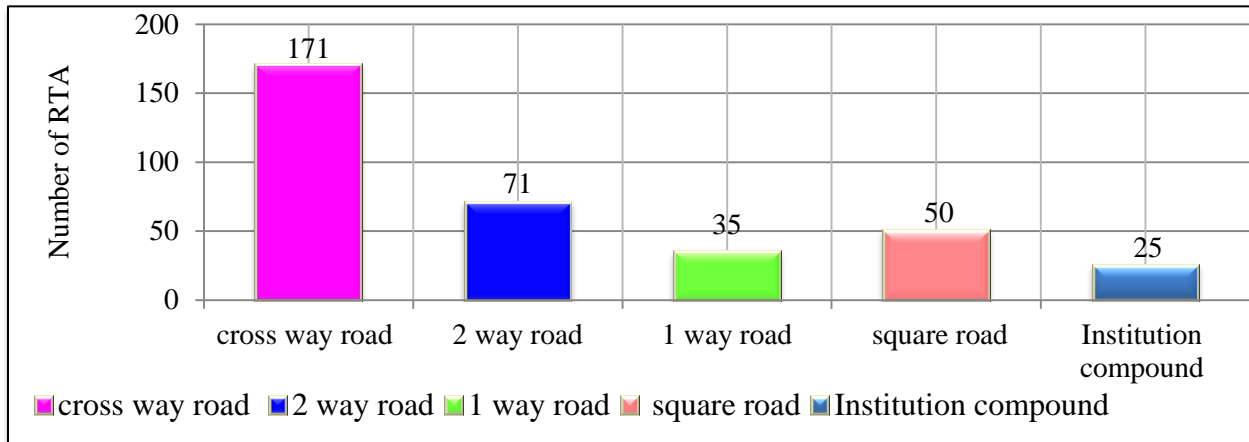
| Road related factors | Respondents |             |                |           |           |             |            |            |
|----------------------|-------------|-------------|----------------|-----------|-----------|-------------|------------|------------|
|                      | Passenger   |             | Traffic police |           | Driver    |             | Total      |            |
|                      | Count       | %           | Count          | %         | Count     | %           | Count      | %          |
| Bad road condition   | 17          | 14.2        | 10             | 8.3       | 18        | 15          | 45         | 37.5       |
| Road divide          | 14          | 11.7        | 5              | 4.2       | 6         | 5           | 33         | 27.5       |
| Road type            | 11          | 9.2         | 4              | 3.3       | 2         | 1.7         | 17         | 14.2       |
| Relief of the roads  | 8           | 6.7         | 11             | 9.2       | 14        | 11.7        | 25         | 20.8       |
| <b>Total</b>         | <b>50</b>   | <b>41.7</b> | <b>30</b>      | <b>25</b> | <b>40</b> | <b>33.3</b> | <b>120</b> | <b>100</b> |

Source: Field survey Computed by the Author, 2022

As shown in Table 24, from the total responses bad road conditions accounted for 45(37.5%), Road divides 33(27.5), Relief of the roads 25(20.8), and Road type 17 (14.2%). Therefore, bad road conditions and road divide are leading responsible factors of RTAs in Durame town.

#### 4.4.3 Road Divide and RTAs

Based on the RTA data collected from the recorded police statistics, the crossway road division types produce 171(50%) of all road crashes because of the absence of Traffic signs and signals.



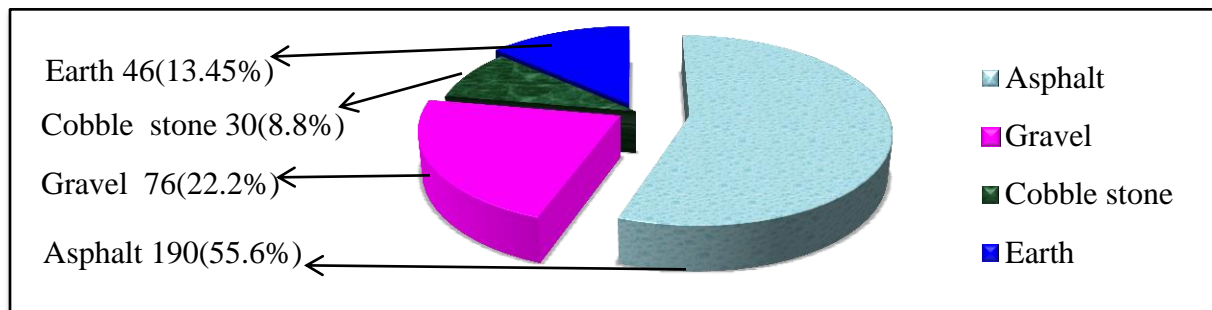
*Source: Compiled from Durame town police commission traffic accident data (2016-2021)*

Figure 25: Road divide and RTA in Durame town (2016-2022).

Following bad road conditions, two-way roads contribute 71 (20.8%) of RTAs. The frequency of road accidents on two-way roads is by far higher than on one-way roads. This is attributed to two-way roads hosting the movement of vehicles from opposite directions in the same stream and is usually characterized by traffic crowding. However, the one-way roads have a dividing line that separates vehicles into two and enables them to move only in one direction and allow vehicles to move in a relatively safer route than in the two-way roads. As a result of this, two-way roads are more than two times more prone to RTA incidences than one-way roads in Durame town. In addition, about 50 (14.6%) of road accidents is documented at or near the squares of roads

#### **4.4.3.1 RTAs and Road Surface in Durame Town (2016-2022).**

The other important RTA contributor is the Road type which is categorized into different types including asphalt, cobblestone, gravel, and earthwork. The analysis confirms that above half (190(55.6%)) of all the accidents have happened on asphalt roads in Durame town (2016-2021) because drivers prefer to drive at higher speeds on smoother road types like asphalt roads and due to larger traffic flows on the asphalt roads than others.



Source: Compiled from Durame town police commission traffic accident data (2016-2021)

Figure 26. RTA and road surface characteristics in Durame town (2016-2021)

Gravel roads and cobblestone-covered roads contribute 76(22.2) % and 30(8.8%) in the years 2016 to 2021 respectively (in Figure 26). Drivers have high protection in dangerous locations compared to low-danger locations. This is to mean in places where drivers identify a location as dangerous, they take more care. Accidents may be more likely to happen when dangerous road or traffic conditions are not clear at a glance, or where the conditions are too complicated to observe and react in the time and distance available.

#### 4.4.3.2 Relief of the Roads and RTAs

Moreover, Relief of the Roads has also strong association with the incidence of RTAs in Durame Town. According to traffic police data shown in table 25, about 40.64%,23.4%,17.83% and11.7% of the road accidents are happened on streets with very gentle slope, gently sloping ,Sloping, and plain (Level) roads respectively

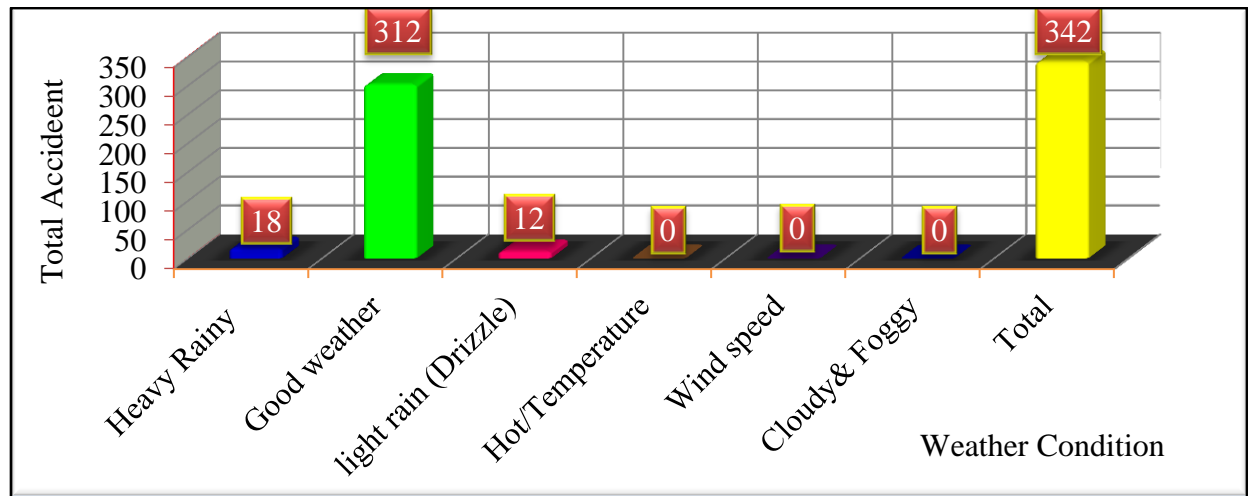
Table 25: Relief of the road and Road traffic accident

| Relief of the roads             | Accident year |      |      |      |      |      | Total | %     |
|---------------------------------|---------------|------|------|------|------|------|-------|-------|
|                                 | 2016          | 2017 | 2018 | 2019 | 2020 | 2021 |       |       |
| Straight and plain(Level)       | 4             | 7    | 5    | 10   | 5    | 9    | 40    | 11.7  |
| Straight with Very gentle slope | 14            | 23   | 21   | 27   | 24   | 30   | 139   | 40.64 |
| gently sloping                  | 9             | 14   | 15   | 17   | 9    | 16   | 80    | 23.4  |
| Sloping                         | 6             | 10   | 7    | 14   | 10   | 14   | 61    | 17.83 |
| Strongly sloping                | 0             | 0    | 0    | 0    | 0    | 0    | 0     | 0     |
| Moderate steep                  | 0             | 0    | 0    | 0    | 0    | 0    | 0     | 0     |
| Very steep                      | 0             | 0    | 0    | 0    | 0    | 0    | 0     | 0     |
| Others                          | 6             | 8    | 0    | 4    | 3    | 1    | 22    | 6.43  |
| Total                           | 39            | 62   | 48   | 72   | 51   | 70   | 342   | 100   |

Source: Durame Town Administration Police Office, 2022

#### 4.6.4 Weather Condition Related Factors RTAs.

The weather condition of the moment plays an essential role in varying the regularity of road accidents (Belay & Mba, 2017). Experiences show that several accidents happen during situations of smoke or fog, which decreases visibility. But, RTAs in Durame town regularly happen through good weather conditions than through rainy and drizzle falling events.



Source: Durame Town Administration Police Office, 2022

Figure 27 Weather condition and RTA in Durame town (2016-2021)

Out of the total 342 RTA records in the last six years in the town, 312 (91.2%) RTAs in the town have been documented in good weather conditions but only 18(5.3%) and 12(3.5%) accidents recorded in rainy weather conditions respectively. Bright and dry weather which covers the longer days of the year in the town produces greater number of RTAs than the rainy weather conditions. In addition, winter is bright, dry, and good for driving which led to overconfidence and high speed of drivers and contributes to a greater number of road crashes. While in the summer season, there are relatively lower traffic accidents because of the short wet season (little number of rainy days) in a year, and a strong sense of responsibility and care.

To summarize the main causes of RTAs, the data collected from the respondents, secondary sources, and the researcher's observation indicate that the most frequent and common causes of RTAs in Durame town are driver-related issues, such as drivers not respecting pedestrian priority

and vehicle priority, Inexperience, lack of discipline especially among motorcycle and three-wheeler drivers, over speeding, drinking problem, negligence of drivers, parking in restricted areas, overloading, drinking problems, not wearing seat belts, and lack of knowledge and awareness of traffic rules and regulations, were the main reasons for RTA Durame town at the time of the study. In addition, the absence of road traffic lights, the limited number of road traffic signs, the limited number and size of side roads, poor road conditions, the narrow width of roads, steepness of places with narrow bridges (for example, Wata Bridge and others) and lack of separate lanes for horse carts and bicycles in the city have played an important role in aggravating the incidence of RTAs.

Besides, the researcher and the driver confirmed that there are various wrong actions and gaps that expose pedestrians and drivers to road traffic accidents. These include pedestrians not using zebra crossings, lack of public awareness of traffic rules and signs, illegal roadside trading, uncontrolled movement of domestic animals and horse-drawn carts, poor traffic law enforcement practices, and poor use of technology by traffic law enforcers, low awareness creation practices, and low cooperation between the traffic office, transport authority, and the city administration for reducing RTA.

#### **4.7 Analysis of Road Traffic Accidents Using Geospatial Technologies**

##### **4.7.1 Spatial Distribution of RTA and Black Spots in Durame Town**

The road traffic accident black spots were unevenly distributed throughout the sub-town of Durame town. According to the criteria set, all places that exhibit five or more road traffic accidents in a year were defined as RTA black spots. The police member's key informant (head of the traffic police department) points out more information concerning the places/black spots where RTA tends to occur more frequently in Durame town. According to his explanations, those black spots are situated along the main road, crossroads, and squares specifically around the new commercial bank of Ethiopia in Zararo, Wata slope, and bridge area, In front of Tackle haymanot charch, Zararo administration office, D.c Bogelach Gabire Matasabt General Hospital, Wachamo University Durame campus, Mesale hotel, and in front of Dongicho health center of the town where different marketing and transportation activities took place. The other key

informant (offender of RTA) also described Bazana tomb areas, and around the stadium as black spots. According to road transport office members, RTA also tends to concentrate or occur more frequently along the principal asphalt road that is around Mesale hotel, Aroge market area, and in the crossroad such as around the Zararo administration office, and around the stadium, and square road such as Colonel Tekatel Wodebo square.

Table 26: Distribution of RTA places/black spots in Durame town.

| RTA occur more frequently places/ black spots | Respondents |             |                |              |           |             |            |            |
|---|-------------|-------------|----------------|--------------|-----------|-------------|------------|------------|
|   | Pedestrians |             | Traffic police |              | Driver    |             | Total      |            |
|   | Count       | %           | Count          | %            | Count     | %           | Count      | %          |
| New commercial bank of Ethiopia (Adisu bank)  | 11          | 9.2         | 9              | 7.5          | 6         | 5           | 26         | 21.7       |
| wata slope and bridge area                    | 9           | 7.5         | 8              | 6.7          | 5         | 4.2         | 22         | 18.3       |
| In front of Tackle haymanot charch            | 7           | 5.8         | 4              | 3.3          | 6         | 5           | 17         | 14.2       |
| Colonel Tekatel Wodebo square                 | 8           | 6.6         | 3              | 0.27         | 4         | 3.3         | 15         | 12.5       |
| Zararo administration office                  | 5           | 4.2         | 3              | 0.27         | 5         | 4.2         | 13         | 10.8       |
| D.c Bogelach Gabire Matasabt General hospital | 4           | 3.3         | _              | _            | 4         | 3.3         | 8          | 6.7        |
| Wachamo University Durame campus              | 3           | 2.5         | _              | _            | 4         | 3.3         | 7          | 5.8        |
| Around Mesale hotel                           | 2           | 1.7         | 3              | 0.27         | 3         | 2.5         | 8          | 6.7        |
| In front of Dongicho health center            | 1           | 0.8         | _              | _            | 3         | 2.5         | 4          | 3.3        |
| <b>Total</b>                                  | <b>50</b>   | <b>41.6</b> | <b>30</b>      | <b>20.54</b> | <b>40</b> | <b>33.3</b> | <b>120</b> | <b>100</b> |

Source: Field survey Computed by the Author, 2022

As shown in Table 26, from the total responses of respondents RTA occur more frequently around New commercial bank of Ethiopia in Zararo sub-town (21.7%), Wata sloppy with its bridge area (18.3%), In front of Tackle haymanot charch (14.2%), Colonel Tekatel Wodebo square (12.5%), D.c Bogelach Gabire Matasabt General hospital (10.8%), Wachamo University Durame campus (6.7%), Around Mesale hotel (5.8%) and in front of Dongicho health center (3.3%) respectively.

#### 4.7.2.1 The Spatial Distribution of RTAs & RTA Spots in Durame Town in 2016 &2017

In 2016 and 2017 Durame town exhibits the occurrence of 33, 54 spatially identified RTAs. The RTAs were unevenly distributed throughout the Sub- town of Durame town in this year.

Table 27: The spatial distribution of RTA occurrences in Durame town (2016 and 2017)

| Year | Sub- town    | No. of RTA Spots | No. of RTAs occurred | % of RTA Spots | % of RTAs occurred |
|------|--------------|------------------|----------------------|----------------|--------------------|
| 2016 | Kasha        | 6                | 9                    | 23             | 27.3               |
|      | Zararo       | 10               | 14                   | 38.5           | 42.4               |
|      | Lalo         | 10               | 10                   | 38.5           | 30.3               |
|      | <b>Total</b> | <b>26</b>        | <b>33</b>            | <b>100</b>     | <b>100</b>         |

|      |        |    |    |      |      |
|------|--------|----|----|------|------|
| 2017 | Kacha  | 3  | 6  | 8.6  | 11.1 |
|      | Zararo | 21 | 27 | 60   | 50   |
|      | Lalo   | 11 | 21 | 31.4 | 38.9 |
|      | Total  | 35 | 54 | 100  | 100  |

Source: Compiled from Durame town Traffic Office (2022)

The above table 27 orders that, 33 RTAs were recorded form 26 RTA spots in the town in 2016. This indicates that an average of 1.27 RTAs have occurred at every RTA spots in the town in 2016. The highest numbers of RTA spots as well as the largest frequency of RTA incidents were recorded from Zararo Sub- town. Zararo Sub- town exhibits 14 (42.4%) of RTAs and 10 (38.5%) of RTA spots in the town by 2016. Kacha Sub- town produced 9(27.3%) of RTAs revealed in 6(23%) RTA spots followed by Lalo Sub- town which shares 10 (30.3%) RTAs happened in 10(38.5 c %) RTA spots. In addition to this 54 RTAs have been recorded form 35 RTA spots in the town in 2017. This indicates an average of 1.54 RTAs have occurred at every RTA spots in the town by 2017. As the same to the year 2016, the highest numbers of RTA spots as well as the largest frequency of RTA incidents are recorded from Zararo in 2017. Zararo sub-town exhibited 27 (50%) of RTAs and 21(60%) of RTA spots in the town by 2017. Lalo sub-town produced 21 (38.9%) of RTAs shown in 11 (31.4%) RTA spots followed by Kacha sub-town which shares 6 (11.1%) of RTA happening in 3 (11.1%) RTA Spots respectively.

#### 4.7.2.2 Spatial Distribution of RTA Black Spots of Durame Town in 2016 & 2017

According to the principles set, all places that exhibit five or more than five RTAs were defined as RTA Black spots. Accordingly, as shown in table 30 and figure30; 4 places were identified as RTA Black spots in Durame town in the year 2016 and 6 places in the year 2017. Compared to 2016, the number of RTA Black spots as well as the frequency of RTAs occurred on the black spots have shown an increasing trend by 2 and by 11 respectively

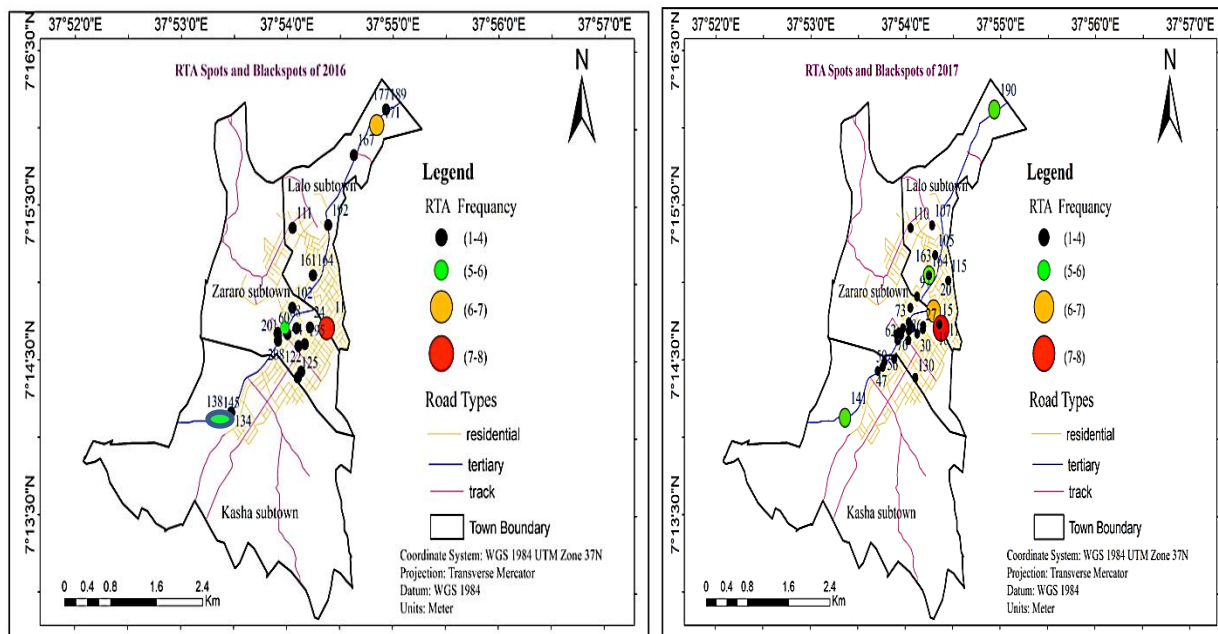
Table 28: Distribution of RTA places/black spots in Durame town (2016 and 2017)

| Year  | Sub- town | No | X coordinate | Y coordinate | RTA Black Spot area                          | Black Spot code | No. of RTAs occurred in the Black spot |
|-------|-----------|----|--------------|--------------|--|-----------------|--|
| 2016  | Zararo    | 1  | 379255.9     | 800998.5     | Around New commercial bank of Ethiopia areas | 11              | 7                                      |
|       |           | 2  | 378531.4     | 801010.4     | Around Masala Hotel areas                    | 68              | 5                                      |
|       | Lalo      | 3  | 380128.3     | 803417.7     | Around Weta slope                            | 171             | 6                                      |
|       | Kasha     | 4  | 377390.3     | 799933.3     | Around Bazana tomb areas                     | 138             | 5                                      |
| Total |           |    |              | 4            |  | 23              |  |
|       |           | 1  | 380287.4     | 803605.5     | In front of Tackle haymanot charch           | 73              | 5                                      |

|      |        |   |          |          |   |     |   |
|------|--------|---|----------|----------|---|-----|---|
| 2017 | Zararo | 2 | 379109.3 | 801205   | Colonel Tekatel Wodebo square                 | 20  | 6 |
|      |        | 3 | 379372.3 | 801095.4 | Around New commercial bank of Ethiopia areas  | 11  | 8 |
|      | Kacha  | 4 | 377390.3 | 799933.3 | In front of Dongicho health center            | 141 | 5 |
|      | Lalo   | 5 | 379109.3 | 801205   | Around Weta slope areas                       | 190 | 5 |
|      |        | 6 | 379020.7 | 801629.5 | D.c Bogelach Gabire Matasabt General hospital | 163 | 5 |
|      | Total  |   |          |          |   | 6   |   |

Source: Compiled from Durame town Traffic Office (2022)

According to table 28, a total of 23 RTAs have been recorded from only 4 RTA black spots in the town in the year 2016 and 34 RTAs have been recorded from 6 RTA black spots in the town in the year 2017. This implies that, an average of 5.75 in year 2016 and 5.7 in year 2017 RTA incidences have occurred at every single RTA Black spot in the town. The highest frequency of RTAs i.e. Happened around new commercial bank of Ethiopia area in 2016 in 2017. In addition to this, the highest RTA black spots recorded Sub- town in these years Zararo sub-town followed by Lalo and kasha sub-town.



(Source: Arc Map 10.8 and primary data collected through GPS records)

Figure 28: Spatial Distribution of RTA Spots and Black Spots in Durame town (2016 & 2017)

### 4.7.2.3 The Spatial Distribution of RTAs & RTA Spots in Durame Town in 2018 &2019

In 2018, Durame Town exhibits the occurrence of 48 spatially identified RTAs and in 2019 (68) spatially identified RTAs. The frequency of RTAs is randomly distributed throughout the Sub-town of Durame town in these years.

Table 29 : The spatial distribution of RTA occurrences in Durame town (2018 and 2019).

| Year | Sub-Town | No. of RTA Spots | No. of RTAs occurred | % of RTA Spots | % of RTAs occurred |
|------|----------|------------------|----------------------|----------------|--------------------|
| 2018 | Kasha    | 3                | 7                    | 7.9            | 14.6               |
|      | Zararo   | 24               | 28                   | 63.2           | 58.3               |
|      | Lalo     | 11               | 13                   | 28.9           | 27.1               |
|      | Total    | 38               | 48                   | 100            | 100                |
| 2019 | Kacha    | 3                | 8                    | 8.33           | 11.8               |
|      | Zararo   | 21               | 34                   | 58.33          | 50                 |
|      | Lalo     | 12               | 26                   | 33.33          | 38.2               |
|      | Total    | 36               | 68                   | 100            | 100                |

Source: Compiled from Durame Town Administration Traffic Office (2022)

Table 29 claims that, 48 RTAs have been recorded form 38 RTA spots in the Town in 2018. This indicates an average of 1.3 RTAs have occurred at every RTA spots in the town by 2018. Like in the preceding years, the highest numbers of RTA spots as well as the largest frequency of RTA incidents are recorded from Zararo in 2018. Zararo sub-town exhibited 28(58.3%) of RTAs and 24(63.2%) of RTA spots in the town by 2018. Lalo sub-town produced 13 (27.1%) of RTAs shown in 11 (28.9%) RTA spots followed by Kacha sub-town which shares 7 (14.6%) of RTA happening in 3 (7.9%) RTA Spots respectively. The above table shows that, 68 RTAs have been recorded form 36 RTA spots in the town in 2019. This indicates that, an average of 1.9 RTAs has occurred at every RTA spots in the town by 2019. Like in 2016 and 2018, the highest numbers of RTA spots as well as the largest frequency of RTA incidents are recorded from Zararo sub-town. Zararo sub-town exhibited 34 (50%) of RTAs and 21 (58.33%) of RTA spots in the town by 2019. Lalo sub-town hosted 26 (38.2%) of RTAs occurred in 12 (33.33%) RTA spots followed by Kacha sub-town which shares 8 (11.8%) RTAs occurrences in 3 (8.33%) RTA spots have recorded from each respectively.

### 4.7.2.4 Spatial Distribution of RTA Black Spots of Durame Town in 2018 and 2019

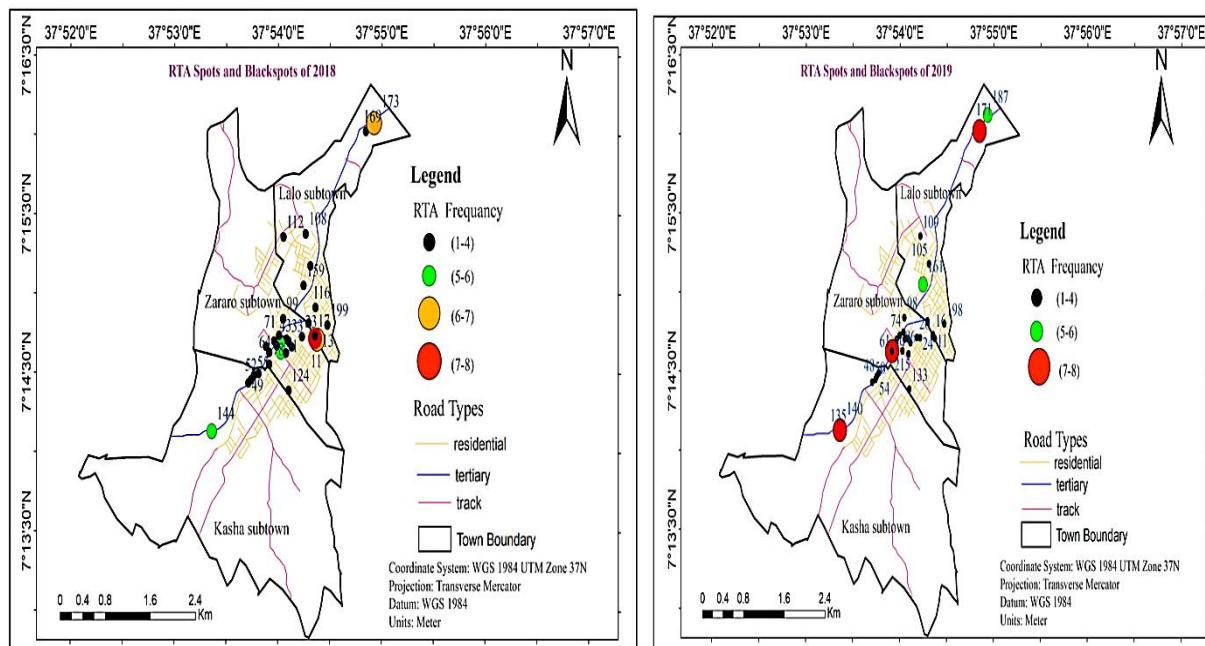
As defined in table 30 and figure 29, places are identified as RTA Black spots in Durame town in the year 2018 and 2019. Comparing to 2018, the number of RTA Black spots as well as the frequency of RTAs occurred on the black spots have shown an increasing trend by 5 and by 27 respectively.

Table 30 Durame Town Administration RTA Black Spot areas (2018 and 2019)

| Year         | Sub-Town | No       | X Coordinate | Y Coordinate         | RTA Black Spot area                                  | Black Spot code | No. of RTAs occurred in the Black spot |
|--------------|----------|----------|--------------|----------------------|--|-----------------|--|
| 2018         | Kasha    | 1        | 377390.      | 799933.3             | Aroge market area                                    | 144             | 5                                      |
|              | Lalo     | 1        | 380272.      | 803514.5             | Wata slope area                                      | 173             | 6                                      |
|              | Zararo   | 1        | 378749.9     | 800984.9             | Around Zararo administration office                  | 33              | 5                                      |
|              |          | 2        | 379255.9     | 800998.5             | Around New commercial bank of Ethiopia areas         | 11              | 7                                      |
|              | 3        | 378621.3 | 800856.3     | Around Stadium areas | 13   | 6               |  |
| <b>Total</b> |          |          |              |                      | <b>5</b>   |                 | <b>29</b>                              |
| 2019         | Lalo     | 1        | 380287.4     | 803605.4             | Wachamo university Durame campus many get            | 187             | 5                                      |
|              |          | 2        | 380128.3     | 803417.7             | Around wata slope and bridge area                    | 171             | 6                                      |
|              |          | 3        | 379020.7     | 801629.5             | Around D.c Bogelach Gabire Matasabt General hospital | 161             | 5                                      |
|              | Kasha    | 1        | 377390.3     | 799933.3             | Above bazana tomb                                    | 140             | 6                                      |
|              | Zararo   | 1        | 378634.5     | 801071               | Around masala hotel                                  | 74              | 5                                      |
|              |          | 2        | 379511.2     | 80073                | In front of Tackle haymanot charch                   | 98              | 6                                      |
|              |          | 3        | 378411.2     | 800853.5             | Many gates of market area                            | 215             | 5                                      |
|              |          | 4        | 378965.1     | 801008.8             | Around stadium                                       | 24              | 5                                      |
|              |          | 5        | 379109.9     | 801191.1             | Colonel Tekatel Wodebo square                        | 21              | 5                                      |
|              |          | 6        | 379255.9     | 800998.5             | Around New commercial bank of Ethiopia areas         | 11              | 7                                      |
| <b>Total</b> |          |          |              |                      | <b>10</b>  |                 | <b>55</b>                              |

Source: Compiled from Durame Town Traffic Office (2019)

According to table 30, a total of 29 RTAs have been recorded from 5 RTA black spots in the town in the year 2018. This implies that, an average of 5.8RTA incidences have occurred at every single RTA Black spot in the town in the year 2018. As will as 55 RTAs have been recorded from 10 RTA black spots in the town in the year 2019. This concludes that, an average of 5.5 RTA occurrences has taken place at every single RTA Black spot in the town in the year 2019. Like in 2018, the highest frequency of RTAs occurred in new commercial bank of Ethiopia areas in 2019. In addition to this, the highest RTA Black spots of the town in these years have occurred in the Zararo sub-town. As Lalo sub-town shared the 2<sup>nd</sup> RTA Black Spots, and kasha sub-town shared the 3<sup>rd</sup> RTA Black Spots.



(Source: Arc Map 10.8 and primary data collected through GPS records)

Figure 29: Spatial Distribution of RTA Spots and Black Spots in Durame town (2018 & 2019)

#### 4.7.2. 5 The Spatial Distribution of RTAs & RTA Spots in Durame Town in 2020 &2021

In 2020, Durame town exhibits 48 spatially identified RTAs and in 2021, Durame town shows the happening of 69 spatially recognized RTAs. The regularity of RTAs is randomly distributed throughout the Sub-towns these years.

Table 31: The spatial distribution of RTA occurrences in Durame town (2020 and 2021)

| Year | Sub-Town     | No. of RTA Spots | No. of RTAs occurred | % of RTA Spots | % of RTAs occurred |
|------|--------------|------------------|----------------------|----------------|--------------------|
| 2020 | Kacha        | 3                | 7                    | 7.7            | 14.6               |
|      | Zararo       | 19               | 21                   | 48.7           | 43.7               |
|      | Lalo         | 17               | 20                   | 43.6           | 41.7               |
|      | <b>Total</b> | <b>39</b>        | <b>48</b>            | <b>100</b>     | <b>100</b>         |
| 2021 | Kacha        | 5                | 9                    | 10.6           | 13.1               |
|      | Zararo       | 25               | 35                   | 53.2           | 50.7               |
|      | Lalo         | 17               | 25                   | 36.2           | 36.2               |
|      | <b>Total</b> | <b>47</b>        | <b>69</b>            | <b>100</b>     | <b>100</b>         |

Source: Compiled from Durame Town Traffic Office (2022)

Table 31 claims that, 48 RTAs have been recorded form 39 RTA spots in the Town in 2020. These shows an average of 1.2 RTAs have occurred at every RTA spots in the town by 2020. Like in the previous years, the highest numbers of RTA spots as well as the largest frequency of RTA incidents are recorded

from Zararo in 2020. Zararo sub-town exhibited 21(43.7%) of RTAs and 17(48.7%) of RTA spots in the town by 2020. Lalo sub-town produced 20 (41.7%) of RTAs shown in 17 (43.6%) RTA spots followed by Kacha sub-town which shares 7 (14.6%) of RTA happening in 3 (7.7%) RTA Spots respectively. Table shows that, 69 RTAs have been documented form 47 RTA spots in the town in 2021. This indicates that, an average of 1.5 RTAs has happened at every RTA spots in the town by 2021. Like in the previous five year, the highest numbers of RTA spots as well as the largest frequency of RTA incidents are documented from Zararo sub-town. Zararo sub-town exhibited 35(50.7%) of RTAs and 25 (53.23%) of RTA spots in the town by 2021. Lalo sub-town hosted 25 (36.2%) of RTAs happened in 17 (36.2%) RTA spots followed by Kacha sub-town which shares 9(13.1%) RTAs occurrences in 5(10.6%) RTA spots have documented from each respectively.

#### 4.7.2.6 Spatial Distribution of RTA Black Spots of Durame Town in 2020 &2021.

As described in table 32 and figure 34, 6 places were identified as RTA Black spots in Durame town in 2020 and in 2021; Durame town shows the happening of 51 spatially recognized RTAs in 10 places. Compared to 2020, the number of RTA Black spots as well as the frequency of RTAs occurred on the black spots have shown an increasing trend by 4 and increasing by 17 respectively.

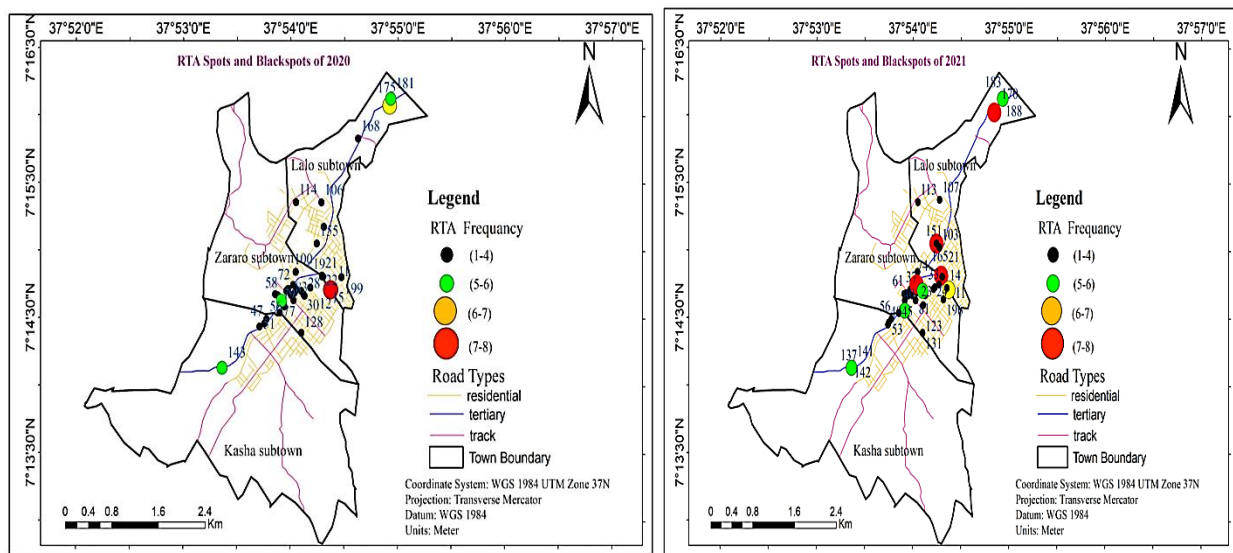
Table 32: Distribution of RTA places/black spots in Durame Town (2020 and 2021).

| Year         | Sub-Town | No | X coordinate | Y Coordinate | RTA Black Spot area                              | Black Spot code | No. of RTAs occurred in the Black spot |
|--------------|----------|----|--------------|--------------|--|-----------------|--|
| 2020         | Kasha    | 1  | 377390.3     | 799933.3     | Around Aroge market area(kasha)                  | 143             | 5                                      |
|              | Lalo     | 1  | 380272.6     | 803514.4     | Around wata slope and its bridge area            | 175             | 6                                      |
|              |          | 2  | 380287.4     | 803605.4     | Around Wachamo university Durame campus          | 181             | 5                                      |
|              | Zararo   | 1  | 380287.4     | 803605.4     | Around Zararo administration office              | 33              | 5                                      |
|              |          | 2  | 379255.9     | 800998.5     | Around New commercial bank areas(Zararo)         | 11              | 8                                      |
|              |          | 3  | 379511.2     | 80073        | In front of Tackle haymanot charch               | 98              | 5                                      |
| <b>Total</b> |          |    |              | <b>6</b>     |  | <b>34</b>       |  |
| 2021         | Lalo     | 1  | 379020.7     | 801629.5     | D.c Bogelach Gabire Matasabt General hospital    | 162             | 5                                      |
|              |          | 2  | 380287.4     | 803605.5     | Wachamo university Durame campus Wata second get | 183             | 6                                      |
|              |          | 3  | 380128.3     | 803605.4     | wata slope areas                                 | 170             | 5                                      |
|              | Zararo   | 1  | 379255.9     | 800941.3     | New commercial bank (Zararo)                     | 11              | 7                                      |
|              |          | 2  | 378407.9     | 800856.3     | Many gates of market area                        | 78              | 6                                      |
|              |          | 3  | 378749.9     | 800984.9     | Zararo administration office                     | 33              | 6                                      |
|              |          | 4  | 379109.9     | 801191.1     | Colonel Tekatel Wodebo square                    | 21              | 5                                      |
|              |          | 5  | 379588.5     | 801357       | In front of Tackle haymanot charch               | 98              | 5                                      |
|              |          | 6  | 378634.5     | 801071.0     | In front of masala hotel                         | 74              | 5                                      |

|              |   |          |          |                                    |     |           |
|--------------|---|----------|----------|------------------------------------|-----|-----------|
| Kasha        | 1 | 377390.3 | 800959.9 | In front of Dongicho health center | 141 | 6         |
| <b>Total</b> |   |          |          | <b>10</b>                          |     | <b>51</b> |

Source: Compiled from Durame Town Administration Traffic Office (2020)

As shown in Table 32 and Figure 30 a total of 34 RTAs have been recorded from 6 RTA black spots in the town in the year 2020. This implies that, an average of 5.7 RTA incidences have occurred at every single RTA Black spot in the town in the year 2020. The available police accident statistics show that a total of 51 RTAs have been recorded from only 10 RTA black spots in the town in the year 2021. This implies that, an average of 5.1 RTA incidences have occurred at every single RTA black spot in the town in the year 2021. In these years the highest frequency of RTAs Black spots in Zararo sub-town. The second highest frequency in Lalo sub-town followed kasha sub-town respectively.



(Source: Arc Map 10.8 and primary data collected through GPS records)

Figure 30: Spatial Distribution of RTA Spots and Black Spots in Durame town in (2020 and 2021)

#### 4.7.2.7 Spatial Distribution of All Spatially Identified RTA Spots & Black Spot of Durame Town from 2016 to 2021.

Based on the data compiled from Durame town Traffic Office (2022), 320 RTAs have occurred in the town on 207 RTA Spots from 2016 to 2021. The following table 41 summarizes the total number of RTA spots and their spatial distribution through all sub-towns.

Table 33: Spatial distribution of total RTA Spots and Black Spot in the Durame town (2016 -2021)

| Sub-town        | Number of RTA Spots | Total RTAs occurred | No.       | RTA Black Spot area  | Black Spot code | No. of RTAs occurred in the Black spot | X coordinate | Y Coordinate |
|-----------------|---------------------|---------------------|-----------|--|-----------------|--|--------------|--------------|
| Zararo Sub-town | 116                 | 159                 | 1         | New commercial bank of Ethiopia (Adisu bank )area          | 11              | 43                                     | 379255.946   | 800998.491   |
|                 |                     |                     | 2         | In front of Tackle haymanot charch                         | 98              | 23                                     | 378659.6     | 801241.5     |
|                 |                     |                     | 3         | Colonel Tekatel Wodebo square                              | 20              | 22                                     | 379109.3     | 801205       |
|                 |                     |                     | 4         | Around Zararo administration office                        | 33              | 18                                     | 378749.9     | 800984.9     |
|                 |                     |                     | 5         | In front of Masala hotel                                   | 68              | 16                                     | 378531.4     | 801010.4     |
|                 |                     |                     | 6         | Many gates of New market area                              | 78              | 12                                     | 378407.9     | 800856.3     |
|                 |                     |                     | 7         | Around stadium areas                                       | 24              | 8                                      | 378965.1     | 801008.8     |
| Lalo Sub-town   | 69                  | 115                 | 1         | Wata slope and its bridge area                             | 171             | 36                                     | 380128.3     | 803417.7     |
|                 |                     |                     | 2         | Around D.c Bogelach Gabire Matasabt General hospital areas | 165             | 17                                     | 379020.7     | 801629.5     |
|                 |                     |                     | 3         | Around Wachamo University Durame campus areas              | 190             | 17                                     | 380287.4     | 803605.5     |
| Kasha Sub-town  | 22                  | 46                  | 1         | In front of Dongicho health center                         | 142             | 14                                     | 377390.      | 800959.9     |
|                 |                     |                     | 2         | In front of Bazana tomb areas                              | 144             | 12                                     | 377390.3     | 799933.3     |
|                 |                     |                     | 3         | Around Aroge market area                                   | 143             | 12                                     | 377390.3     | 801008.8     |
| <b>Total</b>    | <b>207</b>          | <b>320</b>          | <b>13</b> |  |                 | <b>246</b>                             |              |              |

Source: Compiled from Durame town Traffic Office (2022)

As it is clearly indicated in the table 33, Zararo (116 RTA Spots) and 7 RTA Black Spot area as well as Lalo sub- town (69 RTA Spots) and 3 RTA Black Spot area the shared the leading number

of RTA Spots of the town in the last six years. This implies that, 185 (89.4%) of the total RTA Spot and 10(76.9%) RTA Black Spot areas in Durame town are found in Zararo and Lalo sub-towns. The narrow width of bridge, poor condition of the road, larger volume of vehicle and population movement, and extensive business activities makes these two sub-towns to take the lion share of the spatial distribution of RTA Spots and RTA Black Spots of the town from 2016 to 2021. The RTA Spots distribution is concentrated in same areas of among kasha sub- town. However, kasha sub-town contribute 22 total RTA Spots and 3 RTA Black Spot in the town in the whole study period. The slope, 2 way narrow road, larger volume of vehicle and population movement leading cause in this sub- town. Although the number of RTA Spots seems to be similar in Zararo and Lalo sub-towns, the resulting RTA happenings in Zararo sub- town is by 1.38times higher than in Lalo sub-town. The spatial distribution of all the 207 RTA Spots, 13 RTA Black Spot and their frequency of RTAs in the last six years are shown in figure 32.

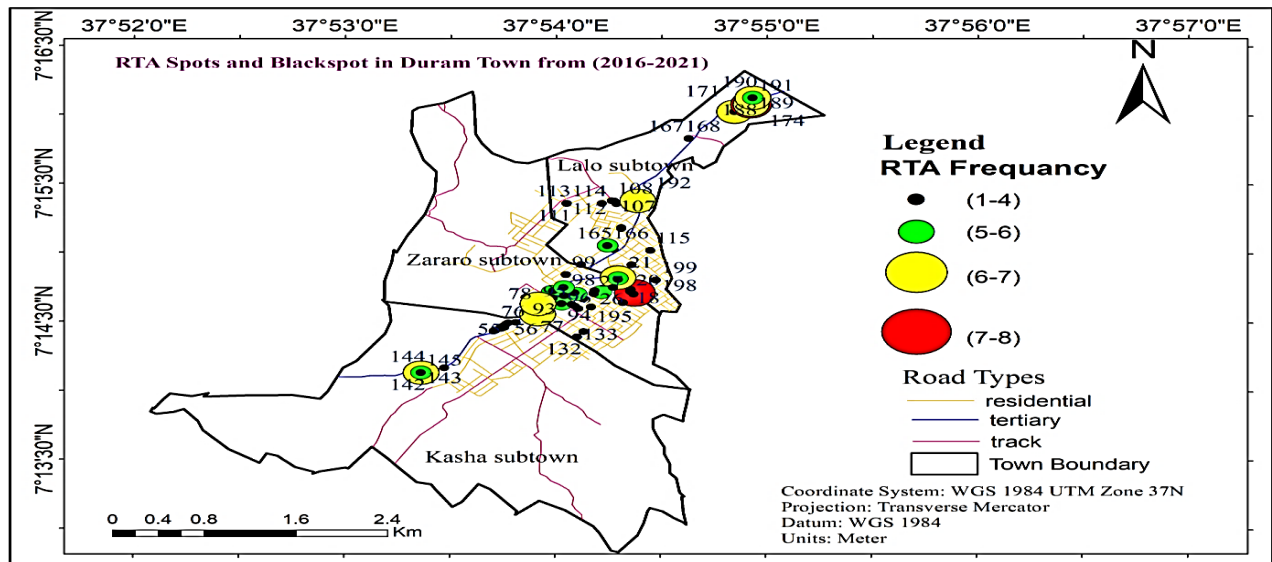


Figure 31: Spatial distribution of all spatially identified RTA Spot and Black Spots s of Durame town from 2017 – 2021

As shown in map the Distribution RTAs point in Durame sub-town based on Geurts and Wets (2003) concept formula for identification spots and black spots. So that .black color point (1-4) represent spots and green color point (5-6), yellow color point (6-7) and red color point (7-8)

represent black spots in study years.

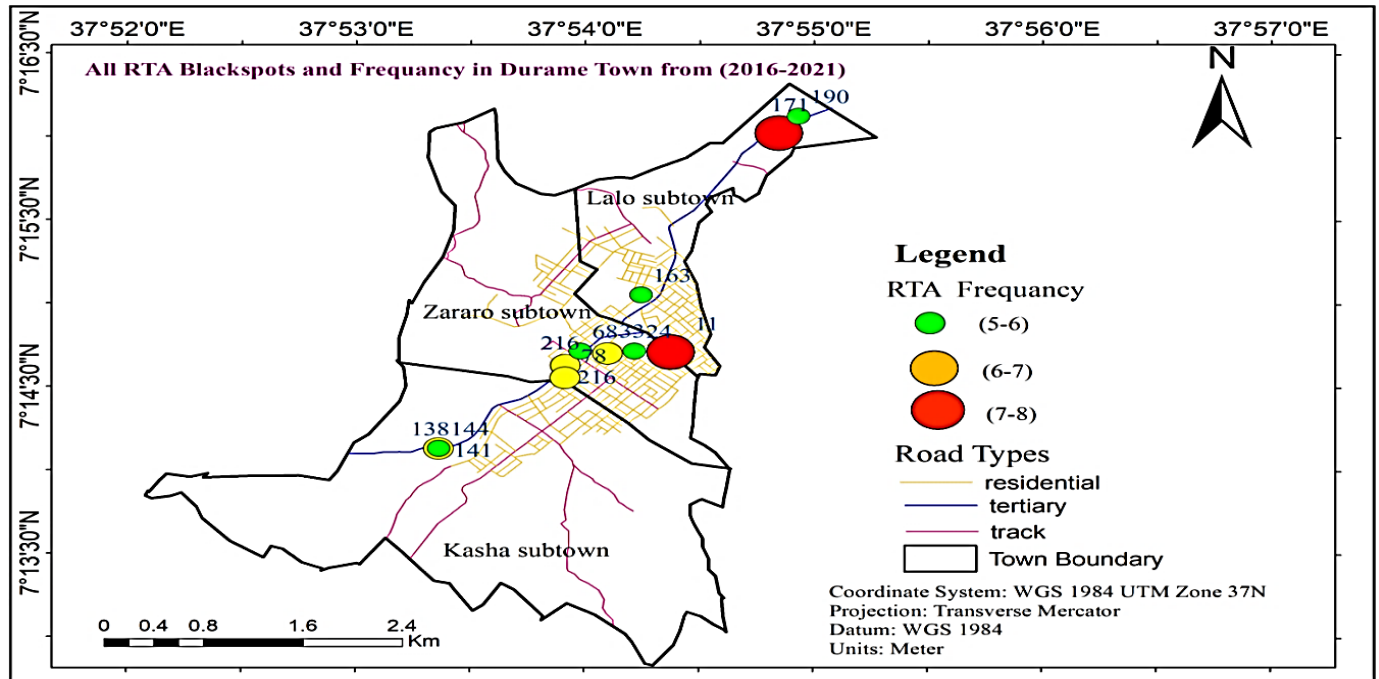
#### 4.7.2.8 The Spatio-Temporal Distribution and Trend of RTA Frequency in All RTA Black Spots of Durame Town

To summarize, as shown in Table 34 and Figure 32, out of a total of 207 RTA spots, 13 different RTA black spots have been identified in the city from 2016 to 2021. Out of 320 total RTA incidences, 246 (76.9%) have occurred in these 13 Black spots. An average of 19 RTAs per RTA black point was recorded during the study period. On the other hand, the Zararo sub-town has 7 different RTA black points, followed by Lalo and Kasha sub-towns which have 3 and 3 RTA black spots each respectively from 2016 to 2021. In particular, the RTA incidences vary from 43 in the new commercial bank of Ethiopia area to 8 in some stadium areas.

Table 34: All RTA Black Spots and Frequency of RTAs in Durame town (2016– 2021)

| NO    | RTA Black Spot                                       | X Coordinate | Y coordinate | RTA Black Spot Code | Accident Year |      |      |      |      |      | Total RTAs | %    |
|-------|--|--------------|--------------|---------------------|---------------|------|------|------|------|------|------------|------|
|       |  |              |              |                     | 2016          | 2017 | 2018 | 2019 | 2020 | 2021 |            |      |
| 1     | New commercial bank of Ethiopia                      | 379255.9     | 800941.3     | 11                  | 7             | 8    | 6    | 7    | 8    | 7    | 43         | 17.2 |
| 2     | Wata slope and its bridge area                       | 380128.3     | 803417.7     | 171                 | 6             | 6    | 7    | 6    | 6    | 5    | 36         | 14.4 |
| 3     | In front of Tackle haymanot charch                   | 378659.6     | 801241.5     | 216                 | 0             | 5    | 2    | 6    | 5    | 5    | 23         | 9.2  |
| 4     | Colonel Tekatel Wodebo square                        | 379109.3     | 801205       | 24                  | 1             | 6    | 5    | 5    | 0    | 5    | 22         | 8.8  |
| 5     | Zararo administration office                         | 378749.9     | 800984.9     | 33                  | 1             | 0    | 5    | 1    | 5    | 6    | 18         | 7.2  |
| 6     | Around D.c Bogelach Gabire Matasabt General hospital | 379020.7     | 801629.5     | 163                 | 1             | 5    | 1    | 5    | 0    | 5    | 17         | 6.8  |
| 7     | Around Wachamo University Durame campus areas        | 380287.4     | 803605.5     | 190                 | 0             | 0    | 1    | 5    | 5    | 6    | 17         | 6.8  |
| 8     | In front of Masala hotel                             | 378531.4     | 801010.4     | 68                  | 5             | 0    | 1    | 5    | 0    | 5    | 16         | 6.4  |
| 9     | In front of Dongicho health center                   | 377390.      | 800959.9     | 141                 | 1             | 5    | 0    | 2    | 0    | 6    | 14         | 5.6  |
| 10    | In front of Bazana tomb areas                        | 377390.3     | 799933.3     | 138                 | 5             | 0    | 1    | 6    | 0    | 0    | 12         | 4.8  |
| 11    | Around Aroge market area                             | 377390.3     | 799933.3     | 144                 | 0             | 0    | 5    | 1    | 5    | 1    | 12         | 4.8  |
| 12    | Many gates of New market area                        | 378407.9     | 800856.3     | 216                 | 0             | 0    | 1    | 5    | 0    | 6    | 12         | 4.8  |
| 13    | Around stadium areas                                 | 378965.1     | 801008.8     | 78                  | 0             | 1    | 0    | 5    | 1    | 1    | 8          | 3.2  |
| Total | 13   |              |              |                     | 27            | 36   | 35   | 59   | 35   | 58   | 246        | 100  |

Source collected from Durame town Traffic Department and flied survey (2022)



(Source: Arc Map 10.8 and primary data collected through GPS records)

Figure 32: RTA Black spots of Durame town (2016 – 2021)

#### 4.7.2.9 The Spatial Distribution of Top 9 RTAs Black Spots & Their Rank in Durame Town

As discussed above, 13 black spots recorded 246 individual crashes, but in this section, the study focused only on 9 RTA black spots and the ranking was based on the weight of each RTA blackspot. The ranking was done by using the Geurts and Wets (2003) ranking scheme.

$$S=x+3y+5z \quad (2)$$

Where S= Severity

Y=total number of major injury each RTAs Black Spot

X=total numbers of minor injury within each RTAs Black Spot

Z= total number fatalities within each RTAs Black Spot

Table 35: Distribution of Top 9 RTAs Black Spots and their Rank in Durame town

| Sub-Town        | RTA Black Spot                                | X coordinate | Y Coordinate | RTA Black Spot Code | Number of RTAs | Death | Serious injures | Light Injures | S-Value | Rank |
|-----------------|---|--------------|--------------|---------------------|----------------|-------|-----------------|---------------|---------|------|
| Zararo sub-town | Around New CBE (Addie Bank) areas             | 379255.9     | 800941.3     | 11                  | 43             | 10    | 16              | 17            | 115     | 1    |
|                 | Around Zararo administration office           | 378749.9     | 800984.9     | 33                  | 18             | 2     | 7               | 9             | 40      | 8    |
|                 | In front of Mesale hotel                      | 378531.4     | 801010.4     | 68                  | 16             | 5     | 4               | 7             | 44      | 6    |
|                 | Colonel Tekatel Wodebo square                 | 379109.3     | 801205       | 20                  | 22             | 6     | 8               | 8             | 62      | 3    |
|                 | In front of Tackle haymanot charch            | 379588.5     | 801357       | 216                 | 23             | 2     | 10              | 11            | 51      | 4    |
| Lalo sub-town   | D.c Bogelach Gabire Matasabt General hospital | 379020.7     | 801629.5     | 163                 | 17             | 3     | 6               | 8             | 41      | 7    |
|                 | wata slope and its bridge area                | 380128.3     | 803417.7     | 171                 | 36             | 8     | 14              | 14            | 96      | 2    |
|                 | Around Wachamo University Durame campus       | 380287.4     | 803605.5     | 190                 | 17             | 5     | 7               | 5             | 51      | 4    |
| Kasha Sub-town  | In front of Dongicho health center            | 377390.3     | 800959.9     | 141                 | 14             | 4     | 4               | 6             | 38      | 9    |
| Total           | 9   |              |              |                     | 206            | 45    | 76              | 85            |         |      |

Source: Compiled from Durame town Traffic Office (2022)

As we can understand from table 34: from 13 RTAs Black spots 9 harshest RTAs Black spots were selected. The most 9 dangers RTAs Black spots 206 numbers of personals victims such as 45 fatalities ,76 Serious injuries and 85 Light Injure. Out of 9 most Black spots 5 were found in Zararo sub-town, 3 in Lalo Sub-Town, while 1 Kasha Sub-town.

In generally in holy study years, the highest number of RTAs (frequency) recorded in front of New CBE (Adisu bank) 43 and in wata slope and its bridge area (36), and (14-23) victims were recorded in all other most Black spots. So in front of NCBE (Adisu bank) and wata slop areas were the most sever road in Durame town in study years.

#### ***4.7.2.10 Ranks Of Top 9 RTAs Black Spots With Their Severity Values In Durame Town.***

Table 36: Ranks of Top 9 RTAs Black Spots with their severity values.

| RTA Black Spot Code | RTA Black Spot areas            | X coordinate | Y coordinate | Number of RTAs | Severity Value | Rank |
|---------------------|---------------------------------|--------------|--------------|----------------|----------------|------|
| 11                  | In front of New CBE(Addis CBE)  | 379255.9     | 800941.3     | 43             | 115            | 1    |
| 171                 | wata slope with its bridge area | 380128.3     | 803417.7     | 36             | 96             | 2    |
| 20                  | Colonel Tekatel Wodebo square   | 379109.      | 801205       | 22             | 62             | 3    |

|     |   |          |          |    |    |   |
|-----|---|----------|----------|----|----|---|
| 216 | In front of Tackle haymanot charch                        | 379588.5 | 801357   | 23 | 51 | 4 |
| 190 | Wachamo University Durame campus areas                    | 380287.4 | 803605.5 | 17 | 51 | 4 |
| 68  | In front of Mesale hotel                                  | 378531.4 | 801010.4 | 16 | 44 | 6 |
| 163 | In front of D.c Bogelach Gabire Matasabt General hospital | 379020.7 | 801629.5 | 17 | 41 | 7 |
| 33  | Blow Zararo administration office                         | 378749.  | 800984.9 | 16 | 40 | 8 |
| 141 | In front of Dongicho health center                        | 377390.3 | 800959.9 | 14 | 38 | 9 |

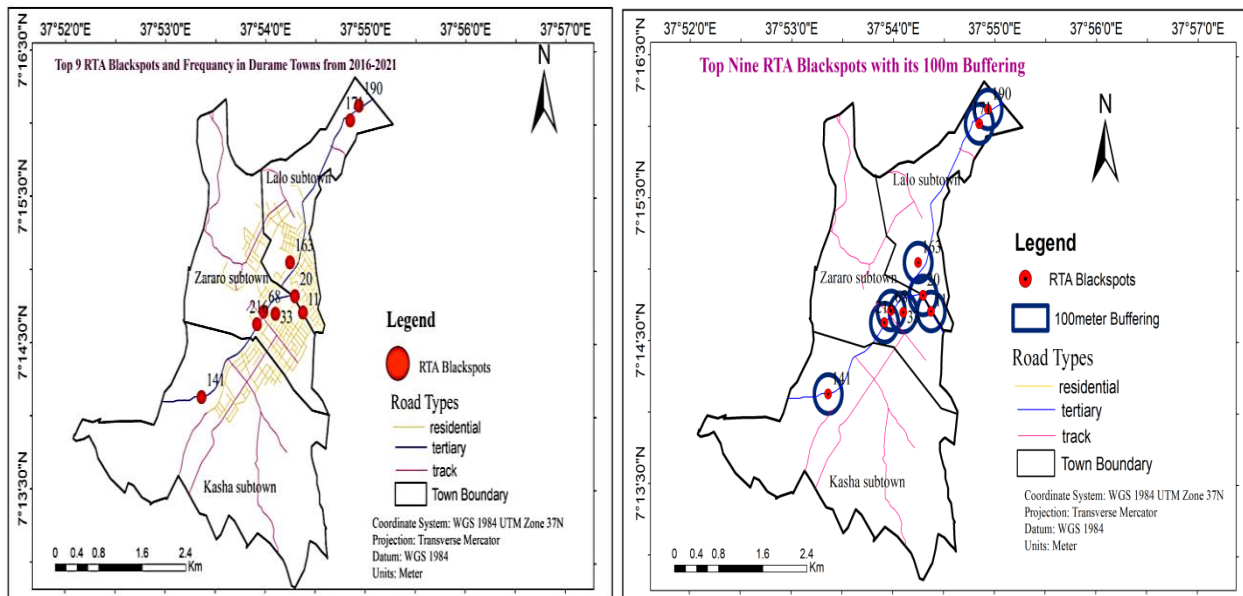
Source: Compiled from Durame town Traffic Office (2022)

The highest number of RTAs was recorded in front of Addis Commercial Bank (New Bank), near the Wata slope and the bridge, and Colonel Tekatel Wodebo square during the whole study years. Since the new commercial bank of Ethiopia area is the main exit and entrance from different parts such as Hawassa, Oromia region, Wolaita, Hadiya, Aleba zone, and others there is high vehicle congestion which contributed to RTA in the town. In addition to this, there is congested pedestrian particularly marketers, stadium users, public Library users, and different governmental and Non-governmental origination office along the road, and other road use also created pedestrian congestion. Absence of speed breakers, invisible traffic signs, and traffic lights also led to road traffic accidents.

Wata slope with its bridge areas in this areas the poor road condition, the road steep slope which is challenge drivers to control, their vehicles, narrowness of bridge, congested pedestrian particularity university students, marketers of Saturday and Tuesday of Durame , because of this the road always crowded with pedestrian, and vehicles. In addition to this, two way roads, absence of speed breakers, nonvisible sings and traffic light.

Whereas Colonel Tekatel Wodebo square is near to bus station, and main route to and from many directions to bus station. Also no pedestrian crossing zebra near to square , Different administrative office, many banks ,hotels and other originations exist around square, and these creates congestion of people and vehicles. In front of Tackle haymanot charch is main get and outlet of vehicles from different direction, gasoil station because of this there is vehicles congestion, charch user, students, marketers, other road users because of this the road crowded with pedestrian, In addition to this absence of zebra, traffic sings, and speed breakers and other.

In front of D.c Bogelach Gabire Matasabt General Hospital Existing in main route to and bus station from west direction. Also there is so many Bajaj and motor cycles congestion that serve for transportation of the patient and other hospital servants. In addition to these ,there were minor traders on side of this road and there are also road infrastructures associated problem. Wachamo University Durame campus areas are poor road condition, congestion of people and vehicles. The others 4 RTAs Black Spot are located near to market, urban business centers and administration areas of town. In addition to these, most of the road is two way roads, and no proper posted traffic sign, insufficient painted zebra cross, no speed breakers and other were the main cause for high RTAs.



(Source: Arc Map 10.8 and primary data collected through GPS records)

Figure 33: The maps shows top 9 RTAs Black Spots with their 100m buffering in Durame town from (2016 – 2021).

#### 4.7.2.11 The Spatio-Temporal Distribution and Trend of RTA Frequency in the Constant and Most harshest RTA Black Spots of Durame Town.

Between 2016 and 2021, there are two RTA black spots that are known to cause frequent road traffic accidents every year. These are around the New Commercial Bank Areas (New Bank) and the steep road of Wata and the Bridge Areas.

Table 37: Constant RTA Black Spots and Frequency of RTAs in Durame town (2016 – 2021)

| No           | RTA Black Spot                    | X coordinate | Y coordinate | RTA Black Spot Code | Accident Year |           |           |           |           |           | Total RTAs | %          |
|--------------|-----------------------------------|--------------|--------------|---------------------|---------------|-----------|-----------|-----------|-----------|-----------|------------|------------|
|              |                                   |              |              |                     | 2016          | 2017      | 2018      | 2019      | 2020      | 2021      |            |            |
| 1            | Around New CBE areas (Adisu bank) | 379255.9     | 800941.3     | 11                  | 7             | 8         | 6         | 7         | 8         | 7         | 43         | 54.4       |
| 2            | wata slope and its bridge areas   | 380128.3     | 803417.7     | 171                 | 6             | 6         | 7         | 6         | 6         | 5         | 36         | 45.6       |
| <b>Total</b> | <b>2</b>                          |              |              |                     | <b>13</b>     | <b>14</b> | <b>13</b> | <b>13</b> | <b>14</b> | <b>12</b> | <b>79</b>  | <b>100</b> |

Source: Compiled from Durame town Traffic Office (2022)

As describe in Table 37 that, Around New commercial bank of Ethiopia areas and Around Wata slope with its Bridge areas are found as RTA Black spots in all years from 2016 to 2021 in the town and are selected as constant RTA Black Spots of Durame town in this study. New commercial bank of Ethiopia areas is an areas where narrows asphalt road, several trucks move, the get of stadium and gets of market area, get of mulluwongal Amagnoh Local church and many government and Non- government organizations office are found along the road which serves as the only way to the many get for the incoming and outgoing vehicles of all types. A Wata bridge area is one way narrow red ash degraded road, there is no sub-road to minimize the vehicles congestion, narrows of bridge, and very a steep and curvy road and, drivers was have less control of their vehicles when joined with speed. These all features make the identified RTA Black spots to be constant and frequent RTA Spots in the town. The spatio-temporal distribution of Constant RTA Black spots and their RTA variation is shown in figure 27.

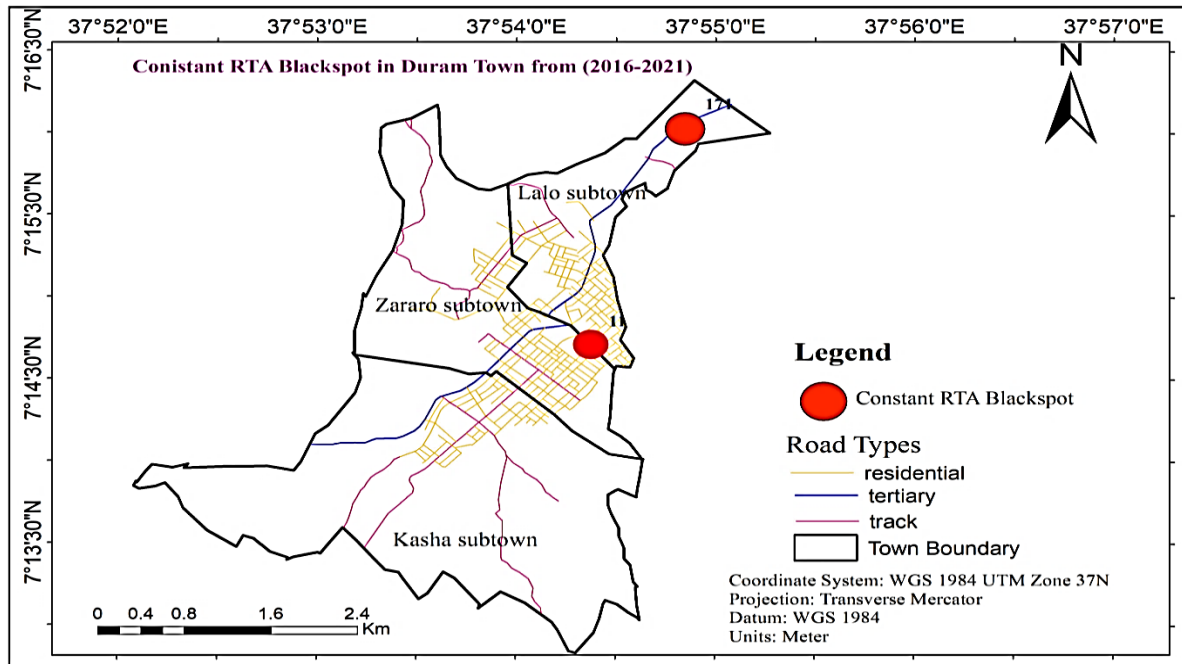


Figure 34: The Spatio-temporal Distribution and Trend of RTA Frequency in the constant RTA Black Spots of Durame town (2016 – 2021)

#### 4.8 Impacts of Road Traffic Accidents in Durame town

All nations in the world are currently affected by (RTAs). They imposed major challenges on health, social, economic, developmental, and environmental components of developing countries, especially those in Africa (WHO, 2009, 2010). The impacts of RTAs in Durame town are also related to the above-mentioned reasons. The next data presentation and analysis describes the recent impacts of RTAs in Durame town.

##### 4.8.1 The Major Health Impacts of RTAs in Durame Town

RTAs can be a cause for fatal accidents, serious injury and slight injury all year in the town and they are the major problems of human health. The police participant key informant describes RTAs can be a cause for fatal accidents, serious injury and slight injury each year in the town and it is a serious problem. Survivors also suffer from diverse types of injuries and ill health which can affect their quality of life. The victims can be drivers; pedestrians, passengers, they can even be the cause of the accident themselves. As these victims suffer, their families and societies will suffer too; they must sometimes carry the burden of caring for the victims.

A victim of RTA key informant said that RTAs affect the physical wellbeing of an individual or groups. In terms of physical wound for instance, the victims of head and spinal injury may be unable to return to their normal lives. They may even require full care at all times. Usually, these conditions are permanent and there are no actual treatments or cures because of the direct wound to the brain and spine, although, there are some rare cases that show physical improvements with limited movement. Regularly, these patients stay at the hospital for a long time. As for partial wound, there are many examples, for instance, fractures of bones, loss of limbs, abrasions, lacerations and blunt injuries.

The Ethiopian insurance company Durame branch members briefly pointed out about the psychological and physical impacts of RTAs on happiness of an individual and families. The physical impacts of RTAs include fatal accidents, serious injury and slight injury. In addition to this, another serious consequence of RTAs is psychological problems which can have a substantial impact on the survivors of RTAs and their families. Families also hurt from their children’s involvement in RTAs. They are considered another hidden victim of RTAs, and need care and support just like other RTAs victims or survivors. Families can be affected psychologically and socially. It was noted in KIIs and FGDs that RTAs is a serious problem of human health.

The findings based on observations, from the KIIs, FGDs and questionnaire survey RTAs is the major cause of fatal accidents, serious injury and slight injury. In general, RTAs in Durame town is the major problem of human health (i.e. physical and psychological).

Table 38: Major health impacts of RTAs in Durame town.

| Major health impacts of RTAs | Respondents |      |                |      |        |      |       |      |
|------------------------------|-------------|------|----------------|------|--------|------|-------|------|
|                              | Pedestrians |      | Traffic police |      | Driver |      | Total |      |
|                              | Count       | %    | Count          | %    | Count  | %    | Count | %    |
| Fatal accident               | 12          | 10   | 7              | 5.8  | 10     | 8.3  | 29    | 24.2 |
| Serious injury accident      | 16          | 13.3 | 10             | 8.3  | 14     | 11.7 | 40    | 33.3 |
| Slight injury accident       | 22          | 18.3 | 13             | 10.8 | 16     | 13.3 | 51    | 42.5 |
| Total                        | 50          | 41.7 | 30             | 25   | 40     | 33.3 | 120   | 100  |

Source: Field survey Computed by the Author, 2022

As displayed in Table 47, the questionnaire survey indications that from the overall responses to major health impacts of RTA, fatal accident, serious injury accident and slight injury accident accounted for 29 (24.2%), 40(33.3%) and 51(42.5%), respectively. So that, the data shows that RTAs is a serious problem

of health in the Durame town. Table 39 computed from the raw data obtained from Durame town police accident statistics to show the major health impacts of RTAs in Durame town from 2016– 2021.

Table 39: The major health impacts of RTA in Durame town (2016 – 2021)

| Accident severity       | Accident year |           |           |           |           |           | Total      | %          |
|-------------------------|---------------|-----------|-----------|-----------|-----------|-----------|------------|------------|
|                         | 2016          | 2017      | 2018      | 2019      | 2020      | 2021      |            |            |
| Fatal accidents         | 7             | 10        | 8         | 6         | 6         | 15        | 52         | 22.3       |
| Serious wound accidents | 8             | 13        | 12        | 25        | 22        | 8         | 88         | 37.8       |
| Slight wound accidents  | 11            | 18        | 11        | 20        | 14        | 19        | 93         | 39.9       |
| <b>Total</b>            | <b>26</b>     | <b>41</b> | <b>31</b> | <b>51</b> | <b>42</b> | <b>42</b> | <b>233</b> | <b>100</b> |

Source: Computed from Data obtained from DTPO by the Author, 2022

As Table 39 shows, the existing police accident statistics indications that from the total RTAs, fatal accidents, serious wound accidents and slight wound accidents accounted for 52 (22.3%), 88 (37.8%) and 93 (39.9%), respectively. The statistics indication that from every 100 RTA casualties in Durame town 22.3 have the probability of loss, 37.8 the fate of serious injury and the rest 39.9 the risk of suffering from slight wound due to RTAs. The maximum frequency of serious wounds and slight wounds in the town have been revealed in the years of 2019 and the greatest shocking fatal accidents of road crashes have been exposed in 2021 in the town. Accordingly, secondary data resulting from Durame town police indication that RTAs is the major problem of human health in Durame town



Plate 3: RTA Casualty around the get of Lalo sub town black spot of Durame town.

(Source: Durame town Traffic Office, 2019).

#### 4.8.2 Economic Impacts of RTAs in Durame Town

RTAs have multidimensional impacts over the economy of the town. In addition to the health impacts of RTAs, Durame town is also suffering huge economic loss from road crashes. The police member key

informant justify that, RTAs have multidimensional impacts over the economy of the town. More specifically, impacts of RTA have direct economic impact when it is manifested over a property and have indirect influence when it is exhibited on pedestrians or/and passengers and drivers. The victim of RTAs key informants point out, RTAs affect the household of victims, the community and the town of economic regarding to loss of property, cost to economy and cost to health service.

Totally FGD members agree that RTAs in Durame town is the major problem of economy. The FGDs from Ethiopian insurance company Durame branch members shown more information concerning the economic impacts of RTAs based on their perceptions and experiences said that the economic impacts of RTAs more sever in Durame town. RTAs are now day worsening the economic wealth of the town regarding to the direct economic costs and the cost of road crash injuries, and therefore, RTAs a serious problem. The FGDs member from traffic police officer agree and said that, the distributions and the cost of property damages due to RTAs have revealed an increasing trend from time to time. It was noted in KIIs and FGDs that RTAs a serious problem of economic. The findings based on observations; from the questionnaire survey, KIIs and FGDs participant show that RTAs have multi.

Table 40: Economic impacts of RTAs in Durame town faceted impacts over the economy of the town.

| Economic impacts of RTA | Respondents |      |                |      |              |      |       |      |
|-------------------------|-------------|------|----------------|------|--------------|------|-------|------|
|                         | Passengers  |      | Traffic police |      | Driver Total |      | Total |      |
|                         | Count       | %    | Count          | %    | Count        | %    | Count | %    |
| cost to economy         | 13          | 10.8 | 8              | 6.7  | 10           | 8.3  | 31    | 25.3 |
| Loss of property        | 22          | 18.3 | 15             | 12.5 | 18           | 15   | 55    | 45.8 |
| Cost to health service  | 15          | 12.5 | 7              | 5.8  | 12           | 10   | 34    | 28.3 |
| Total                   | 50          | 41.7 | 30             | 25   | 40           | 33.3 | 120   | 100  |

Source: Field survey Computed by the Author, 2021

In Table 40 described that , the questionnaire survey indications that from the total responses to economic impacts of RTA, loss of property, cost to health service and cost to economy accounted for 55(45.8%), 34 (28.3%) and 31(25.3%), respectively. The findings prove that RTAs have multidimensional impacts over the economy of the Durame town. Table 50 computed from the raw data obtained from in Durame town police accident statistics to show the economic impacts of RTAs in in Durame town from 2016– 2021.

Table 41: Economic impacts of RTAs in Durame town (2016 – 2021)

| Accident year | Number of property accidents | Property damage estimated cost (ETB) | Average cost (ETB) | %     |
|---------------|------------------------------|--------------------------------------|--------------------|-------|
| 2016          | 13                           | 1,890,233                            | 145,402.6          | 12.03 |
| 2017          | 21                           | 3,450,642                            | 164,316.3          | 21.97 |
| 2018          | 17                           | 1,971,490                            | 115,970            | 12.6  |
| 2019          | 21                           | 2,935,763                            | 139,798.2          | 18.7  |
| 2020          | 9                            | 1,225,489                            | 136,165.4          | 7.8   |
| 2021          | 28                           | 4,231,248                            | 151,116            | 26.9  |
| Total         | 109                          | 15,704,865                           | 852,768.5          | 100   |

Source: Computed from Data obtained from DTPO by the Author, 2022

In Table 41 as described that, the existing police accident statistics indications that the estimated total cost of RTA in Durame town from 2016 to 2021 reached ETB 15,704,865. The highest estimated RTA cost has been recorded at ETB 4,231,248 (i.e. 26.9%) in 2021 and the lowest at ETB 1,225,489 (i.e. 7.8%) in 2020 in the town. The year 2016, 2017, 2018, and 2019 exhibited ETB 1,890,233 (i.e. 12.03%), ETB 3,450,642 (i.e. 21.97%), 1,971,490(i.e. 12.6%), and ETB 2,935,763 (i.e. 18.7%) RTA cost respectively. In general, the town has lost ETB 15,704,865in the last six years only due to RTAs. More specifically, 342 RTAs happened in the town in the last six years, 109 (i.e.31.87%) of the accidents have been accompanied with property damages. Accordingly, every single accident complemented with property damage has led to an average financial loss of ETB 852,768.5in Durame town in the study period. The highest frequency of RTAs resulting property damages (i.e. 28), have been documented in 2021 and the lowest which is (i.e. 9) incidences in 2020. Durame town which is revealed the economic loss of an average ETB 2,617,477.5 every year only due to RTAs.

Plate 4: Different Vehicle crashed in the place/black spot of Durame town



(Source: Durame town Traffic Office, 2022).

In Plate 4, as described that the heavy truck crashed in Zararo and Lalo sub-town place/black spot and suffering huge economic loss (i.e. loss of property, cost to economy). Generally, the findings based on primary and secondary data indications that RTAs is the major problem of economic.

### 4.8.3. Social Impacts of RTAs in Durame Town

The distributions of people to RTAs can be a cause for social insecurity and social crisis. In addition to the health and economic impacts of RTAs, Durame town is also suffering the social impacts from road crashes. In all interviews members said that RTAs are serious social problems. During interview the police member key informant point out, RTAs affect the whole social groups of the community, but especially the young adults group of the community more severely affected. The other victim of RTA KIIs describes children, disabled and female of the community groups are more exposed to RTAs.

The FGDs member from Ethiopian insurance company Durame branch member defend that, RTAs have double impacts over the social aspect of the town and mainly, highly affect the adults and male groups of the community. And also the traffic police officer defines female, elder, children, and disabled of the community groups more exposed to RTAs. The other FGDs member from Durame town road transport office member said that, RTAs impacts have shown an increasing trend with their influence on the social aspects of the livelihood. The town death due to RTAs happens among young adults and productive age and the rates for this age group are higher. It was noted in KIIs and FGDs that RTAs is a serious problem of social.

The findings based on the KIIs and FGDs member and observations, and questionnaire surveys indications that RTAs affect the aggregate social groups of the community, mainly the adults and male groups of the community more severely affected. In addition to these children, elder, female and disabled of the community groups more exposed to RTAs. The findings based on the existing questionnaire survey prove that RTAs the major problem of social.

The next tables from 42 to 44 computed from the raw data obtained from Durame town police accident statistics to indications the social impacts of RTAs in Durame town from 2016 – 2021

Table 42: Distribution of RTA casualties by sex in Durame town (2016 – 2021)

| Accident | Accident year |      |      |      |      |      | Total | % |
|----------|---------------|------|------|------|------|------|-------|---|
|          | 2016          | 2017 | 2018 | 2019 | 2020 | 2021 |       |   |
|          |               |      |      |      |      |      |       |   |

| severity       | M  | F | M  | F  | M  | F  | M  | F  | M  | F  | M  | F  | M   | F  | T   |      |
|----------------|----|---|----|----|----|----|----|----|----|----|----|----|-----|----|-----|------|
| Fatal accident | 4  | 3 | 6  | 4  | 3  | 5  | 3  | 3  | 4  | 2  | 9  | 6  | 29  | 23 | 52  | 22.3 |
| Serious injury | 6  | 2 | 8  | 5  | 8  | 4  | 16 | 9  | 14 | 8  | 5  | 3  | 57  | 31 | 88  | 37.8 |
| Slight injury  | 8  | 3 | 11 | 7  | 6  | 5  | 12 | 8  | 9  | 5  | 11 | 8  | 57  | 36 | 93  | 39.9 |
| Total          | 18 | 8 | 25 | 16 | 17 | 14 | 27 | 20 | 27 | 15 | 25 | 17 | 143 | 90 | 233 | 100  |

Source: Computed from Data obtained from DCP by the Author, 2022

M=Male F= Female

As shows in the table 42, the existing police accident statistics indications that males were more frequently exposed to road crashes than females in the town. Based on the data, 143 (i.e. 61.4%) males and 90 (i.e. 38.6%) females were victims of RTAs in the town from 2016 to 2021. In general, males were 1.59 times more prevalent to RTAs than females in Durame town. More specifically, males were 1.3 times, 1.84 times and 1.58 times much vulnerable than females to fatal accidents, serious injury and slight injury in Durame town respectively. In addition to this, males were more victims of RTAs than females in all accident severity and in all years from 2016 to 2021.

Table 43: Distribution of RTA casualties by age in Durame town (2016 – 2021)

| Age group    | Accident year |      |      |      |      |      | Total | %    |
|--------------|---------------|------|------|------|------|------|-------|------|
|              | 2016          | 2017 | 2018 | 2019 | 2020 | 2021 |       |      |
| Less than 18 | 8             | 9    | 7    | 11   | 10   | 9    | 54    | 23.2 |
| 18 – 30      | 11            | 22   | 18   | 26   | 23   | 24   | 124   | 53.2 |
| 31 – 50      | 4             | 6    | 4    | 10   | 6    | 5    | 35    | 15   |
| More than 51 | 3             | 4    | 2    | 4    | 3    | 4    | 20    | 8.6  |
| Total        | 26            | 41   | 31   | 51   | 42   | 42   | 233   | 100  |

Source: Computed from Data obtained from DTPO by the Author, 2022

In Table 43 as described that the existing police accident statistics show that all age groups are not equally exposed to RTAs. Adults among 18 to 30 years of age are more frequently exposed to RTAs in the town. Based on the data, less than 18 years of age, among 19 to 30 years of age, among 31 to 50 years of age, and more than 50 years of age accounted for 54 (23.2%), 124 (53.2%), 35 (15%) and 20 (8.6%), respectively were victims of RTAs in the town from 2016 to 2021. In general, the severity rate of RTA in all severity classes is much higher in the age groups of 18 to 30 than the others in the town from 2016 to 2021. Accordingly to, the secondary data derived from Durame town indications that RTAs is the major problem of social insecurity and social crisis in the study area.



Plate 5: Motor Bicycle collision with different Vehicle Type crashed in different place/Black spot areas Durame town (Source: Durame town Traffic Office, 2020).

Generally, the findings based on primary and secondary data indications that RTAs is the major social problem in the study area.

**4.8.4 Physical Environment Impacts of RTAs in Durame Town**

The distributions of RTAs have impacts over the physical environment is a serious problem in the study area and the physical environment impacts of RTAs include damage of infrastructures, damage of vegetation and land degradation. In all interviews participants said that RTAs have impacts over the physical environment. During interview one member (police participant) said that RTAs damage the physical environment. These impacts of physical environment include the damage of infrastructure such as damage of road network, telecommunication network and water supply network.

It was added by another participant (victim of RTA) that RTAs can affect the physical environment regarded include damage of physical structure such as damage of bridge, roads, buildings and houses. It was noted in all interviews that RTAs have impacts over the physical environment The FGDs from Ethiopian insurance company Durame branch members provided more information concerning the impacts of RTAs on physical environment. During discussions the members said that impact of RTAs on physical environment include degradation and deterioration of land (i.e. by oils & petroleum), damage of plants, and pollution of air, soil, and water.

As revealed, from the KIIs and FGDs member and questionnaire survey and observations indication that RTAs have impacts over the physical environment. The impacts of RTAs on physical environment not only include the damage of physical structure such as damage of buildings, roads, bridge, , and houses but also include the deterioration and degradation of land (i.e. by oils & petroleum), damage of plants, and pollution of pollution of air, soil, and water.

Table 44: Physical environment impacts of RTAs in Durame town.

| Physical environment impacts of RTA | Respondents |      |                |      |        |      |       |      |
|-------------------------------------|-------------|------|----------------|------|--------|------|-------|------|
|                                     | Pedestrians |      | Traffic police |      | Driver |      | Total |      |
|                                     | Count       | %    | Count          | %    | Count  | %    | Count | %    |
| Damage of infrastructures           | 21          | 17.5 | 13             | 10.8 | 17     | 14.2 | 51    | 42.5 |
| Land degradation                    | 18          | 15   | 10             | 8.3  | 13     | 10.8 | 41    | 34.2 |
| Damage of vegetation                | 11          | 9.2  | 7              | 5.8  | 10     | 8.3  | 28    | 23.3 |
| Total                               | 50          | 41.7 | 30             | 25   | 40     | 33.3 | 120   | 100  |

Source: Field survey Computed by the Author, 2022

As shown in Table 44, the questionnaire survey shows that from the total responses to physical environment impacts of RTA, damage of infrastructures, damage of vegetation and land degradation accounted for 28 (23.3%), 48 (40%) and 44 (36.7%), respectively. Therefore, the data shows that road traffic accidents have impacts over the physical environment.

Plate 6: Minibus and Bus crashed around kasha place/black spot



(Source: Durame town Traffic Office, 2021)

In Plate 6 as indication, the bus crashed around Kasha place/black spot and damaged the physical environment (i.e. plants, land). Generally, the data prove that RTAs have impacts over the physical environment.

Generally, the findings based on primary and secondary data indication that the socioeconomic, health, and physical environment impacts of RTA have shown more severe trend and tends to be the most serious problem in the study period.

#### **4.9 Challenges to the Prevention of RTA in Durame town**

The systems of RTAs prevention or reduction measures in Durame town practice generally based on two types of mechanisms, the first mechanism based on traffic safety management and control activities and the second one by giving education and awareness for the community. The police member key informant (head of traffic police department) provided more information concerning systems of RTA prevention or reduction measures based on his experiences and perceptions. According to the head of traffic police department, under the provisions of the 1942 Police Proclamation, the main functions of the police are the prevention of the occurrence of crime (i.e.RTAs), the apprehension of criminals, the maintenance of law and order, the protection of the safety of people and property, and the regulation of traffic. In doing so, the police are expected to deal with every citizen with the principles of due process of the law and to reach at right place and at right time to prevent or reduce RTAs.

In Durame, police stations and police personnel are randomly distributed, but not based on systematic and problem solving methods (i.e.RTAs). This indicates that the distributions of police stations and police personnel are not based on the real problem of the community and not supported by research rather depend on only traditional mechanism and therefore, the distribution of police station and police personnel are not systematic and not properly structured to prevent RTA in Durame town.

It was added by another police member respondent that, police have primary and secondary goals and objectives; regarding primary objectives and goals, maintaining order and protecting life and property are the most basic functions, and the secondary goals and objectives are meeting the primary goals which includes; preventing crime (i.e.RTAs), arresting and prosecuting offenders, recovering stolen and missing property, assisting the sick and injured and enforcing non-criminal regulations. According to the interviews, the police station (institution) delivering services regarding to the stated goals and objectives related to RTAs prevention or reduction measures are not systematic and modern method but focus only on traditional method.

The basic issues raised by (FGDs)and(KIIS) members are logical regarding the traffic safety management and control supporting materials to prevent or reduce RTAs such as, motorcycle,

pedal cycle, radar, vehicles and alcohols and drugs tester. According to (FGDs) and (KIIS) members, particularly traffic police officers and police members stated that the Durame town police have only 1 motorcycle to perform the activities of traffic safety management and control, and there are no other materials that support traffic safety management and control in the town. Based on these findings, the traffic safety management and control activities are not modern and not properly structured to prevent or reduce RTAs in Durame town.

According to (FGDs) and (KIIS) members, the methods of RTAs reduction or prevention measures in Durame town practice generally based on two types of mechanism, the first mechanism based on traffic safety management and control activities, and enforcing the laws and regulation related to road traffic safety and control by traffic police officers and other concerned body (i.e. Durame town road transport office members) and the second one by giving education and awareness for the community (i.e. drivers ,students, and road users) about traffic safety management and control mechanism. According to the explanation of members, these RTAs reduction or prevention methods relatively play a great role in reduction or prevention of RTAs in the town, and also said that for efficient and effective RTAs prevention, traffic police personnel, logistic and other traffic safety management and control supporting materials such as traffic safety signals and signs (i.e. traffic light) shall be fulfilled in Durame town.

The findings based on observations indication that the distributions of police station, police personnel, and the traffic safety management and control activities are not systematic and properly structured, and not modern to prevent or reduce RTAs in the study period. The findings based on the available questionnaire survey also prove that the methods of RTAs reduction or prevention measures in Durame town practice generally based on two types of mechanism, the first mechanism based on traffic safety management and control activities and the second one by giving education and awareness for the community.

According to the secondary data obtained from Durame town police to indication the trends of RTAs from 2016 – 2021 and accident investigation record reviews the police personnel, and the traffic safety management and control activities are not systematic and properly structured, and not modern to prevent or reduce RTAs in the study period.

Generally, the findings based on primary and secondary data show that the methods of RTAs reduction or prevention measures in Durame town practice generally based on two types of mechanism, the first mechanism based on traffic safety management and control activities and the second one by giving education and awareness for the community. In addition to this, the distributions of police station, police personnel, and the traffic safety management and control activities are not systematic and properly structured, and not modern to prevent or reduce RTAs, and the distributions and frequencies as well as the health, socioeconomic and physical environment impacts of RTAs have revealed more severe trend in the study period

## ***CHAPTER FIVE***

### ***5 Conclusion and Recommendations***

#### ***5.1. Conclusion***

This paper has focuses on the value of using a combination of different types of information based spatio-temporal Analysis of road traffic accident in Durame town. In this study, examine the trend of RTA, identify Underlying causes for RTAs, map places of spots and black spots RTAs was displayed on the crash locations map, analyze the impacts of RTA in terms of time and space RTAs, and the types of measures to be taken to prevent or reduce RTAs in Durame town have been discussed. Occurrence and trend of RTAs in Durame Town exhibits variations because of the impact of various variables like driver factors, vehicle factors, road factors and weather conditions. In Durame Town among the various reasons causing RTAs, driver factors are the leading responsible factor than other factors for RTAs in Durame Town. Vehicle factors, road factors and weather condition accounted for second, third and fourth rank respectively, responsible factors for road traffic accident in Durame Town

RTAs are affecting the inhabitants of the town in several sides. The RTA victims of the town mainly belong to the productive age groups. The statistical analysis of this study revealed that Traffic accidents were increased time to time (2016- 2021) and recorded 52 fatal accident,88 Serious injury accident,93 Slight injury accident, and 109 property damage cases in Durame town level. RTAs are randomly distributed in the town in terms of time and space. The regularities of RTAs as well as the socio-economic impacts of RTAs have shown an increasing trend in the study time. The maps showing the distributions and frequencies of RTAs occurred in the RTA black spots of Durame town exhibits variation. This study shows that 13 black spots with 246 accident frequency were identified in Durame town in past 6 consecutive years (2016-2021). The map indicates that from 342 total RTA incidences 246 (i.e.71.9%) RTAs have occurred in these 13 places/black spots. Zararo sub town holds the lion share of the spatial distribution of RTAs blakspot and frequency of RTAs. Lastly the most 9 severe RTAs blakspot which cause 206 RTAs were identified and they ranked 1-9 respectively. Reduction or

prevention measures are first mechanism based on traffic safety management and control activities and the second one by giving education and awareness for the community.

## **5.2 Recommendations**

On the foundation of the above findings, it is possible to propose the following recommendations. This recommendation will help as the benchmark for scholars, policy makers and road user to focus on selected area of emphasis so as to minimize the level of accident on Durame town.

- The data storage system of Durame town police commission was limited by attribute data. Hence, it is recommended to use a comprehensive (both spatial and non-spatial) database system which is useful to record and provide data in detail and in a specific manner. Primarily training should be provided to traffic police officers on how to collect XY coordinates using GPS to correctly record incidents locations. For this fact, the everyday RTA recording format should be redesigned in a way that the Eastings, Northings and elevation of the accident spot can be recorded. Finally, the data will be very useful and easy to transport-related investigations.
- Durame Town Police should give attention for modern and well organized system regarding traffic police personnel and logistic. By use Smart traffic control technology (artificial intelligence) speed control instruments such as RADAR installation, Robots ,alcohol breath tester, speed limiters (Such as use electric vehicles), handheld speed radars .etc.) Along the road way and others scientific based mechanism which helps to monitor speed of vehicles and implement punishment on those violating speed limit during driving.
- It is important to install Rumble Strip (speed breaker) at a range of minimum stopping site distances from entrances and exit gate in a way that reduce accident frequency.
- Monitoring and evaluation of drivers' training schools, Review of driver testing and Review of medical certificate, Institutional capacity of driver training schools should be following by Global Framework Plan of Action related to Safer Vehicles, Legislation, Enforcement, Education, and Technology standardized; a longer minimum time of driving experience should be imposed before a license is issued to a driver. In addition, there should be additional precondition criteria for drives with regard to their background and good behavior, age, driving experience, free from any addiction like chewing chat, alcoholic drinks, free from criminal acts as well as offending violation of traffic regulations. There should be a restriction for drivers regarding the length of driving hours (working hours) because most drivers are on the road for

about 13 to 16 hours a day continuously, which leads to the use of chat as energizing and that in turn makes them more aggressive drivers.

- Special attention for the identified vulnerable areas have to be given by the concerned stakeholder, institutions, and governmental agencies/authorities such as DTTA, DTTO, DTPO, and KTZPO should perform continuous investigation and assessment to RTAs at the town level. The traffic management agency should prepare hazard/ black spot maps at the town level to regulate and create awareness. Road crash injury is largely preventable and predictable; there are some common prone areas at the unique level in which the prevalence of road casualties was higher. Those unique Black Spot(area)are New commercial bank of Ethiopia(Adisu Bank), wata slope and its bridge area, In front of Tackle haymanot charch, Colonel Tekatel Wodebo square , Zararo administration office, D.c Bogelach Gabire Matasabt General hospital , Wachamo University Durame campus area, Around Mesale hotel ,and In front of Dongicho health center, so special attention should be given to those area with regard to RTAs campaigns.so that prioritization must be given for above sensitive 9 Black Spot(area).
- The misuse of the scarce footways by service giving enterprises such as Garages, Wood and Metal works, Groceries, Restaurants, street peddlers or hawkers, should be controlled. Also parking cars on both or either sides of the road along narrow one-way or two-way streets mainly in front of Hotels, Restaurants and supermarkets can be controlled by introducing paid parking (Parking meters). The absence of traffic signals such as traffic lights and their frequent technical failure creates chaos around squares and major road junctions leading to the incidence of traffic accidents. Therefore, the expansion of traffic lights to all accident-prone squares and major road junctions should receive immediate response. In addition to this order to enable traffic polices control the traffic flow efficiently; building Traffic signs and signals on this areas , widening the major road junctions, by good land-use planning can decrease exposure and crash risks, so that traffic polices could control traffic flow of other roads than mere in the junctions and, special care should be given to the RTA black spots already identified
- The drivers should apply the low of seat belts, safety helmet and child restraints.
- The government should improve the payment of traffic police to decrease corruption and to motive traffics for work.
- Constructed standard way road, vehicle station, and bridge. In line with this, additional pedestrian bridge and side walkways others must be constructed in the side of roads of the town the concern body allocate enough budgets to alleviate the problem.

- Hospitals /health centers servants should be trained how they assist the injured peoples, and should be ready with emergency equipment such as blood and Ambulances to safeguard the destiny of survival of RTA casualties. In line with to Strengthen Pre-hospital care one of mitigation way RTAs.
- Durame Town traffic Police should give special attention to deliver education and awareness in well organized and systematic manner for the whole communities to change the attitude and behavior, and to develop the sense of responsibility and ownership to prevent or reduce RTAs in the Town. society traffic education should be offered and encouraged through the radio, television, newspapers, magazines, books, films, leaflets, social media and posters as well as giving traffic education around worship places and public gatherings, and the like. Basic education about RTAs requires for all level of students at schools.
- Most of the RTAs in Durame town where occurred at market day (Saturday and Tuesday), Evening time special (between 6pm-12pm) and at work day Monday. Hence, traffic polices should be assigned and take special regulations on the major roads and blakspot of the town

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## APPENDIX A

### APPENDIX A: Actual and Compiled RTAs data from Durame Town.

(Source: Durame Town traffic police department)

Table A1 RTAs data by days of week.

| Days         | Accident year |           |           |           |           |           | Total      | %          |
|--------------|---------------|-----------|-----------|-----------|-----------|-----------|------------|------------|
|              | 2016          | 2017      | 2018      | 2019      | 2020      | 2021      |            |            |
| Monday       | 9             | 15        | 11        | 21        | 13        | 20        | 89         | 26         |
| Tuesday      | 4             | 9         | 6         | 8         | 5         | 11        | 41         | 12         |
| Wednesday    | 3             | 5         | 3         | 4         | 2         | -         | 17         | 5          |
| Thursday     | 2             | 4         | 4         | 6         | 4         | 2         | 22         | 6.4        |
| Friday       | 3             | 6         | 5         | 4         | 3         | 6         | 27         | 7.9        |
| Saturday     | 14            | 20        | 16        | 23        | 17        | 22        | 112        | 32.75      |
| Sunday       | 4             | 5         | 3         | 6         | 7         | 9         | 34         | 9.95       |
| <b>Total</b> | <b>39</b>     | <b>62</b> | <b>48</b> | <b>72</b> | <b>51</b> | <b>70</b> | <b>342</b> | <b>100</b> |

Table A2: RTAs data in a year by month

| Months       | Accident Year |           |           |           |           |           | Total      | %          |
|--------------|---------------|-----------|-----------|-----------|-----------|-----------|------------|------------|
|              | 2016          | 2017      | 2018      | 2019      | 2020      | 2021      |            |            |
| January      | 2             | 2         | 3         | 4         | 3         | 4         | 18         | 5.3        |
| February     | 1             | 3         | 0         | 3         | 0         | 3         | 10         | 2.9        |
| March        | 2             | 0         | 2         | 0         | 2         | 1         | 7          | 2          |
| April        | 0             | 1         | 3         | 3         | 4         | 2         | 13         | 3.8        |
| May          | 1             | 3         | 3         | 5         | 3         | 4         | 19         | 5.6        |
| June         | 3             | 4         | 4         | 6         | 4         | 5         | 26         | 7.6        |
| July         | 8             | 13        | 9         | 15        | 11        | 16        | 72         | 21         |
| August       | 7             | 11        | 7         | 13        | 12        | 13        | 63         | 18.4       |
| September    | 3             | 5         | 3         | 4         | 2         | 4         | 21         | 6.2        |
| October      | 2             | 1         | 3         | 2         | 1         | 3         | 12         | 3.5        |
| November     | 4             | 9         | 6         | 8         | 4         | 5         | 36         | 10.5       |
| December     | 4             | 8         | 4         | 6         | 5         | 7         | 34         | 9.9        |
| Unknowns     | 2             | 2         | 1         | 3         | 0         | 3         | 11         | 3.2        |
| <b>Total</b> | <b>39</b>     | <b>62</b> | <b>48</b> | <b>72</b> | <b>51</b> | <b>70</b> | <b>342</b> | <b>100</b> |

Table A3: RTAs data by Drivers age

| Drivers Age in years | Accident year |           |           |           |           |           | Total      | %          |
|----------------------|---------------|-----------|-----------|-----------|-----------|-----------|------------|------------|
|                      | 2016          | 2017      | 2018      | 2019      | 2020      | 2021      |            |            |
| <18                  | 5             | 7         | 2         | 9         | 3         | 13        | 39         | 11.4       |
| 18-30                | 17            | 31        | 28        | 35        | 38        | 36        | 185        | 54.1       |
| 31-50                | 11            | 18        | 14        | 19        | 7         | 18        | 87         | 25.43      |
| >50                  | 6             | 5         | 2         | 7         | 3         | 2         | 25         | 7.31       |
| Unknowns             | 0             | 1         | 2         | 2         | 0         | 1         | 6          | 1.76       |
| <b>Total</b>         | <b>39</b>     | <b>62</b> | <b>48</b> | <b>72</b> | <b>51</b> | <b>70</b> | <b>342</b> | <b>100</b> |

Table A4: RTA data Weather condition factors

| Weather Condition related factors | Accident year |           |           |           |           |           | Total      | %          |
|-----------------------------------|---------------|-----------|-----------|-----------|-----------|-----------|------------|------------|
|                                   | 2016          | 2017      | 2018      | 2019      | 2020      | 2021      |            |            |
| Good weather                      | 35            | 55        | 46        | 63        | 49        | 64        | 312        | 91.2       |
| Temperature/Hot                   | -             | -         | -         | -         | -         | -         | -          | -          |
| Drizzle/light rain                | 1             | 3         | 1         | 4         | -         | 3         | 12         | 3.5        |
| Cloudy & Foggy                    | -             | -         | -         | -         | -         | -         | -          | -          |
| Wind speed                        | -             | -         | -         | -         | -         | -         | -          | -          |
| Heavy rain                        | 3             | 4         | 1         | 5         | 2         | 3         | 18         | 5.3        |
| <b>Total</b>                      | <b>39</b>     | <b>62</b> | <b>48</b> | <b>72</b> | <b>51</b> | <b>70</b> | <b>342</b> | <b>100</b> |

## Appendix B

### Appendix B: Field served plate of most cause for RTAs

#### Drivers and pedestrians' characteristics



In front of Mesale hotel

#### Taken from main road of the Durame town about poor road conditions

Colonel Tekatel Wodebo square



Around Mesale hotel area

Bake of Tackle haymanot church



**Road Traffic Congestion and Durame town traffic police controlling**



Source: Field Survey

## Appendix c

### Appendix c: GPS data with its RTA Spot names and RTA Spot codes

GPS data shown in RS excel data of Road Traffic Accident Location (RTA Spot) names and Road Traffic Accident Location (RTA Spot) codes

| Object ID | shape | RTA Location Name (RTA Spot Name)    | Code | Latitude: | Longitude | Altitude: (m.) | X: (m.)  | Y: (m.)  | Z: (m.) | Height (MSL): (m.) |
|-----------|-------|--------------------------------------|------|-----------|-----------|----------------|----------|----------|---------|--------------------|
| 1         | Point | New CBE (Adisu bank)                 | 11   | 7.245183  | 37.90629  | 2134.96        | 379255.9 | 800998.5 | 2134.96 | 2134.96            |
| 2         | Point | Omo macro finance initiation         | 12   | 7.245046  | 37.9062   | 2135.09        | 379246   | 800983.4 | 2135.09 | 2135.09            |
| 3         | Point | Global insurance company             | 13   | 7.245293  | 37.906    | 2134.4         | 379223.8 | 801010.8 | 2134.4  | 2134.4             |
| 4         | Point | Dabub Global bank                    | 14   | 7.24539   | 37.90595  | 2136.7         | 379217.8 | 801021.5 | 2136.7  | 2136.7             |
| 5         | Point | Durame public Library                | 15   | 7.245593  | 37.90597  | 2140.6         | 379220.4 | 801043.9 | 2140.6  | 2140.6             |
| 6         | Point | Gogota careKTZ people development    | 16   | 7.245593  | 37.90597  | 2140.6         | 379220.4 | 801043.9 | 2140.6  | 2140.6             |
| 7         | Point | kalahywot to stadium                 | 17   | 7.245593  | 37.90597  | 2140.6         | 379220.4 | 801043.9 | 2140.6  | 2140.6             |
| 8         | Point | stadium                              | 18   | 7.245593  | 37.90597  | 2140.6         | 379220.4 | 801043.9 | 2140.6  | 2140.6             |
| 9         | Point | KTZ Administration office            | 19   | 7.246771  | 37.90514  | 2137.17        | 379129   | 801174.4 | 2137.17 | 2137.17            |
| 10        | Point | Colonel Tekatel Wodebo Square        | 20   | 7.247047  | 37.90496  | 2136.89        | 379109.3 | 801205   | 2136.89 | 2136.89            |
| 11        | Point | Colonel Tekatel wodebo square        | 21   | 7.246922  | 37.90497  | 2135.96        | 379109.9 | 801191.1 | 2135.96 | 2135.96            |
| 12        | Point | Stadium                              | 22   | 7.246799  | 37.905    | 2136.91        | 379113.1 | 801177.5 | 2136.91 | 2136.91            |
| 13        | Point | Stadium                              | 23   | 7.245495  | 37.9039   | 2134.49        | 378991.4 | 801033.7 | 2134.49 | 2134.49            |
| 14        | Point | stadium                              | 24   | 7.24527   | 37.90366  | 2133.02        | 378965.1 | 801008.8 | 2133.02 | 2133.02            |
| 15        | Point | Ambericho bilate snadosa parish      | 25   | 7.245453  | 37.90313  | 2131.65        | 378906.8 | 801029.1 | 2131.65 | 2131.65            |
| 16        | Point | Lencho Mobile center                 | 26   | 7.245302  | 37.9031   | 2132.54        | 378903.4 | 801012.5 | 2132.54 | 2132.54            |
| 17        | Point | Gasor middle drag center             | 27   | 7.24508   | 37.90308  | 2132.29        | 378901   | 800987.9 | 2132.29 | 2132.29            |
| 18        | Point | Golden computer center               | 28   | 7.244426  | 37.90225  | 2126.76        | 378809.7 | 800915.8 | 2126.76 | 2126.76            |
| 19        | Point | Abiti medium clinic                  | 29   | 7.244501  | 37.90221  | 2127.11        | 378805.1 | 800924.1 | 2127.11 | 2127.11            |
| 20        | Point | Earu Mobile                          | 30   | 7.244608  | 37.9021   | 2128.17        | 378792.6 | 800936   | 2128.17 | 2128.17            |
| 21        | Point | Grmach juice house                   | 31   | 7.244738  | 37.90195  | 2127.83        | 378775.9 | 800950.5 | 2127.83 | 2127.83            |
| 22        | Point | Durame town administration office    | 32   | 7.24497   | 37.90175  | 2126.42        | 378754   | 800976.1 | 2126.42 | 2126.42            |
| 23        | Point | Zararo administration office         | 33   | 7.245049  | 37.90171  | 2125.86        | 378749.9 | 800984.9 | 2125.86 | 2125.86            |
| 24        | Point | Nazr ate drag store                  | 34   | 7.245183  | 37.90154  | 2124.48        | 378731.6 | 800999.7 | 2124.48 | 2124.48            |
| 25        | Point | Nazi raw drag store                  | 35   | 7.245237  | 37.90143  | 2123.25        | 378718.5 | 801005.7 | 2123.25 | 2123.25            |
| 26        | Point | Bearn bank                           | 36   | 7.245241  | 37.90125  | 2121.76        | 378698.7 | 801006.2 | 2121.76 | 2121.76            |
| 27        | Point | CBE kokata Branch                    | 37   | 7.245169  | 37.90106  | 2120.47        | 378678.6 | 800998.3 | 2120.47 | 2120.47            |
| 28        | Point | Above CBE kokata Branch              | 38   | 7.245126  | 37.90096  | 2119.76        | 378667.6 | 800993.7 | 2119.76 | 2119.47            |
| 29        | Point | CBE kokata Branch                    | 39   | 7.245108  | 37.90092  | 2119.47        | 378663.2 | 800991.6 | 2119.47 | 2116.07            |
| 30        | Point | CBE kokata Branch                    | 40   | 7.245073  | 37.90086  | 2119.01        | 378655.6 | 800987.7 | 2119.01 | 2119.01            |
| 31        | Point | Gabta cafe and reiterate             | 41   | 7.245002  | 37.90074  | 2118.24        | 378642.7 | 800979.9 | 2118.24 | 2118.24            |
| 32        | Point | Many gates of market area            | 42   | 7.244917  | 37.90062  | 2117.41        | 378629   | 800970.6 | 2117.41 | 2117.41            |
| 33        | Point | Nib international bank               | 43   | 7.244747  | 37.90039  | 2116.27        | 378604.3 | 800951.9 | 2116.27 | 2116.27            |
| 34        | Point | Durame town mazagaja office          | 44   | 7.244536  | 37.90014  | 2115.35        | 378576.4 | 800928.6 | 2115.35 | 2115.35            |
| 35        | Point | kedida gamelan court office          | 45   | 7.242317  | 37.89763  | 2105.1         | 378298.3 | 800683.9 | 2105.1  | 2105.1             |
| 36        | Point | Cristan Middam clinic                | 46   | 7.241604  | 37.89693  | 2105.57        | 378221.4 | 800605.2 | 2105.57 | 2105.57            |
| 37        | Point | Durame town police officer           | 47   | 7.241002  | 37.89603  | 2104.71        | 378121.4 | 800538.9 | 2104.71 | 2104.71            |
| 38        | Point | Durame town administration office    | 48   | 7.240849  | 37.89576  | 2104.5         | 378091.8 | 800522.1 | 2104.5  | 2104.5             |
| 39        | Point | Durame town police office            | 49   | 7.24063   | 37.89529  | 2104.56        | 378039.7 | 800498.1 | 2104.56 | 2104.56            |
| 40        | point | Foundation by foundation nous crimes | 50   | 7.24057   | 37.8952   | 2104.6         | 378029.5 | 800491.4 | 2104.6  | 2104.6             |
| 41        | point | Foundation by foundation Nous crimes | 51   | 7.24061   | 37.89528  | 2104.75        | 378039.2 | 800495.8 | 2104.75 | 2104.75            |
| 42        | point | Durame future and preparatory school | 52   | 7.240927  | 37.89569  | 2105.04        | 378084.6 | 800530.7 | 2105.04 | 2105.04            |

|    |       |  |     |          |          |         |          |          |         |         |
|----|-------|--|-----|----------|----------|---------|----------|----------|---------|---------|
| 43 | point | Nib international bank Durame Branch             | 53  | 7.241117 | 37.89589 | 2105.13 | 378106.6 | 800551.7 | 2105.13 | 2105.13 |
| 44 | point | Wegagen bank Durame Branch                       | 54  | 7.241179 | 37.89596 | 2105.16 | 378113.6 | 800558.5 | 2105.16 | 2105.16 |
| 45 | point | Public service social security agency DBO        | 55  | 7.241393 | 37.89617 | 2105.08 | 378137.7 | 800582.1 | 2105.08 | 2105.08 |
| 46 | point | Ethio telecom Durame                             | 56  | 7.241546 | 37.89633 | 2105.08 | 378154.7 | 800599   | 2105.08 | 2105.08 |
| 47 | point | Durame city first institute Court                | 57  | 7.244611 | 37.8977  | 2098.15 | 378307.3 | 800937.6 | 2098.15 | 2098.15 |
| 48 | point | Entrance of manariya                             | 58  | 7.244484 | 37.8981  | 2102.7  | 378350.6 | 800923.4 | 2102.7  | 2102.7  |
| 49 | point | Entrance of manariya                             | 59  | 7.24454  | 37.89845 | 2106.41 | 378390   | 800929.5 | 2106.41 | 2106.41 |
| 50 | point | Entrance of manariya                             | 60  | 7.244647 | 37.89858 | 2107.6  | 378404   | 800941.3 | 2107.6  | 2107.6  |
| 51 | point | Behan bank Durame Branch                         | 61  | 7.244716 | 37.89878 | 2110.46 | 378426.5 | 800948.9 | 2110.46 | 2110.46 |
| 52 | point | In front of Behan bank Durame Branch             | 62  | 7.244749 | 37.89888 | 2111.11 | 378436.9 | 800952.5 | 2111.11 | 2111.11 |
| 53 | point | Omo microfinance kedida Gamelan Branch           | 63  | 7.244831 | 37.89907 | 2112.67 | 378458.4 | 800961.5 | 2112.67 | 2112.67 |
| 54 | point | In front of Abyssinian Bank                      | 64  | 7.245038 | 37.89943 | 2115.01 | 378497.9 | 800984.3 | 2115.01 | 2115.01 |
| 55 | point | In front of Dashen bank Durame Branch            | 65  | 7.245097 | 37.89952 | 2115.56 | 378507.9 | 800990.8 | 2115.56 | 2115.56 |
| 56 | point | MKC charch                                       | 66  | 7.245164 | 37.8996  | 2115.91 | 378517   | 800998.2 | 2115.91 | 2115.91 |
| 57 | point | MKS charch                                       | 67  | 7.245188 | 37.89963 | 2116.05 | 378520.4 | 801000.8 | 2116.05 | 2116.05 |
| 57 | point | Masala hotel                                     | 68  | 7.245275 | 37.89973 | 2116.5  | 378531.4 | 801010.4 | 2116.5  | 2116.5  |
| 58 | point | Durame town Aden kalahyot charch                 | 69  | 7.245404 | 37.89988 | 2117.03 | 378547.6 | 801024.6 | 2117.03 | 2117.03 |
| 59 | point | Tackle Haymanot charch                           | 70  | 7.245529 | 37.90005 | 2117.83 | 378566.4 | 801038.4 | 2117.83 | 2117.83 |
| 60 | point | Many get of Tackle haymanot charch               | 71  | 7.245636 | 37.90023 | 2118.52 | 378586.3 | 801050.2 | 2118.52 | 2118.52 |
| 61 | point | Aklya furniture                                  | 72  | 7.245747 | 37.90048 | 2119.89 | 378614   | 801062.4 | 2119.89 | 2119.89 |
| 62 | point | in front of Tackle haymanot charch               | 73  | 7.245801 | 37.90061 | 2120.56 | 378628.8 | 801068.3 | 2120.56 | 2120.56 |
| 63 | point | Bake of masala Hotel                             | 75  | 7.245834 | 37.9007  | 2121.14 | 378638.9 | 801072   | 2121.14 | 2121.14 |
| 64 | point | In front of Tackle haymanot charch               | 74  | 7.245826 | 37.90066 | 2120.84 | 378634.5 | 801071   | 2120.84 | 2120.84 |
| 65 | point | Wogame medium clinic                             | 76  | 7.241862 | 37.89805 | 2091.46 | 378345.4 | 800633.4 | 2091.46 | 2091.46 |
| 66 | point | Second get of market area                        | 77  | 7.242329 | 37.8984  | 2094.89 | 378383.6 | 800685   | 2094.89 | 2094.89 |
| 67 | point | First gates of market area                       | 78  | 7.242584 | 37.89862 | 2095.98 | 378407.9 | 800713.1 | 2095.98 | 2095.98 |
| 68 | point | Mola Butuk                                       | 79  | 7.243094 | 37.89913 | 2100.29 | 378464   | 800769.5 | 2100.29 | 2100.29 |
| 69 | point | 3 rd. get of market area                         | 80  | 7.243883 | 37.90055 | 2112.7  | 378621.3 | 800856.3 | 2112.7  | 2112.7  |
| 70 | point | 4th get market area                              | 81  | 7.243883 | 37.90055 | 2112.7  | 378621.3 | 800856.3 | 2112.7  | 2112.7  |
| 71 | point | Ayzak zone trance Abonsa                         | 82  | 7.243883 | 37.90055 | 2112.7  | 378621.3 | 800856.3 | 2112.7  | 2112.7  |
| 72 | point | In front of trance Abonsa                        | 83  | 7.243883 | 37.90055 | 2112.7  | 378621.3 | 800856.3 | 2112.7  | 2112.7  |
| 73 | point | flour factory Abonsa                             | 84  | 7.243883 | 37.90055 | 2112.7  | 378621.3 | 800856.3 | 2112.7  | 2112.7  |
| 74 | point | Flour factory of Abonsa                          | 85  | 7.243883 | 37.90055 | 2112.7  | 378621.3 | 800856.3 | 2112.7  | 2112.7  |
| 75 | point | Flour factory of Abonsa                          | 86  | 7.243883 | 37.90055 | 2112.7  | 378621.3 | 800856.3 | 2112.7  | 2112.7  |
| 76 | point | Bereket General metal &building materials supply | 87  | 7.243883 | 37.90055 | 2112.7  | 378621.3 | 800856.3 | 2112.7  | 2112.7  |
| 77 | point | Mulu wangle charch                               | 88  | 7.243883 | 37.90055 | 2112.7  | 378621.3 | 800856.3 | 2112.7  | 2112.7  |
| 78 | point | mulluwongal Amagnoh Local church                 | 89  | 7.243883 | 37.90055 | 2112.7  | 378621.3 | 800856.3 | 2112.7  | 2112.7  |
| 79 | point | Mulluwongal Amagnoh Local church                 | 90  | 7.243883 | 37.90055 | 2112.7  | 378621.3 | 800856.3 | 2112.7  | 2112.7  |
| 80 | point | Colonel Tekatel Wodebo Square                    | 91  | 7.243883 | 37.90055 | 2112.7  | 378621.3 | 800856.3 | 2112.7  | 2112.7  |
| 81 | point | Durame town administration Health center         | 92  | 7.243883 | 37.90055 | 2112.7  | 378621.3 | 800856.3 | 2112.7  | 2112.7  |
| 82 | point | In front of Durame General hospital              | 93  | 7.243883 | 37.90055 | 2112.7  | 378621.3 | 800856.3 | 2112.7  | 2112.7  |
| 83 | point | Many get of KTZ Health Administration            | 94  | 7.243883 | 37.90055 | 2112.7  | 378621.3 | 800856.3 | 2112.7  | 2112.7  |
| 84 | point | In front of KTZ Police Department                | 95  | 7.243883 | 37.90055 | 2112.7  | 378621.3 | 800856.3 | 2112.7  | 2112.7  |
| 85 | point | Bake of takla haymanot charch                    | 96  | 7.243883 | 37.90055 | 2112.7  | 378621.3 | 800856.3 | 2112.7  | 2112.7  |
| 86 | point | Tomb area of zararo kebele                       | 97  | 7.248602 | 37.90205 | 2102.33 | 378788.9 | 801377.6 | 2102.33 | 2102.33 |
| 87 | point | Haylu midam clinic                               | 98  | 7.247368 | 37.90089 | 2102.95 | 378659.6 | 801241.5 | 2102.95 | 2102.95 |
| 88 | point | company area                                     | 99  | 7.247368 | 37.90089 | 2102.95 | 378659.6 | 801241.5 | 2102.95 | 2102.95 |
| 89 | point | Bake of KTZ Administration Head office           | 100 | 7.247368 | 37.90089 | 2102.95 | 378659.6 | 801241.5 | 2102.95 | 2102.95 |
| 90 | point | Back of KTZ Administration Head office           | 101 | 7.247368 | 37.90089 | 2102.95 | 378659.6 | 801241.5 | 2102.95 | 2102.95 |
| 91 | point | Bake of KTZ Administration Head office           | 102 | 7.247368 | 37.90089 | 2102.95 | 378659.6 | 801241.5 | 2102.95 | 2102.95 |
| 92 | point | Kambata Tambaro zone police head office          | 103 | 7.250437 | 37.90464 | 2129.4  | 379074.7 | 801579.9 | 2129.4  | 2129.4  |
| 93 | point | Hanbarco view hotel                              | 104 | 7.252936 | 37.90523 | 2128.99 | 379140.2 | 801856   | 2128.99 | 2128.99 |
| 94 | point | Hanbarco view hotel                              | 105 | 7.253058 | 37.90525 | 2128.92 | 379142.3 | 801869.5 | 2128.92 | 2128.92 |
| 95 | point | Dc. Tashoma midam clinic                         | 106 | 7.255964 | 37.90485 | 2149.16 | 379099.7 | 802190.9 | 2149.16 | 2149.16 |
| 96 | point | Dr. Bogelach Gabire Matasabya General hospital   | 107 | 7.256275 | 37.90467 | 2150.45 | 379079.9 | 802225.4 | 2150.45 | 2150.45 |
| 97 | point | Kijan Drag store                                 | 108 | 7.25631  | 37.90448 | 2148.73 | 379059   | 802229.2 | 2148.73 | 2148.73 |

|     |       |  |     |          |          |         |          |          |         |         |
|-----|-------|--|-----|----------|----------|---------|----------|----------|---------|---------|
| 98  | point | The get of Durame poly technical college       | 109 | 7.255975 | 37.90369 | 2140.29 | 378971.1 | 802192.4 | 2140.29 | 2140.29 |
| 100 | point | Markos bread store                             | 110 | 7.255967 | 37.9009  | 2124.5  | 378663.6 | 802192.3 | 2124.5  | 2124.5  |
| 101 | point | Zararo kebeles administration office           | 111 | 7.255967 | 37.9009  | 2124.5  | 378663.6 | 802192.3 | 2124.5  | 2124.5  |
| 102 | point | Zararo kebeles administration office           | 112 | 7.255967 | 37.9009  | 2124.5  | 378663.6 | 802192.3 | 2124.5  | 2124.5  |
| 103 | point | Lalo kebeles to coffee machine                 | 113 | 7.255967 | 37.9009  | 2124.5  | 378663.6 | 802192.3 | 2124.5  | 2124.5  |
| 104 | point | Lalo kebeles contractor sambo building         | 114 | 7.255967 | 37.9009  | 2124.5  | 378663.6 | 802192.3 | 2124.5  | 2124.5  |
| 105 | point | world bright college                           | 115 | 7.250323 | 37.90754 | 2159.38 | 379395   | 801566.5 | 2159.38 | 2159.38 |
| 106 | point | Durame corporation unions Head office          | 116 | 7.248566 | 37.90605 | 2151.15 | 379230.5 | 801372.6 | 2151.15 | 2151.15 |
| 107 | point | Azak primary school                            | 117 | 7.243276 | 37.90187 | 2124.49 | 378766.9 | 800788.8 | 2124.49 | 2124.49 |
| 108 | point | Meklit pension                                 | 118 | 7.243571 | 37.9016  | 2122.6  | 378737.1 | 800821.5 | 2122.6  | 2122.6  |
| 109 | point | Durame town administration office              | 119 | 7.243796 | 37.90136 | 2121.29 | 378710.4 | 800846.5 | 2121.29 | 2121.29 |
| 110 | point | Durame town administration office              | 120 | 7.244821 | 37.90074 | 2115.44 | 378642.5 | 800959.9 | 2115.44 | 2115.44 |
| 111 | point | IN front of kidsta Maryam university           | 121 | 7.244821 | 37.90074 | 2115.44 | 378642.5 | 800959.9 | 2115.44 | 2115.44 |
| 112 | point | Lalo coffee machine                            | 122 | 7.240495 | 37.9023  | 2096.3  | 378813.6 | 800481.2 | 2096.3  | 2096.3  |
| 113 | point | Lalo coffee machine                            | 123 | 7.239855 | 37.90176 | 2091.44 | 378753.6 | 800410.6 | 2091.44 | 2091.44 |
| 114 | point | Durame town education office                   | 124 | 7.239855 | 37.90176 | 2091.44 | 378753.6 | 800410.6 | 2091.44 | 2091.44 |
| 115 | point | IN front of kedida gamla police officer        | 125 | 7.239855 | 37.90176 | 2091.44 | 378753.6 | 800410.6 | 2091.44 | 2091.44 |
| 116 | point | kadada gamelan health Administration           | 126 | 7.239855 | 37.90176 | 2091.44 | 378753.6 | 800410.6 | 2091.44 | 2091.44 |
| 117 | point | kasha future and kalahyot charch               | 127 | 7.239855 | 37.90176 | 2091.44 | 378753.6 | 800410.6 | 2091.44 | 2091.44 |
| 118 | point | Durame town primary school                     | 128 | 7.239855 | 37.90176 | 2091.44 | 378753.6 | 800410.6 | 2091.44 | 2091.44 |
| 119 | point | IN front of Durame town primary school         | 129 | 7.239855 | 37.90176 | 2091.44 | 378753.6 | 800410.6 | 2091.44 | 2091.44 |
| 120 | point | Get of Durame town primary school              | 130 | 7.239855 | 37.90176 | 2091.44 | 378753.6 | 800410.6 | 2091.44 | 2091.44 |
| 121 | point | kasha kebeles fra woya vision kG school        | 131 | 7.239855 | 37.90176 | 2091.44 | 378753.6 | 800410.6 | 2091.44 | 2091.44 |
| 122 | point | Aroge Mamran Lazy                              | 132 | 7.239855 | 37.90176 | 2091.44 | 378753.6 | 800410.6 | 2091.44 | 2091.44 |
| 123 | point | Many gates of Aroge market area                | 133 | 7.239855 | 37.90176 | 2091.44 | 378753.6 | 800410.6 | 2091.44 | 2091.44 |
| 124 | point | Many get of Aroge market area                  | 134 | 7.236099 | 37.89127 | 2070.9  | 377595   | 799998.1 | 2070.9  | 2070.9  |
| 125 | point | kasha sub town administration office           | 135 | 7.235545 | 37.88992 | 2055.34 | 377445.6 | 799937.2 | 2055.34 | 2055.34 |
| 126 | point | kasha sub town administration office           | 136 | 7.235508 | 37.88942 | 2050.8  | 377390.3 | 799933.3 | 2050.8  | 2050.8  |
| 127 | point | In front of Dongicho health center             | 137 | 7.235508 | 37.88942 | 2050.8  | 377390.3 | 799933.3 | 2050.8  | 2050.8  |
| 128 | point | IN front of bazana Tomb areas                  | 138 | 7.235508 | 37.88942 | 2050.8  | 377390.3 | 799933.3 | 2050.8  | 2050.8  |
| 129 | point | Bazana tomb and birge area                     | 139 | 7.235508 | 37.88942 | 2050.8  | 377390.3 | 799933.3 | 2050.8  | 2050.8  |
| 130 | point | Above bazana tomb                              | 140 | 7.235508 | 37.88942 | 2050.8  | 377390.3 | 799933.3 | 2050.8  | 2050.8  |
| 131 | point | kasha sub town Administration office           | 141 | 7.235508 | 37.88942 | 2050.8  | 377390.3 | 799933.3 | 2050.8  | 2050.8  |
| 132 | point | In front of Dongicho health center             | 142 | 7.235508 | 37.88942 | 2050.8  | 377390.3 | 799933.3 | 2050.8  | 2050.8  |
| 133 | point | Aroge market area                              | 143 | 7.235508 | 37.88942 | 2050.8  | 377390.3 | 799933.3 | 2050.8  | 2050.8  |
| 134 | point | In front of Bazana tomb areas                  | 144 | 7.235508 | 37.88942 | 2050.8  | 377390.3 | 799933.3 | 2050.8  | 2050.8  |
| 135 | point | Durame town administration police office       | 145 | 7.235508 | 37.88942 | 2050.8  | 377390.3 | 799933.3 | 2050.8  | 2050.8  |
| 136 | point | Bake of stadium                                | 146 | 7.245833 | 37.90461 | 2147.3  | 379070.3 | 801070.8 | 2147.3  | 2147.3  |
| 137 | point | In front of kTZ police head office             | 147 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 138 | point | In front of Hdase second school                | 148 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 139 | point | Back of Hdase second school                    | 149 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 140 | point | Hdase second school                            | 150 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 141 | point | Bethel atshada hthsanat first cycle school     | 151 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 142 | point | Betel Atshada hthsanat first cycle school      | 152 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 143 | point | Durame kalahyot charch                         | 153 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 144 | point | Durame poly technical college                  | 154 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 145 | point | Durame poly technical college                  | 155 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 146 | point | Poly technical college                         | 156 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 147 | point | Durame poly technical college                  | 157 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 148 | point | Durame poly technical college                  | 158 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 149 | point | Durame polytechnic college                     | 159 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 150 | point | Dr. Bogelach Matasabya General hospital        | 160 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 151 | point | Dr. Bogelach Gabire Matasabya General hospital | 161 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 152 | point | Dr. Bogelach Gabire Matasabya General hospital | 162 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 153 | point | Dr. Bogelach Gabire Matasabya General hospital | 163 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 154 | point | In front of Gedicho tomb areas                 | 164 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 155 | point | Hanbarco view hotel                            | 165 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 156 | point | Gadcho 25 area                                 | 166 | 7.250885 | 37.90415 | 2114    | 379020.7 | 801629.5 | 2114    | 2114    |
| 157 | point | Many get of Taza Agara millennium school       | 167 | 7.263836 | 37.91054 | 2122.31 | 379730.3 | 803059.8 | 2122.31 | 2122.31 |

|     |       |  |     |          |          |         |          |          |         |         |
|-----|-------|--|-----|----------|----------|---------|----------|----------|---------|---------|
| 158 | point | in front of Taza Agara tombs areas       | 168 | 7.263836 | 37.91054 | 2122.31 | 379730.3 | 803059.8 | 2122.31 | 2122.31 |
| 159 | point | Dabu mangadoch Durame district office    | 169 | 7.267082 | 37.91414 | 2091.5  | 380128.3 | 803417.7 | 2091.5  | 2091.5  |
| 160 | point | wata slope area                          | 170 | 7.267082 | 37.91414 | 2091.5  | 380128.3 | 803417.7 | 2091.5  | 2091.5  |
| 161 | point | 171wata birge area                       | 171 | 7.267082 | 37.91414 | 2091.5  | 380128.3 | 803417.7 | 2091.5  | 2091.5  |
| 162 | point | wata slope area                          | 172 | 7.267082 | 37.91414 | 2091.5  | 380128.3 | 803417.7 | 2091.5  | 2091.5  |
| 163 | point | wata slope area                          | 173 | 7.26796  | 37.91545 | 2085.4  | 380272.6 | 803514.5 | 2085.4  | 2085.4  |
| 164 | point | wata birge area                          | 174 | 7.26796  | 37.91545 | 2085.4  | 380272.6 | 803514.5 | 2085.4  | 2085.4  |
| 165 | point | wata slope area                          | 175 | 7.26796  | 37.91545 | 2085.4  | 380272.6 | 803514.5 | 2085.4  | 2085.4  |
| 167 | point | Taza catholic church health center       | 176 | 7.268783 | 37.91558 | 2083    | 380287.4 | 803605.5 | 2083    | 2083    |
| 168 | point | Taza catholic church                     | 177 | 7.268783 | 37.91558 | 2083    | 380287.4 | 803605.5 | 2083    | 2083    |
| 169 | point | Taza kebeles administration office       | 178 | 7.268783 | 37.91558 | 2083    | 380287.4 | 803605.5 | 2083    | 2083    |
| 170 | point | Above Taza kebeles Administration office | 179 | 7.268783 | 37.91558 | 2083    | 380287.4 | 803605.5 | 2083    | 2083    |
| 171 | point | Wachamo university Durame campus         | 180 | 7.268783 | 37.91558 | 2083    | 380287.4 | 803605.5 | 2083    | 2083    |
| 172 | point | Durame campus Wata get                   | 181 | 7.268783 | 37.91558 | 2083    | 380287.4 | 803605.5 | 2083    | 2083    |
| 173 | point | Durame campus Wata get                   | 182 | 7.268783 | 37.91558 | 2083    | 380287.4 | 803605.5 | 2083    | 2083    |
| 174 | point | Durame campus Wata get                   | 183 | 7.268783 | 37.91558 | 2083    | 380287.4 | 803605.5 | 2083    | 2083    |
| 175 | point | Durame campus many get                   | 184 | 7.268783 | 37.91558 | 2083    | 380287.4 | 803605.5 | 2083    | 2083    |
| 176 | point | Durame campus manygates                  | 185 | 7.268783 | 37.91558 | 2083    | 380287.4 | 803605.5 | 2083    | 2083    |
| 177 | point | Durame campus many gates                 | 186 | 7.268783 | 37.91558 | 2083    | 380287.4 | 803605.5 | 2083    | 2083    |
| 178 | point | Durame campus many get                   | 187 | 7.268783 | 37.91558 | 2083    | 380287.4 | 803605.5 | 2083    | 2083    |
| 179 | point | Durame campus many gates                 | 188 | 7.268783 | 37.91558 | 2083    | 380287.4 | 803605.5 | 2083    | 2083    |
| 180 | point | Ethiopia hwariyat Durame campus          | 189 | 7.268783 | 37.91558 | 2083    | 380287.4 | 803605.5 | 2083    | 2083    |
| 181 | point | Wachamo university Durame campus         | 190 | 7.268783 | 37.91558 | 2083    | 380287.4 | 803605.5 | 2083    | 2083    |
| 182 | point | Wachamo university Durame campus         | 191 | 7.268783 | 37.91558 | 2083    | 380287.4 | 803605.5 | 2083    | 2083    |
| 183 | point | Ambericho view hotel                     | 192 | 7.256295 | 37.90649 | 2137.5  | 379281.1 | 802227.1 | 2137.5  | 2137.5  |
| 184 | point | CBE Durame kokata Branch                 | 193 | 7.244704 | 37.89947 | 2112.08 | 378502.6 | 800947.4 | 2112.08 | 2112.08 |
| 185 | point | Durame city administration head office   | 194 | 7.244546 | 37.89984 | 2114.39 | 378543   | 800929.8 | 2114.39 | 2114.39 |
| 186 | point | kidsta Maryam university                 | 195 | 7.243471 | 37.90284 | 2132.46 | 378874.6 | 800810.1 | 2132.46 | 2132.46 |
| 187 | point | Bake of stadium                          | 196 | 7.244016 | 37.90538 | 2134.08 | 379154.6 | 800869.7 | 2134.08 | 2134.08 |
| 188 | point | Zanza frnchare                           | 197 | 7.246722 | 37.90799 | 2141.93 | 379443.7 | 801168.3 | 2141.93 | 2141.93 |
| 189 | point | Bake of future school                    | 198 | 7.246722 | 37.90799 | 2141.93 | 379443.7 | 801168.3 | 2141.93 | 2141.93 |
| 190 | point | Many get of future school                | 199 | 7.246722 | 37.90799 | 2141.93 | 379443.7 | 801168.3 | 2141.93 | 2141.93 |
| 191 | point | Exist of manariya                        | 200 | 7.244454 | 37.89926 | 2108.18 | 378478.8 | 800919.7 | 2108.18 | 2108.18 |
| 192 | point | Many gates of market area                | 201 | 7.243854 | 37.89865 | 2104.23 | 378411.2 | 800853.5 | 2104.23 | 2104.23 |
| 193 | point | In front of Gabta cafe and restraint     | 202 | 7.243854 | 37.89865 | 2104.23 | 378411.2 | 800853.5 | 2104.23 | 2104.23 |
| 194 | point | Eto flour factory                        | 203 | 7.243854 | 37.89865 | 2104.23 | 378411.2 | 800853.5 | 2104.23 | 2104.23 |
| 195 | point | Eto flour factory                        | 204 | 7.243854 | 37.89865 | 2104.23 | 378411.2 | 800853.5 | 2104.23 | 2104.23 |
| 196 | point | Eto flour factory                        | 205 | 7.243854 | 37.89865 | 2104.23 | 378411.2 | 800853.5 | 2104.23 | 2104.23 |
| 197 | point | Bazana primary school                    | 206 | 7.243854 | 37.89865 | 2104.23 | 378411.2 | 800853.5 | 2104.23 | 2104.23 |
| 198 | point | kedida gamelan azadabo malahtsam         | 207 | 7.243854 | 37.89865 | 2104.23 | 378411.2 | 800853.5 | 2104.23 | 2104.23 |
| 199 | point | Exit of shnscho                          | 208 | 7.243854 | 37.89865 | 2104.23 | 378411.2 | 800853.5 | 2104.23 | 2104.23 |
| 200 | point | kebeles 18                               | 209 | 7.243854 | 37.89865 | 2104.23 | 378411.2 | 800853.5 | 2104.23 | 2104.23 |
| 201 | point | Durame cache                             | 210 | 7.243854 | 37.89865 | 2104.23 | 378411.2 | 800853.5 | 2104.23 | 2104.23 |
| 202 | point | Durame chacha                            | 211 | 7.243854 | 37.89865 | 2104.23 | 378411.2 | 800853.5 | 2104.23 | 2104.23 |
| 203 | point | Durame chacha                            | 212 | 7.243854 | 37.89865 | 2104.23 | 378411.2 | 800853.5 | 2104.23 | 2104.23 |
| 204 | point | Durame chacha                            | 213 | 7.243854 | 37.89865 | 2104.23 | 378411.2 | 800853.5 | 2104.23 | 2104.23 |
| 205 | point | Durame chacha                            | 214 | 7.243854 | 37.89865 | 2104.23 | 378411.2 | 800853.5 | 2104.23 | 2104.23 |
| 206 | point | kebeles 19                               | 215 | 7.243854 | 37.89865 | 2104.23 | 378411.2 | 800853.5 | 2104.23 | 2104.23 |
| 207 | point | Many gates of New market area            | 216 | 7.243854 | 37.89865 | 2104.23 | 379588.5 | 801357   | 2104.23 | 2104.23 |

## Appendix D

### Appendix D: Questionnaire Survey for the Drivers, pedestrian & Traffic Police Officers.

Jimma University College of Social Science and Humanity Department of Geography and Environmental Studies

#### Questionnaire Introduction

This questionnaire survey is designed to the “Spatio--temporal Assessment of Road Traffic Accident Durame Town”. Moreover, this questionnaire is prepared to assemble information which can help to study the general trend of road traffic accidents, the major factors of RTAs, the impacts of RTAs on health, socioeconomic, and physical environment, the frequent RTAs places or black spots and the types of measures to be taken to prevent or reduce RTAs in Durame Town in Partial Fulfillment of the Requirement For the Degree of Master of Science in Geographic Information Systems And Remote Sensing. The information that you were provide to me undoubtedly were have paramount significance for the success of the study. I appreciate your willingness to participate. Please, answer the information and questions truthfully. There is no right or wrong answer.

Direction: Circle and/or write in the blank spaces for the following information.

#### Part I. General Information

1. Name of the enumerator: \_\_\_\_\_
2. Enumeration kebeles: \_\_\_\_\_
3. Date of the enumeration: \_\_\_\_\_

#### Part II. Personal Information

1. Name of respondents \_\_\_\_\_
2. Gender A. Male B. Female
3. Respondent Age A.18 to 24 B.25 to 34 C. 35 to 44 D. Over 45
4. Education level of Respondents \_\_\_\_\_
5. Please, would you mention your type of your job? \_\_\_\_\_
6. Job experience: A. 4 to 9 years B.10 to 20 years C.More than 20 years
7. Job category: A. Public B. Private C.NGO D. If other, please specify
8. Marital status  
A. Single B. Marriage C. Divorced D. Separated E. Cohabitated F. Widow  
H .Others (specify) \_\_\_\_\_

#### Part III. General Questions

Direction: Circle and/or write in the blank spaces for the following questions. You can choose more than one option when necessary.

1. How old are you? \_\_\_\_\_
2. How many children do you have? \_\_\_\_\_

- Q3 For driver. How many years of driving experience do you have? \_\_\_\_\_
- Q4 For traffic police. How many years of traffic police experience do you have? \_\_\_\_\_
- Q5 For pedestrian. For how many years of waking in this road? \_\_\_\_\_
4. In your experience, road traffic accident is a problem in Durame Town? A. yes B. no
- 5 In your experience, the distribution of RTAs trend. A. more severe B. severe C. less severe
6. If your response to Q4 is “yes”, in your experience, which factor(s) are more or less (i.e. rank these factors, e.g. first, second ..... ) responsible for road traffic accident?  
 A. driver factors B. road factors C. vehicle factors D. weather condition
7. If your first rank is “B”, in Q6 above, in your experience, which road factors are more responsible for road traffic accident? A. road type B. bad road condition C. Road type
- D Relief of the roads. If other \_\_\_\_\_
8. If you have ranked “C” as the main responsible factor for RTAs, in your experience, which vehicle factors are more responsible for RTAs? A. vehicle type B. poor technical condition C. vehicle design. D. Vehicle Service Age What is the reasons? \_\_\_\_\_
9. If your first rank is “D” in Q6 above, in your experience, which weather condition is responsible for road traffic accident? A. precipitation B. temperature C. winds speed. D. Cloudy & Foggy E. Drizzle/light rain F, Heavy rain. What are the reasons? \_\_\_\_\_
10. in your experience, in which place/spot do the road traffic accidents tend to concentrate or occur more frequently in Durame Town? A. Lalo sub-town B. Zararo sub-town C. Kacha sub-town. What are the reasons? \_\_\_\_\_
11. What time does the accident more take place? A. day time from 12am-6am  6am-12pm  B. evening time from 12pm-6pm  6pm-12pm  what are the reasons? \_\_\_\_\_
11. On what day of the week is the accident more frequent? A. Monday B. Tuesday C. Wednesday D. Thursday E. Friday F. Saturday G. Sunday .What is the reason? \_\_\_\_\_
12. What are the major health impacts of road traffic accidents in Durame Town?  
 A. fatal Accident B. serious injury C. slight injury
13. What are the economic impacts of road traffic accidents in Durame Town?  
 A. loss of property B. cost to economy C. cost to health service
14. What are the physical environment impacts of road traffic accidents in Durame Town?  
 A. damage of infrastructures B. damage of vegetation’s C. land degradation
15. What kinds of measures to be taken to prevent or reduce road traffic accidents in Durame Town? \_\_\_\_\_

**Thank you for participating in this study.**  
**If you have any further comments and opinions, you can add.**

## Appendix E

### Appendix E: Key Informant Interview Questionnaire

**Interview Questions prepared for the key informants interviewers.**

This interviews is prepared to collect information which can help to identify major factors/ cause of road traffic accident, trend and distribution RTAs hotspots, socio-economic impacts and severity level of RTAs blakspot of Durame town in partial fulfillment for the requirements of the award of master of degree of science in Geography and Environmental studies specialization on GIS and Remote sensing. The information that you will provide to me undoubtedly will have significance value to achieve the study. The researcher kindly requests you to give real information.

**I would like to thank you in advance for your time and cooperation.**

Name \_\_\_\_\_ sector/office name \_\_\_\_\_ Position \_\_\_\_\_

1. Sex A. Male B. Female 2. Age \_\_\_\_\_

3. Marital status: A. Married B. Single C. separated D. Widowed

4. Education level A. Illiterate B. 1 to 10 C. 10+1 to 10+2 D. Above 10+2

5. How long have you been in your office? A. 4 to 9 years B 10 to 20 years C More than 20 years

6. What is the main cause contributing for the majority of RTAs occurrences in Durame Town?

A. Over speeding B. Overloading C. Improper Turning D. Technic defect E. Poor Road Condition F

Heavy rain H Sloppiness of areas I. Lack of experience J. Road users such as pedestrians and pedal

cyclists problem K. Drunken driving L. Weak low traffic enforcement M. Drivers not respecting

pedestrians priority. If you have knew other causes \_\_\_\_\_

7. Which type of vehicles mostly participates in accident in Town? (You can choice more as much as you

know). A. Minibus B. Bus C. Three wheels Bajaj D. Horse Cart E.Trucks F. Motor

Bicycle H Bicycle If you have knew other \_\_\_\_\_

8. Have you assess the progress of RTAs in the Town? If so, what are the level of /condition of road

traffic accident? Is it increasing or decreasing during last six years? \_\_\_\_\_

9. In which sub Town more RTAs blakspot are found in Durame Town? \_\_\_\_\_

10. How many RTAs blakspot are found in Durame Town? And where they found? \_\_\_\_\_

11. How many time the Road traffic accidents occurred in each blakspot from 2016-2021? \_\_\_\_\_

12. In which hotspot the most frequented RTAS occurring in the Town? \_\_\_\_\_

13. How is the service year of vehicles engaged in Road Traffic Accidents assessed? \_\_\_\_\_

14. How is the technical condition of vehicles in the time of accident inspected? \_\_\_\_\_

15. What methods are applied to assess the slope of roads where Road Traffic Accidents occur?

16. How do you assess the quality and distribution of road infrastructures like quality of roads, number of

road traffic lights, road traffic signs, side walkways and cross ways in the city? \_\_\_\_\_

17. How is the price of property damages caused by Road Traffic Accidents estimated? \_\_\_\_\_

18. How is the Road Traffic Accident Data recorded? \_\_\_\_\_

19. Outline the impacts of road traffic accident \_\_\_\_\_

20. What was done to minimize the frequency of occurrence of RTAS in each hotspot sites? \_\_\_\_\_

21. Which intervention measures or managements techniques should be effective in reducing the

accidents level of each hotspot sites? \_\_\_\_\_

Thank you for participating in this study.  
If you have any further comments and opinions, you can add.

## Appendix F

### Appendix F: Focus group Discussion Questionnaire.

Jimma University Collage of social sciences and humanity department of geography and environmental studies

#### Interview Questions prepared for the key informants interviewers.

This interview is prepared to collect information which can help to identify major factors of RTAs, distribution RTAs hotspots, socio-economic impacts and severity level of RTAs hotspots of Durame town in partial fulfillment for the requirements of the award of master of degree of science in Geography and Environmental studies special ion in GIS and R mote sensing. The information that you will provide to me undoubtedly will have significant value to achieve the study. You are kindly requested to give information freely as pertaining to this questionnaire. Please write for the each question the responses in the space provided.

**Thanks you for your cooperation.**

1. Name \_\_\_\_\_ sector/office name \_\_\_\_\_ Position \_\_\_\_\_
2. Sex A. Male B. Female 3. Age \_\_\_\_\_
4. Marital status: A. Married B. Single. C. Separated D. Widowed
5. Education level A. Illiterate B. 1 to 10 C. 10+1 to 10+2 D Above 10+2
6. How long have you been in your office? A. 4 to 9 years B 10 to 20 years C More than 20 years
7. What are the major causes and contributing factors for occurring RTAs in Durame Town? \_\_\_\_\_
8. In which sub- town of Durame more RTAs occurred? Way? \_\_\_\_\_
9. Do you know RTAs hotspots in Durame town? \_\_\_\_\_
10. If the answer is yes, for question number 4 how many RTAs hotspots have in Durame Town in the last six years? In which sub town they found? \_\_\_\_\_
11. Do your get or your office give awareness-lesson to the people, drivers and stockholder about RTAs during 2016-2017? If so, when \_\_\_\_\_
12. What is the condition of infrastructures especially in hotspots like quality of road, number of road lights, road traffic signs, side walkways and cross ways in Town Durame? \_\_\_\_\_
13. What type of accident minimization mechanisms should be done in each hotspot sites?
  - i. Role of the individual or the community \_\_\_\_\_
  - ii. Role of the government \_\_\_\_\_
  - iii. Role of the other stakeholders \_\_\_\_\_

**Thank you for participating in this study.**  
**If you have any further comments and opinions, you can add.**