Modelling and analysis of vehicle accident under mixed traffic conditions in Ilu Ababor zone, Ethiopia

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Abstract. Modelling and analysis of traffic accident has vital role in reduction of vehicle accident. This study is aimed to assess the rate traffic accident over the ranges of several years and to model traffic accident with influencing parameters. The data used for study were; Geometry of the road, recorded traffic accidents, traffic volume, surface condition of the road, driver behavior and road infrastructure. The result shows that, the death rate in vehicle accident from 2001 to 2004, 2006 to 2008 and 2009-2010 is increasing. Also, from 2004 to 2006, 2008 to 2009 and 2010 to 2013 shows the decreasing. In major injury, it is increasing in first five years except 2004 which shows some significant change. In the next four years from 2005 to 2009 it shows decreasing except 2007 which shows a significant increasing. From 2010 to 2013 it is decreasing in non-uniform manner. In minor injury due to vehicle accident, it shows increasing in first seven years and decreasing from 2004 to 2013, which improvement in road safety aspect. In property damage, it shows in increasing significantly from 2001 to 2005. After 2005 even though, estimated property lost is increasing or high the number of accidents recorded as property damage is decreasing which shows a little improvement. The important index of vehicle accident in heterogeneous traffic condition is rate of accident which has been computed for four years. Estimated rate of accident for 2010, 2011, 2012 and 2013 are 152, 98, 469, and 103 respectively. Multiple linear regression model has been developed to show the significance the predictors on the traffic accident. The developed regression model indicates that, lack of geometric design is the major factor that pay role in traffic accident of study area. The determinant of vehicle accident is operating speed. Finally, black spot area in each Woreda has been identified.

1. Introduction

Whether it's for work, recreation, shopping, or business, everyone travels. All raw materials must be transported from the source to the location of production or use, and all products must be transferred from the factory to the market and from the employees to the customers. Transport is the medium through which such activities take place; it serves as the adhesive that holds the communities and their activities together. The task of transportation has been and remains to be meeting these needs.

Due to changes in transportation options and lifestyle factors, people's ways of living and working have evolved. Future events can be predicted with accuracy, and it will be the job of the transportation planner and traffic engineer to deal with these interactive changes. Because of how prevalent transportation is, finding solutions to transportation issues can have a significant impact on people's lives. In order to ensure the safe, quick, comfortable, convenient, affordable, and environmentally friendly movement of people and goods, transport engineering applies technological and scientific principles to the planning, functional design, operational, and management of facilities for any mode of transportation. The planning, geometric design, and traffic operation of roads, streets, and highways, as well as their network, terminals, adjacent land, and interface with other modes of transportation, are the focus of traffic engineering, a subfield of transport engineering. The primary purposes of transportation networks are mobility and accessibility. Reaching desired commodities, services, activities, connections, and destinations is what is meant by accessibility. The movement of people and things is known as mobility. The national economy, quality of life, and safety and security of the country are all significantly impacted by accessibility and mobility restrictions, which can be brought on by traffic congestion. We can comprehend interruptions in transportation systems, foresee their effects, and afterwards lessen their effects thanks to

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Intelligent Transportation Systems (ITS) and transportation analysis tools. Traffic Accident Definition: A traffic collision, also called a motor vehicle collision among other terms, occurs when a vehicle collides with another vehicle, pedestrian, animal, road debris, or other stationary obstruction, such as a tree, pole or building. All facets of society are impacted by the global problem of road traffic injuries. Road safety hasn't gotten enough attention at the national and local levels up until now. This is due in part to a lack of knowledge regarding the scope of the issue and its preventability, a fatalistic view of traffic accidents, and a lack of the political accountability and multidisciplinary cooperation required to effectively address it. But there is plenty that may be done to lessen the issue of traffic accidents. In fact, during the past few decades, many high-income countries have been able to cut their burden of traffic injuries by up to 50%. Safety is one of the difficult problems in Ethiopia's transportation sector, despite a decline in the overall number of recorded accidents in recent years. The necessity to assess how traffic signals (in the traffic network) affect safety motivated the development of an appropriate technique in this thesis to address a number of related concerns. This thesis will offer a safety model based on crash frequencies from the national accident database. The established statistical accident rate model will incorporate benchmark estimates of absolute crash risk rates by crash type and facility at the national level.

The knowledge of the crash factors that were ultimately utilized in the multinomial logit model with additional consideration of the current architecture of the statewide GDL program was assisted by an exhaustive analysis of prior literature coupled with engineering judgments. Results showed that the top 10 prevalent factors in several groups of young drivers were driving violations, distractions, passenger present, the time of the crash, and driver protection systems [1]. Road traffic accidents are now the biggest cause of death for those between the ages of 15 and 29 years old, according to WHO (2016). Only 48% of the world's registered vehicles are in low- and middle-income nations, which account for almost 90% of road traffic fatalities and injuries. The majority (46%) of people who pass away on the world's roadways are "vulnerable road users" like motorcyclists, cyclists, and pedestrians. In addition to the pain and suffering they inflict, traffic accidents also cost most nations between one and three percent of their gross national product. If nothing is done, it is predicted that by 2020, 1.9 million people will die each year as a result of traffic accidents.

Traffic accidents pose significant dangers to personal security, according to UNDP (1994). For those between the ages of 15 and 30 in industrialized nations, automobile accidents constitute the greatest cause of death. Additionally, at least 50% of all accidental deaths in developing nations are caused by automobile accidents. For instance, 10,000 people died on South African roads in 1993, which was three times as many as people died in political violence. Road traffic injuries, according to WHO [2], are a significant yet underappreciated public health issue that calls for coordinated measures for effective and long-term prevention. Road traffic systems are the most intricate and hazardous of all the systems that humans engage with on a daily basis. 400 million Birr are lost annually in traffic accidents in Ethiopia, one of the world's poorest nations (up from 12 million Birr per year 15 years ago). The socioeconomic costs linked to the accidents are not included in this. This startling accident rate has been identified as the third leading cause of death in recent years. Even while the statistics released based on official statistical data indicate a dangerous condition, it doesn't appear that enough is being done to lower this frightening accident rate. Because road transportation is the main mode of transportation in Ethiopia, together with inadequate road infrastructure, lax enforcement of traffic laws, and other causes, the rate of road traffic accidents (RTAs) is relatively high. With more vehicles and traffic in the capital, it is necessary to analyze the causes, effects, and measures in reducing or preventing vehicle crashes in the context of the Iu Ababor Zone in order to identify what should be done in a way that contributes to the reduction of RTAs. The Ethiopian traffic control system archives data on various aspects of the traffic system, such as traffic volume, concentration, and vehicle accidents.

Generally, the central argument of the study is to assess the traffic accident trends, causes that contributes the accident and to model the rate of traffic accident.

Vehicle accident is principal issue which is to be considered when economy of one's country or town is rising and increasing in number of vehicles. Ilu Ababor is one of the zone which is under highly growing. This is due to high trip attractions to tourism sites, production of different fruits and crops, increment of knowledge centers /or sources like universities and colleges and other many positive changes. Tourism sites in Ilu Ababor zones are: "*Soor, Bacho Woredas Gorges"* and others. In parallel to this development many traffic accidents (TA) are occurring in this zone. It is necessary to model vehicle traffic accident, in order to know the traffic accident trends and to predict traffic accident intensity.

Even, many researches are done on this topic; still there are traffic accident problems. RTA problem is observed in this study area. Therefore researcher wants to put his own part to minimize the gap of these ideal and actual conditions by modeling Traffic accident under mixed traffic conditions in order to evaluate traffic accident trends and to predict traffic accident intensity.

The research is aimed to Model and analyze Vehicle accidents in Ilu Ababor in order to search the way to reduce it.

The significance of this study is improving the economic development of the study area by indicating the direction how to minimize vehicle accident; this indirectly adds positive value on reduction of traffic accident of our country Ethiopia. The beneficiaries of this study are vehicle users and passengers, owners of vehicles, government organizations and non-government organizations, policy makers, the coming new researchers and etc. The benefit of this study is maximization of the reliability of traffic safety and minimization of vehicle accidents. Modeling of traffic accident helps to understand the pattern of traffic accident on the given route.
The extent of this study is modelling and analysis of vehicle accident in woreda and towns in Ilu Ababor Zone by developing fitted n model by considering influencing factors or dependent variable (traffic accident).

Literature Review

Pedestrians at a marked but signalized pedestrian crossing have to made visible to drivers in the approaching traffic at enough distance away from the crossing, and this distance is necessary for stopping a vehicle before the leading Ped-Xing edge to avoid am potential traffic collision [3]. Study of [4] revealed that, Successful management of traffic safety requires effective community participation in the, process of traffic awareness, planning and management along with the executive bodies concerned with traffic planning and m16anagement. Just as important to reinforcing a shared vision among people and management bodies is the idea of people participation in decision-making. The researcher [5] has tried to investigate the crash reports, road geometric characteristics, and traffic volume data were also obtained using valid references such as the care package, Post-spacing and height of side traffic barriers were affecting the severity of ROR crashes on horizontal curves and Side traffic barriers with a short height are not recommended to be used on curved segments. Including the accident year as a factor to account for the effect of time series on the crashes, the analysis included a total of eleven variables influencing traffic crashes on urban interstate highway segments. Among these variables, traffic volume, unprotected median type, and segments with two lanes were found to be significantly associated with the likelihood of occurrences of crashes on urban interstate highways. The categories of weather conditions (snow & rain) were primarily related to an increase in fatal crashes but not on non-fatal injury crashes. On the other hand, the drivers' gender was not associated with all categories of crash types. However, as compared with middle aged and older drivers, younger drivers' appeared to have a higher likelihood of involvement of non-fatal injury, and property damage only crashes. While a close examination of every potential cause of crashes appears to lead to a more realistic understanding of the factors involved in a traffic crash, it is impractical to cross-examine all the drivers involved in crashes and investigate the causes [6].Study has been conducted by [7] on how traffic volume is the most common factor associated with road traffic crash frequency. The researcher used of aggregate volume measures may lead to biased prediction of crash frequencies. [8] Provided that studies on machine learning applications in crash severity crash severity modelling and results interpretation.

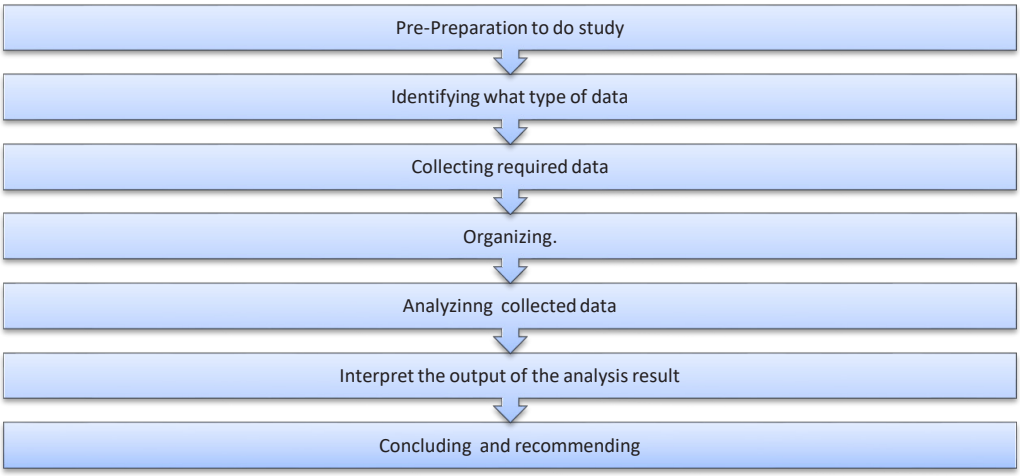

Fig. 1. Research Methodology

The World Health Organization (WHO) estimated that road accidents worldwide cause the death of 1.3 million people annually, and injure 50 million people with a number of them suffering extremely serious injuries, in

addition to enormous financial losses [9]. Another study done by [10] revealed Listening to music and conversing on the phone negatively influence cyclists' auditory perception, self-reported crash risk and cycling performance. [11] Proposed an approach to assessing the level of traffic safety, which is based on the principles of multi-criteria assessment. It was noted that the key task of traffic organization and traffic safety is to prevent RTAs, reduce accident rates and injuries, and save lives [12].

Methodology and Materials

This part shows the way how to arrive to the result of the objectives this research. The researchers attempted to model or equation of vehicle accident in Ilu Ababor Zone, to evaluate the past and present traffic accident trends, recommending policy makers and coming new researchers by extracting from analysis of this study). And also it contains materials that has been used for the study. To achieve intended purpose the following major procedures has been followed (Figure 1).

3.1. Study Area

The study area of this research is Ilu Ababor zone (Figure 2); which is located in south west of Addis Ababa (capital city of Ethiopia) with driving distance of 600km. Geographical location is latitude of $8^{0}30'5''$ and longitude of $35^{0}42'42''$Based on the 2007 Census conducted by the CSA, this town has a total population of 1,271,609 of whom 636,986 are men and 634,623 women, with an area of 15,135.33 square kilometers, Iluabor has a population density of 84.02. While 124,428 or 12.16% are urban inhabitants, a further 68 persons are pastoralists. A total of 272,555 households were counted in this Zone, which results in an average of 4.67 persons to a household, and 263,731 housing units. Ilu Ababor is known as a source for fruit, including mango, banana, orange, and pineapple, and is also known for home of coffee.

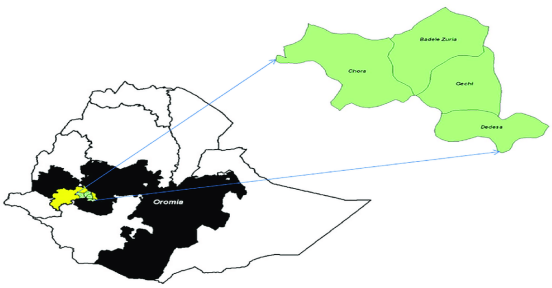

Fig. 2. Study area map Source

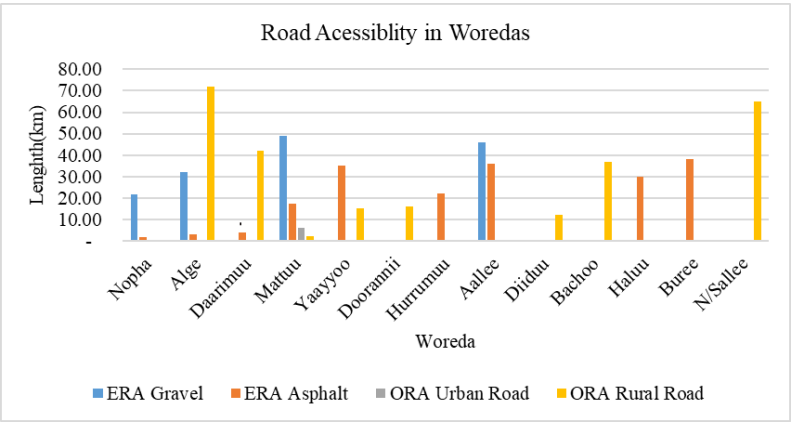

Fig. 3. Road accessibility network by Woreda

Identifying the road surface type is very important to know whether it would trigger the road Traffic accident that happened along the road network of the town. According to the surface type, the road network of the woreda is

identified in four categories. These four categories are: ERA gravel, ERA Asphalt, ORA urban road and ORA rural road (red ash and compacted earth).
Figure 3 provides that, the road accessibility and road surface in study area.
The number of population or pedestrians moving on the sided of the road has directly relationship with traffic accident. Here below Figure 4 dictates the estimated population of woreda in Iluabor zone. Darimu Woreda has high number of population compared to others. Halu woreda has least number of population which is the movement of the traffic is low.

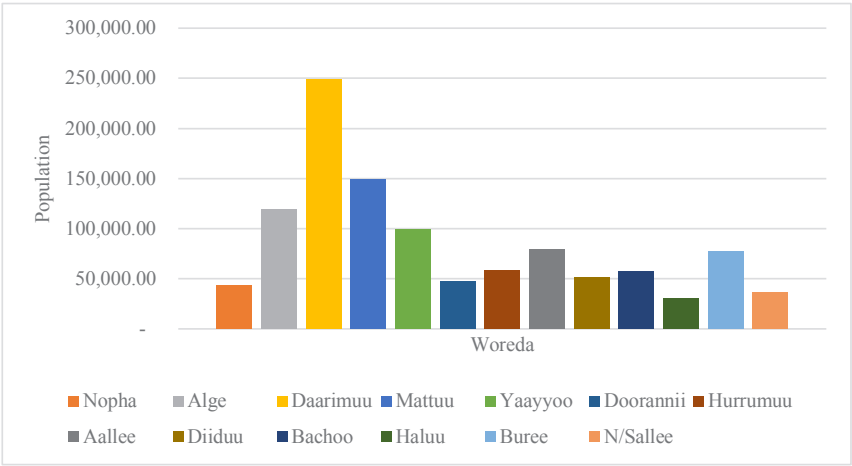

Fig. 4. Population in Study Area

The area coverage of each woreda has been provided in Figure 5. *Nono Sallee* has largest area coverage approximately 2200 square kilometers. *Halu* woreda has least area coverage from all study area which is approximately 250 square kilometers.

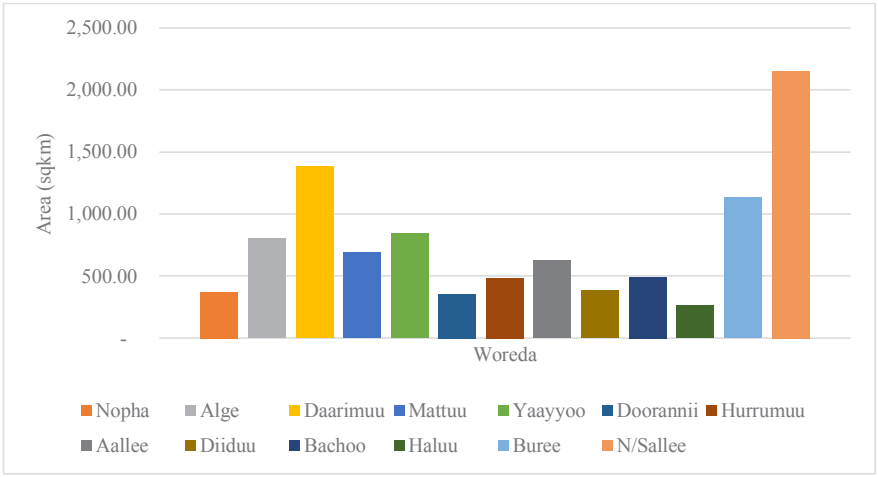

Fig. 5. Area coverage of Woreda in Ilu Ababor Zone

3.2 Population and Sample

The entire population of this study is all vehicles getting into accidents and segments of Woreda which are found in Ilu Ababor zone. Those Woredas are: *Yayo. Mettu, Hurrumu, Dorani, Suphe, Bure, Darimu, Halu, Bacho, Alge, Nopha, Nono Sale*. For the sake minimizing cost of research with respect to time needed and birr paid for data

collection, modeling and analysis sample selection is efficient. The method that that has been employed to select sample from population is purposive sampling. After conducting pilot survey, which means in each Woreda the segments with high traffic volume and traffic accidents has been selected purposively as sample or representative of study.

3.3 Data Source

Both qualitative and quantitative data has been collected from primary and secondary sources. Primary data has been directly be recorded by data collectors from study area. Secondary data has been obtained from;

- Daily traffic police records(Ilu Ababor Police Station)
- Ilu Ababor Woredas'offices
- Ilu Ababor Zone Road and Logistics Office
- Books on related issues
- Scientific journals
- Articles
- Magazines
- Reports from organizations, research papers,
- Web site

Questionnaire has been the instrument for primary data collection for this study. Oral interviews are also used as an instrument to collect data's. Quantitative data has been collected from Traffic police stations.

3.4 Procedure of data collection

For the purpose of analyzing Traffic accident and suggesting countermeasures, information is needed on crashes or accidents, and it is desired to relate crashes to exposure. Some measure of traffic volumes is also necessary; therefore, the necessary reliable data that were collected are accident data, road data, traffic data, and field observations

- Before data collection preparation of data sheet, preparation of questionnaires has been done for primary data collection.
- To collect secondary data related to accident from government offices or other institution having formal letter which shows the (aim)
- Data has been collected either in soft copy or hardcopy.

Collection and handling of data needs greater knowledge. Wrong data will cause wrong conclusion. So that researcher focused on accuracy of data. Having number data and using high quality instrument will increase certainty. Since it is expensive to use such combination.

Results and Discussion

Raw data collected needs arrangement (organizing it in way that facilitating for analysis). Data organizing mean summarizing data in form of tables, charts, pie charts and graphs. After data organized in proper manner identifying the relationship between each parameter both independent and dependent variable and independent variables has been studied. Then data gained from differing sources are compared for the purpose of critical examination of the various claims. Statistical data analysis from the all sources has been analyzed to give meaning full findings.

4.1 Evaluating the past and the present traffic accident trends

The data collected in the above methods is has been analyzed to evaluate accident rate of the past and the present situations and identifying segment which is more severed by traffic accident. Evaluating the past and the present traffic accident is useful to inspect how to minimize by providing engineering solution. Identifying the traffic accidents over the ranges of years and segments is critical tasks to reduce traffic accident based up the factors influencing the road traffic accidents.

Figure 6 provides the number of road traffic accident occurred in 2010 E.C in four categories; Death, Major Injury, Minor injury and Property damage. *Yayo* is a peak in major injury and *Mettu* town is a peak in death which means 7 persons are died in this year due to traffic accident. *Didu* and *Bacho* woredas are least in major injury which means, no person is died in this year due to traffic accident. In property damage *Mettu, Yayo* and *Bacho* woredas are ranked First to third respectively in this year. Minor injuries occurred not more than twice in woreda in this year.

Figure 7 provides the number of people injured and died in 2010 E.C in Iluabor due to road traffic accident. 23 persons are injured and died in *Nono Sale* woreda in this year which highest recorded death and injury in traffic accident in 2010 E.C. There no injury and death in *Bacho* and *Halu* woreda in this year. *Mettu* Town and *Yayo* woreda are top ranked in major personal injury. *Nono, Hurrumu* and *Alle* woredas are the top three ranked in minor injury for this year.

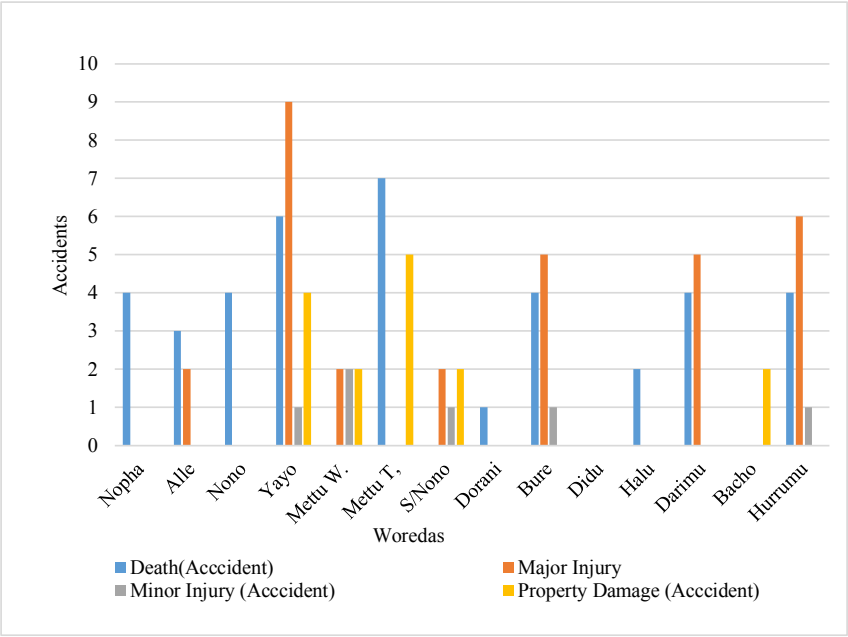

Fig. 6. Number of traffic accidents occurred in categories in 2010 E.C

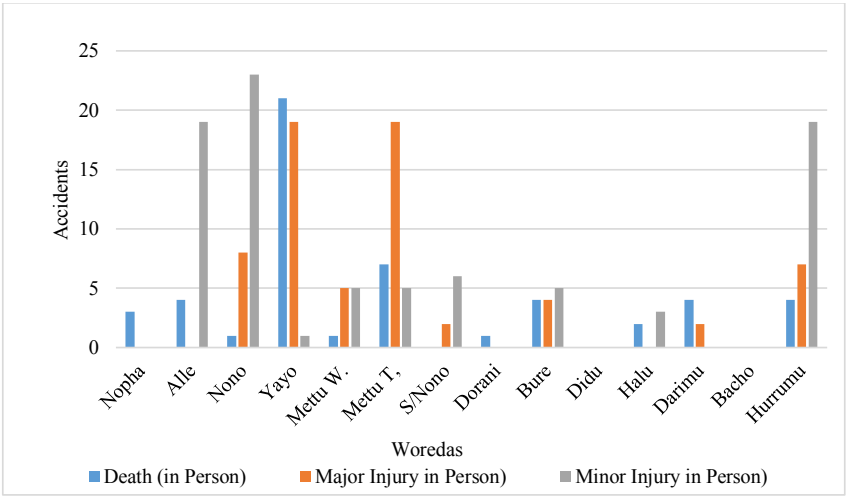

Fig. 7. Number of People Injured and Died in 2010 E.C

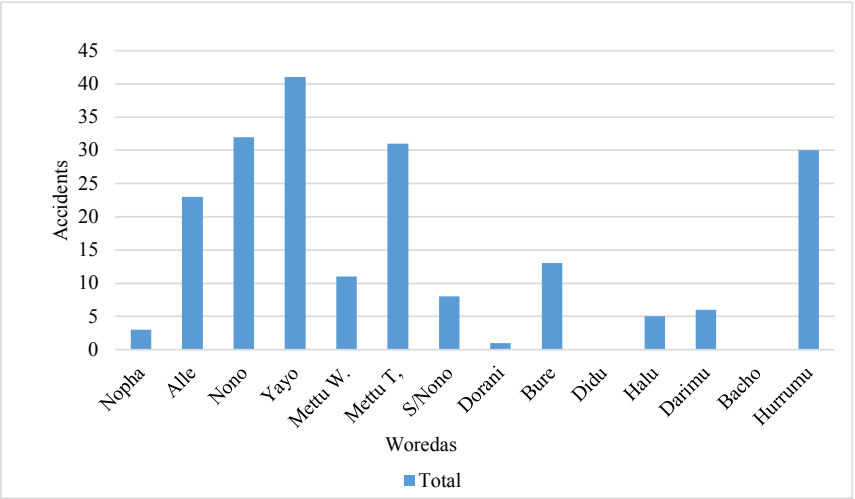

Fig. 8. Total traffic accident occurred in Woredas in 2010 E.C

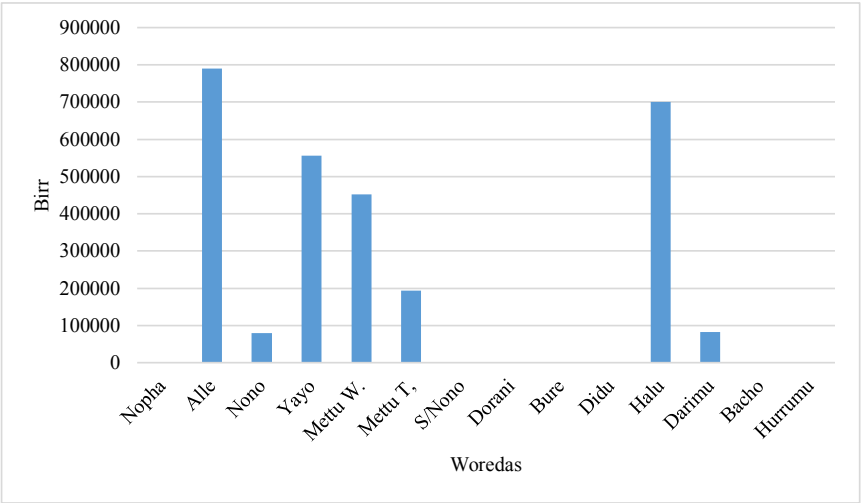

Fig. 9. Estimated Property Loss in 2010 E.C

In 2010 total traffic accident in in Yayo and Nono woredas are 41and 33 respectively which mean the higher recorded accident in this year (Figure 8). Nopha, Dorani, Didu, Halu and Bacho woredas have minimal record of accidents which is less than 5 in this year.

Figure 9 provides that the estimated property loss in 2010 of study area in woredas. This Figure indicates that, almost 800, 000 a birr lost due to road traffic accident in *Alle* woreda which is a peak and that of *Halu* woreda 700000 birr. This indicates that much money is lost due to this incident in one year. So that, the traffic accident has negative impact on economy of these study areas.

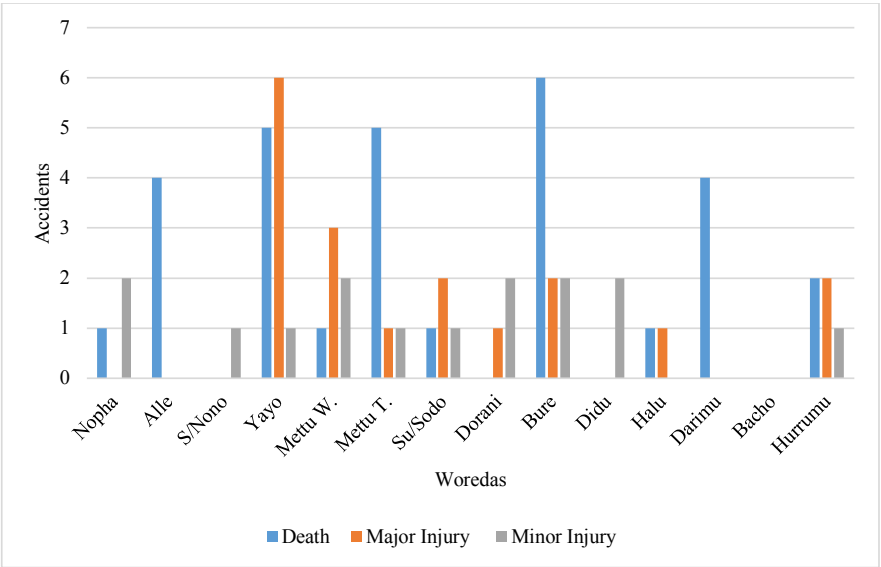

Fig. 10. Number of road traffic accident occurred in categories in 2011 E.C

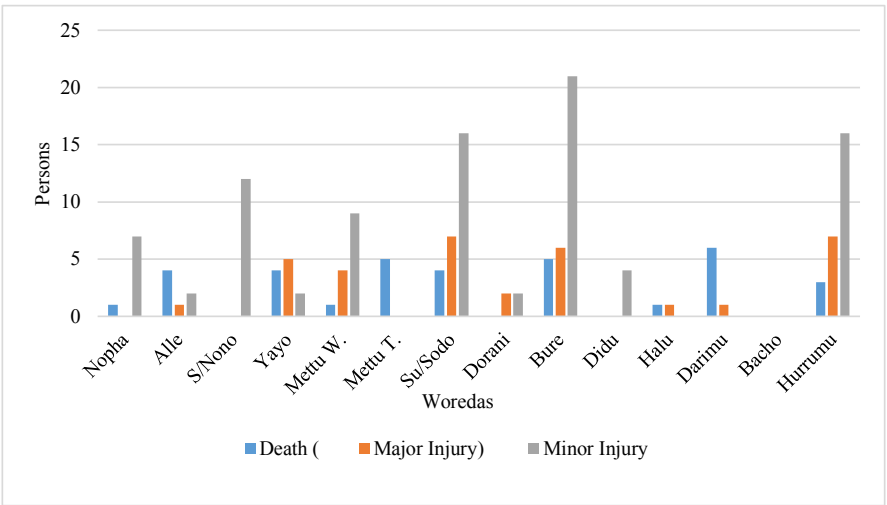

Fig. 11. Number of Injured and died people in 2011 E.C

Above Figure 10 provides the number of road traffic accident occurred in 2011 E.C in four categories; Death, Major Injury, Minor injury and Property damage. Yayo is a peak in major injury as 2011 and Bure Woreda is a peak in death which means 7 persons are died by vehicle accident in this year. Didu, Darimu, Bacho, Nopha, Alle, S/Nonno and Bacho woredas are least in major injury which means, no person is died in this year due to traffic accident. Minor injuries occurred not more than twice in Woreda in this year which the same as previous year.
Figure 11 provides the number of people injured and died in 2011 E.C in Iluabor due to road traffic accident. 22 persons are injured in *Bure* woreda and 7 persons died in *Darimu* woreda in this year which highest recorded injury and death in traffic accident in this year respectively. There no injury and death in *Bacho* woreda in 2011. *Hurrumu*, *Bure* and *Su/Sodo* woreda are top three in major and minor personal injury.

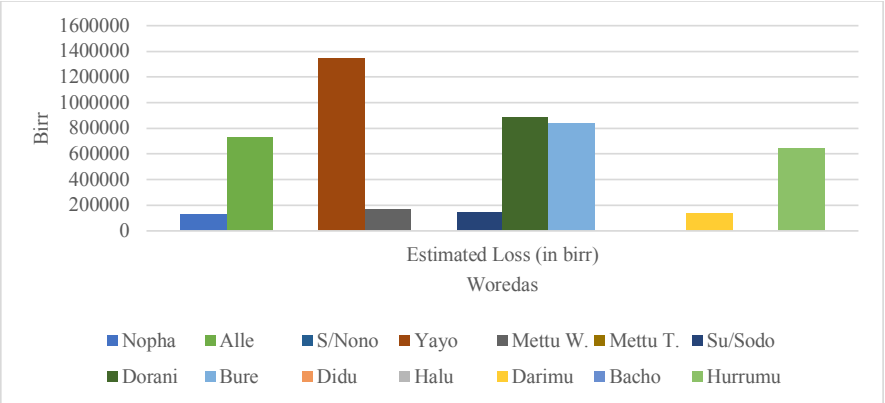

Fig. 12. Estimated property loss in 2011 E.C

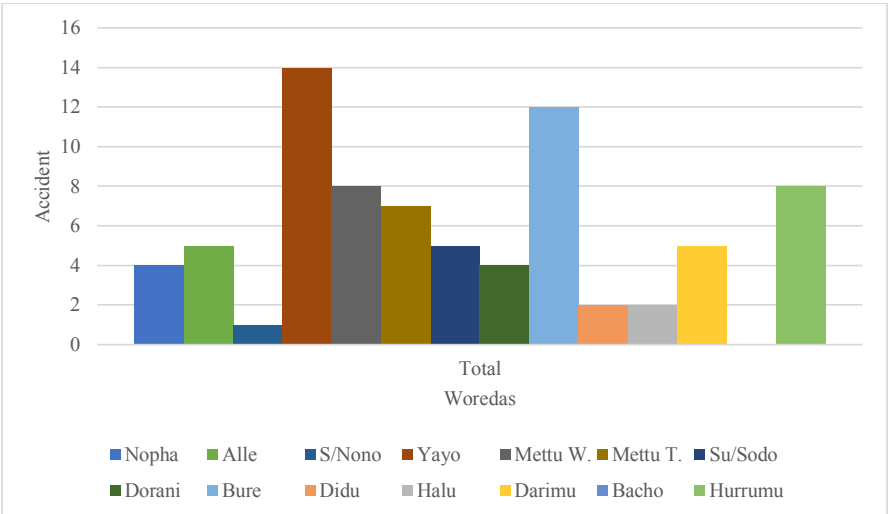

Fig. 13. Total Traffic accident occurred in 2011 E.C

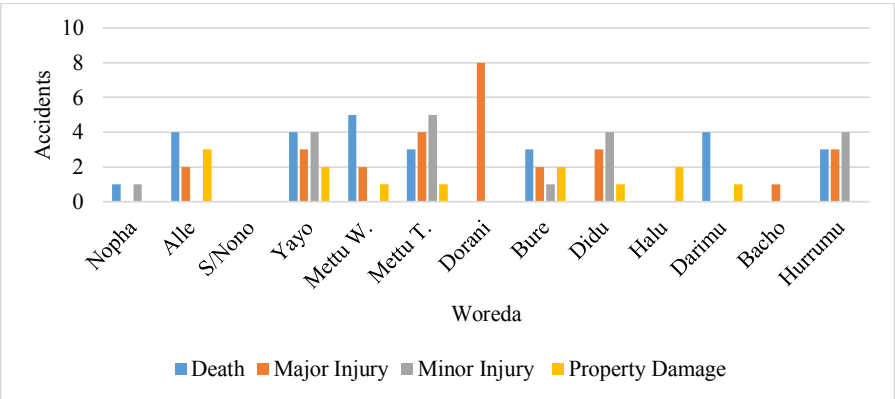

Fig. 14. Number of road traffic accident by categories in 2012 E.C

Figure 12 provides that the estimated property loss in 2011 of study area in woredas. This Figure indicates that, almost 1.4 million birr lost due to road traffic accident in Mettu Town which is a peak property loss. In Hurrumu woreda 800000 birr has been lost due to traffic accident in this which makes the 2nd recorded damage in property. This indicates that a massive money is lost due to this vehicle accident in each year.
In 2011 total traffic accident in in *Yayo* and *Bure* woredas are 14 and 13 respectively which mean the higher recorded accident in this years. *Didu, Halu* and *Bacho* woredas have minimal accident record of accidents which is less than 5 in this year which almost similar to that of 2010 (Figure 13).
Above Figure 14 provides the number of road traffic accident occurred in 2012 E.C in four categories; Death, Major Injury, Minor injury and Property damage. *Dorani* Woreda is a peak in major injury as 2012 and *Mettu* Woreda is a peak in death which means 5 death accident by recorded in this year. *Darimu, Nopha, Halu* and *Hurrumu* woredas are least in major injury which means, no person is died in this year due to traffic accident. Minor injuries occurred in this year increased compared as previous year.

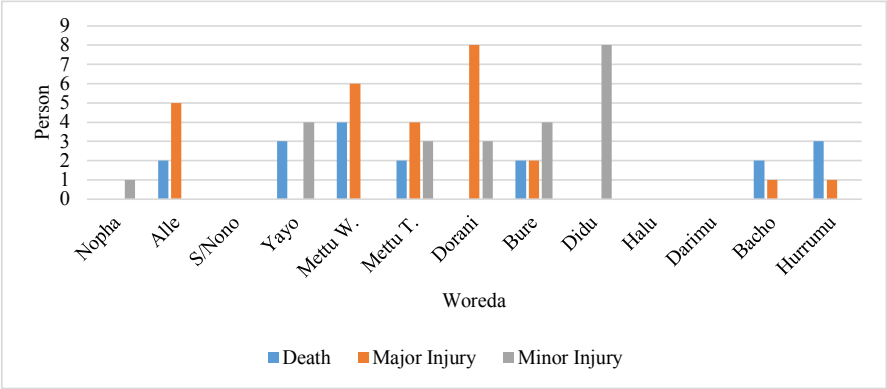

Fig. 15. Number of injured and dead in 2012 E.C

Above Figure 15 provides the number of people injured and died in 2012 E.C in Iluabor due to road traffic accident. 8 persons are injured in *Dorani* woreda and 4 persons died in *Mettu* Town in this year which highest recorded injury and death in traffic accident in this year respectively. There no injury and death in *Nopha, S/Nono, Didu, Halu,* and *Darimu* woreda in 2012. *Dorani, Mettu Town, Alle woreda, Didu,* and *Bure* woreda are the highest recorded accident in major and minor personal injury.

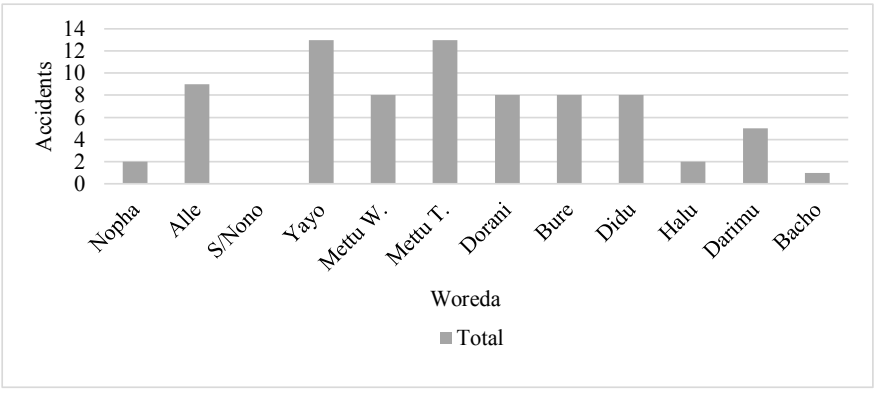

Fig. 16. Total Road traffic accident in 2012

In 2012 total traffic accident in in *Yayo* and *Bure* woredas are 13 which mean the higher recorded accident in this years. *Nopha, S/Nono, Halu* and *Bacho* woredas have minimal accident record of accidents which is less than 2 in this year which shows decreasing compared to that of 2011 (Figure 16).

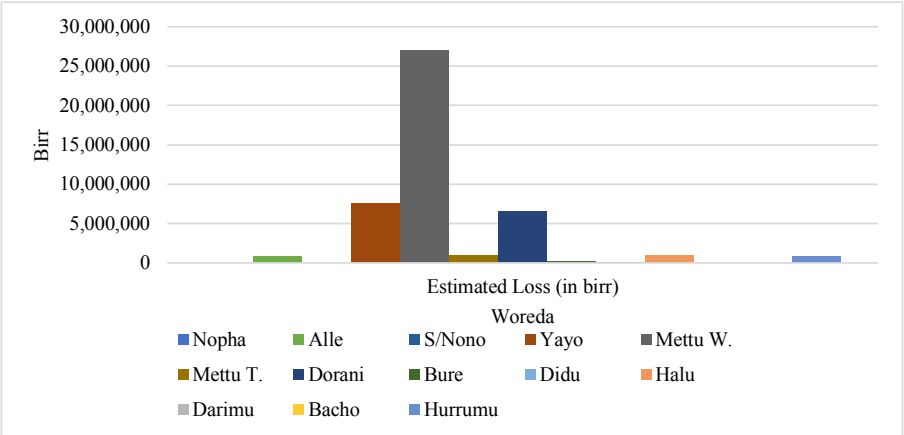

Fig. 17. Estimated property loss in 2012 E.C

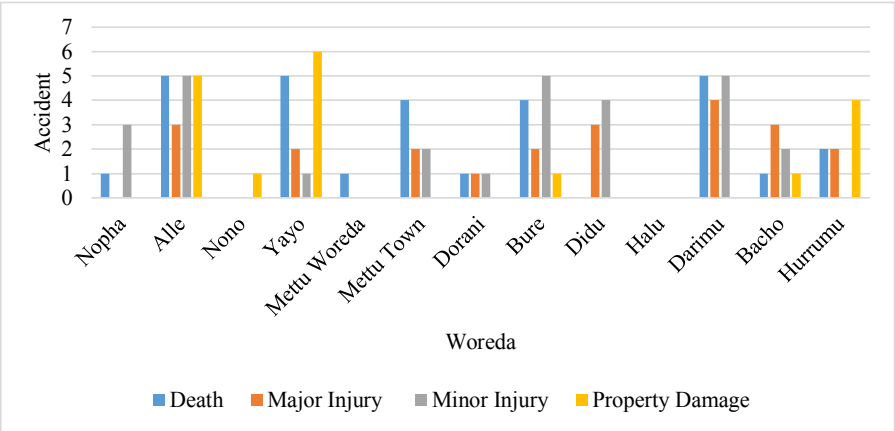

Fig. 18. Number of road traffic accidents occurred in categories in 2013 E.C

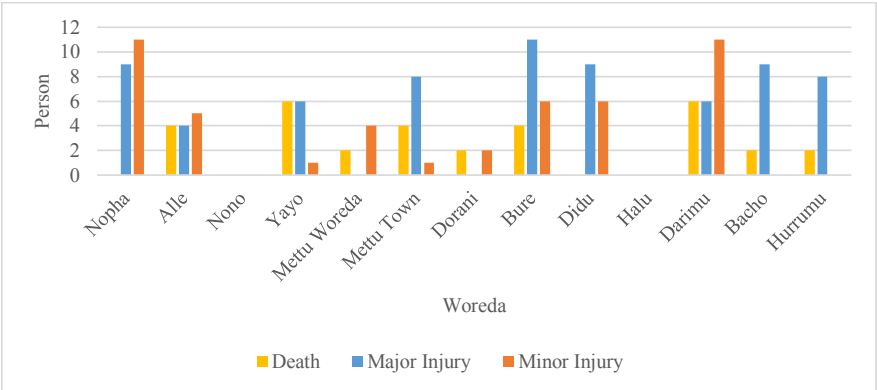

Fig. 19. Number of Injured and died in 2013 E.C

Figure 17 provides that the estimated property loss in 2012 of study area in woredas. This Figure indicates that, almost 25 million birr lost due to road traffic accident in this year in *Mettu Town* which is a peak property loss. In *Hurrumu* woreda 8 million birr has been lost due to traffic accident in this which makes the 2nd recorded damage in property. This indicates that this massive money is lost due to the vehicle accident in each year.
Above Figure 18 provides the number of road traffic accident occurred in 2013 E.C in four categories; Death, Major Injury, Minor injury and Property damage. *Darimu* Woreda is a peak in major injury as 2012 and Alle, Yayo and Darimu Woreda is a peak in death which means 7 death accidents are occurred in this year. Nopha, Mettu, Bure and Dorani woredas are least in major injury which means, no person is died in this year due to traffic accident. Minor injuries occurred more than 5 time in Bure, Darimu and Alle Woredas.
Above Figure 19 provides the number of people injured and died in 2013 E.C in Iluabor due to road traffic accident. 12 persons are injured in both Dorani and Nopha woredas and 11 persons died in Bure Woreda in this year which highest recorded injury and death in traffic accident in this year respectively. There no injury and death in Nono and Halu woredas in 2013.

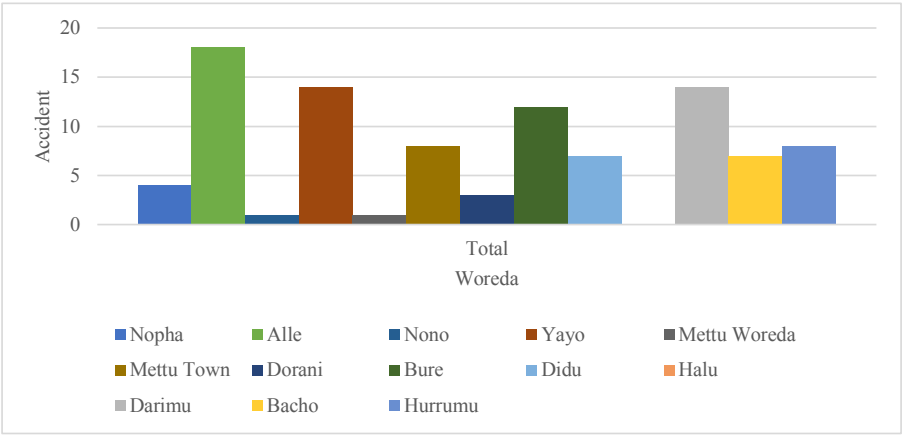

Fig. 20. Total number of road traffic accident occurred in 2013E.C

Figure 20 provides that, the total traffic accident in in Alle Woreda and Mettu Town are 18 and 14 respectively, which mean the higher recorded accident in this years. Mettu and Hurrumu woredas have minimal accident record of accidents which is less than 2 in this year which shows decreasing compared to that of 2013.

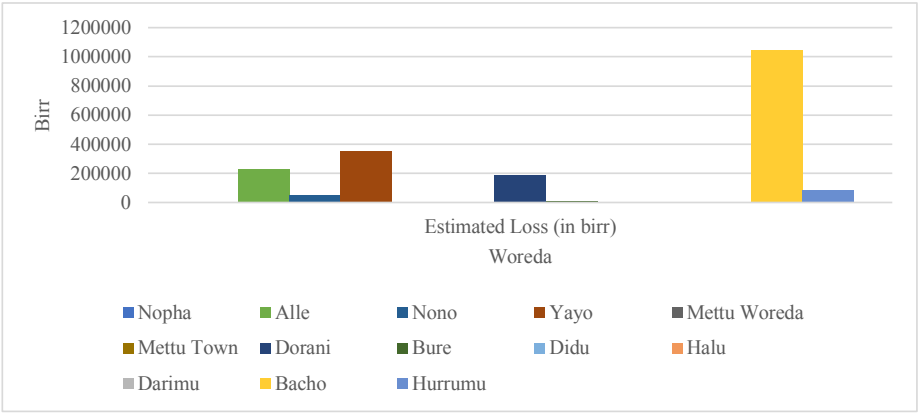

Fig. 21. Estimated property loss in 2013 E.C

Figure 21 provides that the estimated property loss in 2013 of study area in woredas. This Figure indicates that, almost 11 million birr lost due to road traffic accident in this year in *Bacho Woreda* which is a peak property loss.

In *Mettu Town* almost 3.5 million birr has been lost due to traffic accident in this which makes the 2nd recorded damage in property. This indicates that this massive money is lost due to the vehicle accident in each year which lower the economy of the country.

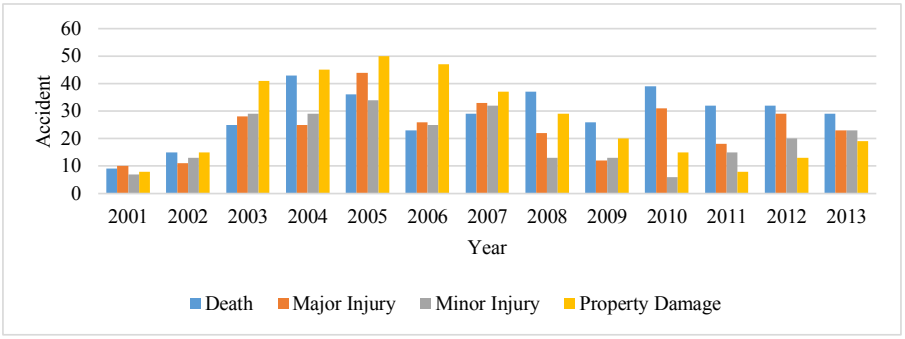

Fig. 22. Road traffic accidents in 13 years (2001-2013 E.C)

Figure 22 provides that the number of recorded road traffic accidents in 13 years in categories (2001-2013 E.C) of study area in woredas. This Figure indicates that, the death rate in vehicle accident from 2001 to 2004, 2006 to 2008 and 2009-2010 is increasing. And also from 2004 to 2006, 2008 to 2009 and 2010 to 2013 shows the decreasing.

Consider major injury, from it shows increasing in first five years except 2004 which shows some significant change. In the next four years from 2005 to 2009 it shows decreasing except 2007 which shows a significant increasing. From 2010 to 2013 it decreasing in non-uniform manner. This might be due how concerned government body are exercising their responsibility and taking in reduction of traffic accident. Recorded accident in number which termed as minor injury due to vehicle accident, it shows increasing in first seven years and decreasing from 2004 to 2013, which improvement in road safety aspect. Consider that the property damage, it shows in increasing significantly from 2001 to 2005. After 2005 even though estimated property lost is increasing or high the number of accident recorded as property damage is decreasing which shows a little improvement.

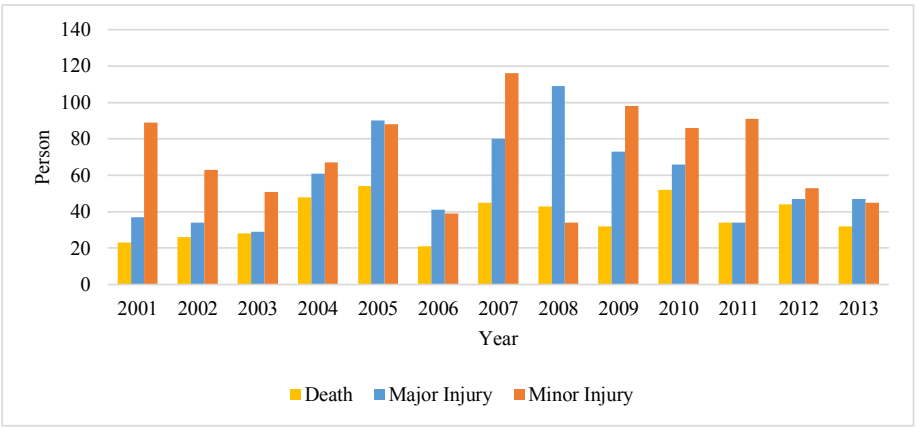

Fig. 23. Number of Injured and died people in 13 years (2001-2013)

Figure 23 provides that the number of Injured and died people in 13 years of study area in Ilu Ababor zone. This Figure indicates that, the death rate in vehicle accident from 2001 to 2004, 2006 to 2008 and 2009-2010 is increasing. And also from 2004 to 2006, 2008 to 2009 and 2010 to 2013 shows the decreasing. In 2007 almost 120 person has been passed away due to traffic accident which is a peak death recorded in 13 years. This figure shows that the traffic accident a critical issue in developing like Ilu Ababor zone. In 2011 almost 90 person has been passed away due vehicle accident which makes the problem more severe. Within the late three consecutive

year 2011 to 2013 it is abruptly decreasing which shows a good improvement. So that, the concerned body like transport office, traffic police, road and logistic authority and road users are the primary responsible stakeholders in reduction this human being enemy (traffic accident).

4.2 Estimating accident rate and developing regression model

Accident analysis includes

1) Fatalities (Death and Major Injury): The major accident that occurs on the road such as death, heavy property damage, head injury, heavy body injury, etc. comes under fatal accident.
2) Injuries: The medium accident that occurs on the road such as Minor property damage, Minor fractions, etc. comes under Minor accident.
3) Minor or properties damages: Small accidents that occur on the road such as Minor damage to vehicle or body comes under Minor accident.

Indicator of Accident

$$\text{Accident rate}\left(\frac{\text{Acc}}{\text{MV}}\right)=\frac{\text{Number of Accident}\times 10^{6}}{\text{ADT}\times\text{Number of Year}\times 365\,\frac{\text{Day}}{\text{Year}}} \quad (1)$$

$$Accident\ rate\left({}^{Acc}/_{MVM}\right)=\frac{\text{Number of Accident}*10^{6}}{\text{ADT}\times\text{Number of Year}\times 365\,\frac{\text{Day}}{\text{Year}}*\text{Length of Segment}} \quad (2)$$

$$Accident\ rate\left({}^{Acc}/_{HMVM}\right)=\frac{\text{Number of Accident}*108}{\text{ADT}\times\text{Number of Year}\times 365\,\frac{\text{Day}}{\text{Year}}*\text{Length of Segment}} \quad (3)$$

Table 1. Estimated rate of accidents for four years

Year	GD	RS	OS	DB	Total	AADT	Rate of Accident
2010	92	82	90	77	341	6143	152
2011	115	67	18	32	232	6450	99
2012	36	19	30	31	116	677	469
2013	99	53	55	61	268	7111	103

Key Note: GD: Geometric Design, RS: Road Surface, OS: Over Speeding, DB: Driver Behavior

To develop multiple regression model for forecasting the rate of traffic accident: Current procedure of estimating accident rate is useful in reduction of accident and benefit applies fixed accident rates for each road level. In order to solve the problems mentioned in the previous chapters, models have been developed considering the characteristics of roadway and traffic characteristics like operating speed, driver behavior etc. The developed models is useful to estimate the accident rates on new or improved roads. First of all, factors influence accident rates were selected. Those factors such as traffic volumes, road geometry, road surface and operating speed has been are considered. In this study, the regression analysis has been performed for each group with actual data associated with traffic, roads and accidents. When road types and characteristics change, characteristics of traffic accidents also change but it is not seen yet a proper measure to predict changes of traffic accidents according to traffic characteristics and road types. So this study is to develop a systematic accident prediction model reflected by physical characteristics of road types through a survey of characteristics of roads and accidents in Ilu Ababor Zone. Estimated rate of accidents, road traffic accident with influencing factors in woreda are shown in Table 1 and 2.

$$\text{Accident Rate}\,(\,\text{Acc/MV})=\frac{(Number\ of\ accident)*10^{6}}{(AADT)*(number\ of\ years)*(\frac{365\ Days}{years})}$$

MVK = Accident per million Vehicle – Kilometers of travel (From World Health Organization).
Pearson's correlation Road Surface (RS), Geometry of the road (GD), Operational Speed and Accident and identified accident prone area in Iluabor zone are shown in Table 3 and 4.

Table 2. Road Traffic accident with influencing factors in woreda

Woreda/Town	%ages of defects	Carriage way Length	Operational Speed	Accident occurred
Nopha	98	8.20	45	20+
Alle	99	9.40	62	18
Nono	98	9.60	40	1
Yayo	90	8.60	78	19
Mettu Woreda	76	9.60	55	6
Mettu Town	10	9.20	45	13
Dorani	78	9.60	50	4
Bure	82	8.00	90	22
Didu	98	8.40	65	15
Darimu	63	8.00	50	23
Bacho	65	8.20	45	12
Hurrumu	56	7.80	70	14

Table 3. Pearson's correlation between dependent and independent variables

	RS	GD	V
GD	0.071		
V	0.202	-0.403	
Acc	0.013	-0.722	0.502

Key Note: RS: Road Surface, GD: Geometric Design, V: Operational Speed, Acc: Accident

Regression Equation

Acc = 61.5 + 0.0017 RS - 6.24 GD + 0.116 V

Where, RS: Road Surface, GD: Geometric Design, V: Operational Speed, Acc: Accident

Table 4. Identified Accident Prone area in Iluabor Zone

S/N	Woreda/Town	Primary Reasons	Identified Prone Areas
1	Nopha	Geometric Design, Road Surface	Ganda Dizi and Abu
2	Alle	Overspeeding	Bishan Dikuli, Bishan Gore and Gumaro Fafate
3	Nono	Geometric Design, Road Surface	Taba Gito, Taba Goroso, Taba Tiki, Taba Barasha, and Taba Koti
4	Yayo	Overspeeding, Driver Carelessness	Witate, Laga Gaba, Ganda Gechi, Ganda Wabo, Laga Oboo
5	Mettu Woreda	Road Surface and Driver Carelessness	Gaba Guda, Cogi, Alle Bu'a
6	Mettu Town	Overspeeding, Driver Carelessness	4 kilo, Decha Uke, College, Post Office

8	Dorani	Geometric Design	Haro Melka, Laga Lili=mo and Taba Genga
9	Bure	Geometric Design	Kulalite, Miriga and Ilke
10	Didu	Geometric Design	Lalo and Gordomo
11	Halu	Geometric Design	Wangas, Yatu and KidaneMiheret
12	Darimu	Overspeeding, Geometric Design and Absence of traffic Signs	Kattaa Bako, Gobe,Boto School and Wabeekoo
13	Bacho	Road Surface	Taba Kabar, Tullu Suna and Kodo Culrvert
14	Hurrumu	Geometric Design, Road Surface	Yaha Adami, Gabbaa, Dacha Bulgee, Laga Bala

4.3 Discussion

Traffic Accident modelling and simulation has a vital role in forecasting and identify the prominent factor in accidents. Several studies have been conducted on Analysis and modelling of traffic accident under heterogeneous traffic conditions. This study revealed the trend of the traffic accident over thirty years (2001-2013) E.C, estimation accident rate, modelling of traffic accident, identifying accident prone area and suggesting scientific recommendation for policy makers, road users, traffic police, road and transport authorities. From developed multiple non-linear regression model above more significant parameter for the accident occurred due to the geometric design and operating speed on the routes. Geometric design includes all cross-sectional elements of the road.

It is observed that the faulty in geometric design is major contributing factor in this paper. This finding is similar with the study conducted in Tianjin in China by [13]and the same another study that has been conducted in Tianjin by [14] showed that the traffic accident is critical issue in transport industry.

One important parameter of traffic accident in this study was accident rate. By equation 1 and 2 for selected study accident rate has been estimated. The current study found that the accident rate is decreasing from 2012 E.C to 2013 E.C which means 469 and 103 respectively. For the drivers who are running in high operating speed, the tendency for getting accident is high.

5. Conclusions and Recommendation

Ilu Ababor zone is characterized by poor traffic control systems and regulations, lack of good geometric design and the surface of the road is a full of potholes and defects. This study revealed that, deficiency in geometric design is the primary factor that because traffic accident in Ilu Ababor zone and also operation speed on the road is one of the key factor that contributing in this zone. Besides absence of road safety, the drivers are driving in carelessness which makes another accident contributing factor. Drivers are not respecting pedestrian priority, over loaded or improperly loaded vehicles, poor bolo inspection system of vehicles, weak traffic law enforcement.

The result shows that, the death rate in vehicle accident from 2001 to 2004, 2006 to 2008 and 2009-2010 is increasing. And also from 2004 to 2006, 2008 to 2009 and 2010 to 2013 shows the decreasing. In major injury, it is increasing in first five years except 2004 which shows some significant change. In the next four years from 2005 to 2009 it shows decreasing except 2007 which shows a significant increasing. From 2010 to 2013 it is decreasing in non-uniform manner. In minor injury due to vehicle accident, it shows increasing in first seven years and decreasing from 2004 to 2013, which improvement in road safety aspect. In property damage, it shows in increasing significantly from 2001 to 2005. After 2005 even though estimated property lost is increasing or high the number of accident recorded as property damage is decreasing which shows a little improvement. The important index of vehicle accident in heterogeneous traffic condition is rate of accident which has been computed for four years. Estimated rate of accident for 2010, 2011, 2012 and 2013 are 152, 98, 469, and 103 respectively. Multiple linear regression model has been developed to show the significance the predictors on the traffic accident. The developed regression model indicates that, lack of geometric design is the major factor that pay role in traffic accident of study area. The determinant of vehicle accident is operating speed. Finally black spot area in each Woreda has been identified.

Based on the above results of the study and discussion, the researcher has forwarded some important suggestions and recommendations, which thus works to reduce the aggravation of the problem of traffic and public safety on the citizen and the security of the national economy. The most important of these suggestions and recommendations include:

a) Awareness of traffic stakeholders
b) Implement Drink/drive measures
c) Road safety engineering measures
d) Implement road safety audit and engineering measures
e) Implement mandatory vehicle insurance law
f) Implement traffic safety education for children
g) Promote road safety publicity on speed limits and pedestrian priority
h) Improve accident data collection and processing system (data management)
i) Implement research on road safety publicity and accident costing
j) Prohibition of use of hand-held mobile telephones while driving
k) Use of seatbelts

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