

# Identification of Road Traffic Accident Blackspot locations and its countermeasures in Oromia Region, East Wollega Zone

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**Abstract**— One of the input for the economic development of a country is the expansion of road network, which is important for the transportation of people and freights from place to place. With this expansion, the occurrences of a road traffic accident is increasing in all parts of the world from time to time, killing the lives of many peoples and damage to properties. This problem is growing with the highest rate in sub Saharan African countries like Ethiopia. The general objective of this study is to identify the hazardous locations of road traffic accidents and suggest countermeasures to mitigate the occurrence of road accidents. The study area was conducted in the East Wollega Zone of Southwestern part of Ethiopia in Oromia Region. Districts exposed to high traffic volume are sampled using purposive sampling method. Those sampled districts include Digga, Sibbu Sire, Nekemte town, Wayyu Tuka, Guto Gidda, Gobbu Sayyo, Leka Dullacha and Jimma Arjo. Road accident data are collected from all administrative districts from September 2012 to June 2015 (2005 -2007 E.C), and it was used for the analysis. In addition, a field survey was made to observe the existing geometry, environment of the roadside, traffic flow regulators and markings of the road sections. To rank each of the sample districts, evaluation of Priority value had been used consisting of a number of deaths, minor and major injuries occurred for three years. Based on these parameters, each of the districts was listed from highest to lowest (i.e. Digga, Nekemte town, Sibbu Sire, Wayyu Tuka, Guto Gidda and Gobbu Sayyo) out of the whole sample districts.

This research study had found out that there was a significant increase in terms of the number of deaths occurring due to road traffic accident as a result of the increase in the coverage of road crashes and its consequences. The major causes of the road accidents include over-speeding, ignoring warning posts, road geometry, deterioration of pavement and roadside environment. In order to minimize the frequency of road traffic accidents at the identified hazardous road locations, countermeasures is recommended, addressing to the concerned agency which includes speed breakers, installation of guardrails at curvatures, installation of hazard light to minimize night time road accidents, removing roadside obstructions, repair and maintenance of pavement defects to restore to as-is good condition, and building additional facilities for pedestrians in urban area.

**Index Terms**— Fatality rate, Hazard locations, Injury rate, Property damage, Road accident blackspot, Road network Road, traffic accident.

## 1 INTRODUCTION

Road transport is a critical mode of transportation in the development of a country, in which there are different negative impacts related to it. The effects are related to road traffic accidents, that are considered to be a major critical problem all over the world. While, this incident is more affecting countries in sub-Saharan Africa.

Each year an estimated 1.24 million people are killed in road traffic accident and up to 50 million people injured worldwide. Third world countries bear the brunt of the fatalities from road traffic accidents, accounting for more than 85% of the world's road fatalities. Thus road traffic accident is the most dangerous health problem all over the world [1].

There are different rates of fatalities by road traffic accident in different parts of the world. And the highest rate of fatalities per 100,000 Population is in Africa, 24.1, which have only 48% of the world's registered vehicles [2]. In developed countries, the rate of road traffic accident is decreasing as compared to developing one. For instance, in the first decades of the 21<sup>st</sup> Century most member countries of the International Transport Forum saw the lowest level of

fatalities due to road traffic accident. Overall, the number of people killed on road in 2013 declined by 5% in the 34 countries. Only one of those countries reported an overall increase of its fatalities from 1995 to 2013 [3]. But this is the opposite in developing countries such as in sub Saharan Africa. For example, the total number of reported accidents in Kilimanjaro Region, Tanzania in 2008 was 906 while in 2009 it was 1125 accounting for an increase of 24%. The total mortality reported in 2008 was 147 and 202 in 2009 with an increase of 37%. The total morbidity was 622 in 2008 and 933 in 2009 account for 50% increase. From these, we can conclude that road traffic accident in developing countries is a major health problem and needs an immediate solution which reduces the fatality, injury and property damage happening due to the accidents [4].

In Ethiopia, this road traffic accident is one of the crucial health problems similar to the other sub Saharan regions. There are different causes for the occurrence of the accidents in Ethiopia, such as problems due to drivers. In the United States of America, for instance, 60% of the fatalities account to

car drivers, while in Ethiopia, 5% account for drivers. This implies that in one crash the number of people killed or injured in Ethiopia is about 30 times higher than in the United States of America. Therefore, in Ethiopia fatalities due to traffic accident is the worst problem facing us in our day to day life [5]. Similar to the other sub Saharan Regions, road traffic accident in Ethiopia is increasing from time to time. For example, on a research conducted in Addis Ababa from 2001 to 2008 it increased from 9.27% to 13.9% with a typical pick in 2006, which was 15.1% [6].

All of the above illustrations explain the severity of road traffic accidents all over the world. And as the life standards of the peoples is getting down the road traffic accident is increasing, the more developed the lesser traffic accident rate and better safety. In each part of the world, there are different magnitudes of road traffic accidents and it depends upon the life standards of the people and policies used for the road transportation system in order to reduce road traffic accidents. Not only the two factors reduce the fatalities and injuries due to road traffic accident. But also the mitigation development after the accident happened will play a great role. One of the methods for the reduction of accident on road transportation is the identification of hazardous locations, with the highest traffic accident. Thus, this research project was conducted for the identification of such locations in Oromia Region, East Wollega Zone.

Identifying and investigating hazardous highway safety problems and roadway locations and features, and establishing countermeasures and priorities to correct identified hazardous locations is one of the methods used for the fulfillments of road traffic safety objectives [7]. Highway accident blackspots are highway or road locations where the potential for accidents is unacceptably high or highest number or rate of accident happening in a certain location [7], [8], [9].

For the identification of such hazardous locations, there are different approaches used. Some of these methods include using manuals and guidelines which are limited to a specific standard of the countries and defines their own criteria's for the locations of the accident spot [11] and statistical method called Rate Quality Control method [10], [11]. The others are using a conventional method in which it relies on a fixed length of road sections and manual method used in which road inspectors travel along a highway and inspect all accident records [8]. And some of them uses priority value for the identification of hazardous locations. According to this method in order to be the location is a road blackspot area, it must exceed some value [14].

## 2 RESEARCH METHODOLOGY

### 2.1 Study Area

The study was conducted in the western part of the Ethiopia Oromia region, East Wollega zone. This zone is divided into 17 administrative districts with one administrative city covering an area of 141,103km<sup>2</sup> with a population of 1,021,649. The capital Nekemte is located at 331km from Addis Ababa centered in Southwest part of the country. This zone is bounded by Amhara National region in North, West Shawa zone in the East, Jimma zone in Southeast, Ilu Aba Bora zone in Southwest, West Wollega zone and Beni Shangul Gumuz National region in West direction [12].

This zone is bounded by all mentioned parts of the country. There are also national road networks connecting the capital of the zone with the neighbors as shown in figure 1. The road network shows towards Addis Ababa in the East, Amhara National Region in the North, to Jimma and Ilu Aba Bora zone in the Southwest, to West Wollega and Beni Shangul Gumuz National Region in the West from the capital Nekemte.

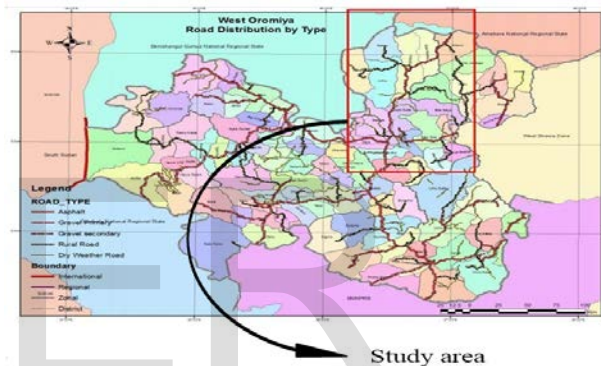


Figure 1. West Oromia Region Road Distribution [12]

### 2.2 Sampling Technique and Sample Population

The sample population was taken out from all districts found in the East Wollega zone while the method of sampling used, is purposive sampling technique. The areas to be sampled in this research project are all districts located on the major national road networks as they are known to have high traffic volume. These districts are Nekemte town, Digga, Guto Gidda, Wayyu Tuka, Sibbu Sire, Gobbu Sayyo, Leka Dullacha and Jimma Arjo.



Figure 2. National road networks with high traffic volume

and AC pavement of sample districts [13]

### 2.3 Data collection method

The main objective of this research project is to identify road traffic accident black spots in the study area. The types of data collected, are both primary and secondary, comprising of quantitative and qualitative types.

These collected data include:

- Road traffic accident data according to their severity, i.e. Fatality, injury (major and minor) and property damage with the number of crashes happened to all districts in the zone.
- The major causes of crashes, according to their weight (high, medium and low).
- Listing out the road accident prone areas of the sample population (districts).
- Characteristics of road sections of the sample population with a high frequency of road traffic accident which includes description of road geometry, road side condition/ environment, and road traffic regulation signs, warning posts and markings.
- Environment, and road traffic regulation signs, warning posts and markings.
- Measures taken or implemented to minimize the occurrence of road traffic accident in the identified sections.

The method used for the collection was review of historical road accident data organized at zone level and discussion with traffic officials during the site survey on the causes of road crashes and how road accidents are happening in the locations. The collected road accident data ranges from September 2012 - June 2015 (2005-2007 E.C) for administrative districts and from September 2009 – June 2015 (2002-2007 E.C) for Nekemte town. Thus, for analysis purpose and prioritization a 3year data was used, i.e. 2012/13 (2005 E.C), 2013/14 (2006 E.C) and 2014/2015 (2007 E.C).

### 2.4 Data Analysis

The data collected was analyzed according to their types as quantitative and qualitative. The raw data collected were organized and grouped to be easy for the analysis. The quantitative data are used to explain the general characteristics of road traffic accident in the East Wollega zone, to compare the severity of road crashes between the sample population and the other districts.

Also, using these data, the prioritization of the sample population is done by using the following equation [14].

$$P = X + 3Y + 5Z \quad (1)$$

Where, P= priority value

X = total number of slight injuries

Y = total number of serious injuries

Z = total number of deaths.

Based on the priority value of each location, those recording values greater than or equal to 15 were selected as road traffic accident blackspots. The other data collected and analyzed includes qualitative data, such as road characteristics and its environment, causes of crashes and measures taken before this study to reduce the happenings of road accidents. These data are listed, explained and each of them were related how they contribute to cause the damage. This helps in proposing possible countermeasures to minimize the effects of accidents on human life and property.

### 2.5 Study variables

#### Independent variables

- Road traffic accidents
- Fatality rate
- Injury rate
- Property damage rate

#### Dependent variable

- Locations of RTA blackspots

## 3 RESULTS AND DISCUSSION

Based on the priority value evaluation for each of the sample areas, the accident prone areas are identified and the result is presented as follows:

In the East Wollega zone the amount of fatality rate was increased from 19.85% to 52.21% during the study period as shown in Figure 3.

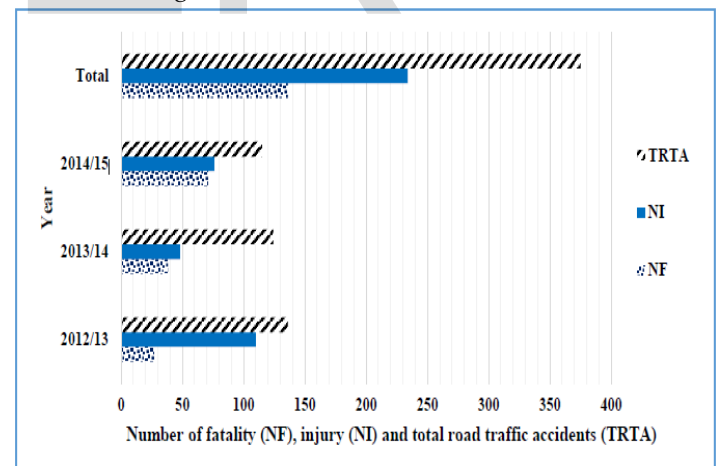


Figure 3. Total number of fatality, injury and road accident in East Wollega zone from 2012/13 – 2014/15

This increase is mostly recorded by Digga district, which covers about 20.59%, where Sibbu Sire and Wayyu Tuka are also those recorded the highest value which is about 18.38% and 11.01% respectively following Digga district. Thus, these three districts are those with the highest rate of fatality. As this rate is increasing the number of districts with no fatal accident is decreasing from 52.94% to 29.41% (Figure 4).

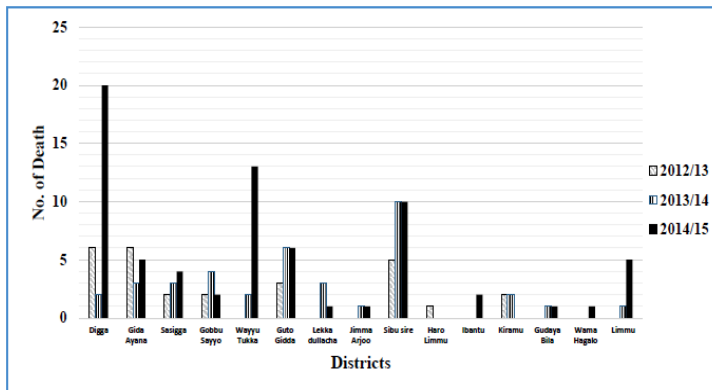


Figure 4. Fatality due to road traffic accidents of East Wollega Zone

These values show most of the areas are facing loss of human life from time to time. While the number of fatalities is increasing with each year the number of injuries is not occurring in the same fashion. There is a fluctuation in each year as it was decreased as compared to the first year. But there is an increase in the last year as compared to that of the second year. Similar to that of the districts registering the highest rate of fatal accident Gidda Ayana, Digga and Sibbu Sire districts are those having highest rate of injury.

The last two districts are also those having higher rates of fatal accident in the East Wollega zone. In each year from 2012/13 to 2014/15 on the average about 125 road accidents are happening in administrative districts found in the East Wollega zone and there is a decrease of 15.44%. There is a total of 234 injuries and 136 deaths occurred due to the road traffic crashes (Figure 3). The number of fatal accidents occurring is increasing each time. Also the number of injury is high, which was only decreased once. Thus the severity of road traffic on road users is increasing opposite to the number of road crashes happening and only the amount of property damage is decreasing each year as that of the number of road accidents. The above results explain the general characteristics of road traffic accident in the study area.

As this study focus on the road section having high traffic volume the behavior of road traffic accident in the sample population is its concern. These sample population has a total coverage of about 41.17% plus one administrative city, Nekemte. The districts in the sample population, i.e. Digga, Guto Gidda, Wayyu Tuka, Sibbu Sire and Gobbu Sayyo have high traffic flows and they are located on national road networks extending from Addis Ababa to Asosa except Leka Dullacha and Jimma Arjo districts which are on the way diverting to Bedelle from the main route. Based on the analysis the sample districts are those having a high severity of road traffic accident in the study area even though there is a decrease of road crash by 13.18%. It comprises about 71.32% of fatal accidents, 45.72% of injury and 66.4% of total road accidents. Also, they are constituting about 52% of PD and

thus they are comprising more than half of the road traffic accident and its outcomes except for the injury of users (Figure 5).

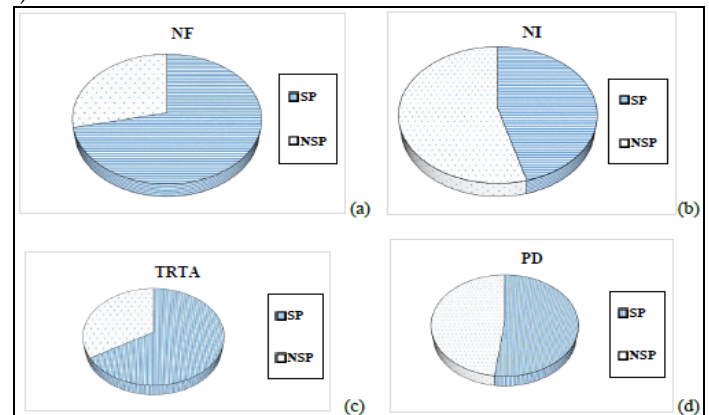


Figure 5. Coverage of severity due to road traffic accident between sampled and non-sampled population

- a) Rate of fatality (NF)
- b) Rate of injury (NI)
- c) Total road traffic accident (TRTA), and
- d) Rate of property damage (PD)

On the other hand, the sample area, the rate of fatal and injury due to the road crashes is increasing with each year. There was an increase of death by 75% in 2013/14 and 89.28% in 2014/15. Similarly, the rate of injury was increased by 33.33% and 59.37% in the last two years. This trend is opposite to that of the total road traffic crash happening in the study samples in which it is 91 in the first year and decreased to 79 in the last two years i.e. a decrease by 13.18%.

All of these, give the behavior of road traffic accident in the East Wollega zone and the sample populations. And only having this property, identifying the prone areas will be confusing to rank the districts. Thus to simplify and to make it clear the ranking procedures, evaluation of priority values (P-value) is executed in the analysis. Digga, Sibbu Sire, Wayyu Tuka, Guto Gidda and Gobbu Sayyo districts are those which are exposed to high road traffic flow as they are located on the main route. Nekemte city is also one of the locations which is found in this group. The other two districts Leka Dullacha and Jimma Arjo with less rate of fatality, injury and road traffic accident have less road traffic flow as they are diverting from the main route.

The common thing they have is the type of road they are using, which is asphalt concrete pavement. According to the evaluation of P-value, out of the total road locations in sample districts only two of them recorded below the requirement i.e. less than 15. These two locations are Ariya Jawwi section (P-value of 13) in Wayyu Tuka and Dhokonnu section (P-value of 12) in Gobbu Sayyo districts. Besides these



two locations the other sections have priority values greater than 15.

Therefore, they are road traffic accident blackspot location in the East Wollega zone. Out of all the road traffic accident blackspot locations Qajela (Digga district), Gindo (Sibbu Sire district), Bellam-Sorga (Guto Gidda district), Katta Fola (Digga district) and Gulliso (Wayyu Tuka district) are the top five locations in East Wollega zone.

All road sections will not have equal frequency of road traffic accident rate. Always there is a section of a road with a repeated road crash and thus within a road stretch in each district there is no uniform distribution of road accidents. Based on the identified P-value of the sample population the following result is obtained. Table 1 below summarizes the P-value of each district with their identified hazardous sections.

**Table 1. Road traffic accident blackspot locations of East Wollega zone**

No.	Districts	Road crash location	P-value	Rank
1	Digga	Qajela	86	1
		Katta Fola	52	4
		Arjo	18	10
2	Nekemte town	In front of Ethio-telecom Western regional office	31	6
		Bus Station	16	11
		Qera	26	7
3	Sibbu	Gindo	67	2
		Jalalle	24	8
4	Wayyu	Gulliso	50	5
5	Guto	Hadiyya-Mino	16	11
6	Gobbu	Bellam-Sorga	65	3
		Qejjo Michael	20	9

Each of the road hazardous locations listed in table 1 have their own characteristics. For instance, only the road sections found in Nekemte town are flat, even though they have different width. Thus, for the hazardous locations in Nekemte town the road found in front of Ethio-telecom Western regional office is characterized by a 2-way, 4-lane highway with a median. The other two road sections are 1- way, 2- lane (Qera section) an unmarked roadway (Bus station).

The former road section which has a length of about 350m is a congested road due to parking of vehicles on both sides of road as shown in the figure below. Also, there is no adequate road side walkway for pedestrian and over the whole section of the road there are no any zebra markings available allowing to cross the road at intersections. Thus, these behaviors of, the road sections are leading to road accidents such as driving accidents, collision with medians and crossing over accidents.



**Figure 6. Roadside vehicle parked in front of Ethio-telecom Western regional office, Nekemte**

The other two sections are those having a high frequency of road crashes. Qera section is characterized by a flat road type and it is a market area. Also the road accidents are happening in the market than the other days.

Like that of the above road section there is no adequate road side walkway for pedestrian and zebra crossing at intersections and joints which is also common for the prone section of the bus station. The type of accident happening is driving accidents and crossing over accidents.

The existing road width is not sufficient and no road side walkway for users at the Bus station hazardous section mostly the crashes are causing property damage than the other and it is during the exit and entrance of buses to the station. Except those discussed above (hazardous locations found in Nekemte town) all of them are found in rural areas and Gulliso hazardous location is the one found at the entrance of Sire town in the Sibbu Sire district.

Among these hazardous location Digga districts comprises of the longest section (Qajela hazardous location) which is about 17.7km and comprise of three hazardous sites as listed in table 1 above. Some of the accident prone road sections such as Qajela (Digga district), Bellam-Sorga (Guto Gidda district) and Gulliso (Wayyu Tuka district) are those located in a mountainous area. And all of the area have similar geometrical features such as curved both horizontally and vertically, sloped ( up to 9%, example Qajela road section) and bridge existence (such as Hadiyya-Mino Minch, Gulliso, Jalalle and Gindo hazardous locations).

The roadside environments are some common properties of the accident prone locations. These include vegetation which limits the visibility of drivers (Katta Fola, Qejjo Michael, Bellam-Sorga, Qajela, Jalalle, some portions of Hadiyya-Mino Minch and Gullisosections) and absence of guard rails (Dhaga Kaba in Qajela hazardous location, Gulliso and Jalalle). Besides the geometric and environmental behavior of the accident prone areas there are causes for the existence of road traffic accidents.

Out of them the most common causes of crashes are road surface condition (such as road deterioration in Katta Fola site), speed, ignoring warning posts, traffic congestions and parking along the roadside. These causes alone couldn't result with road accidents.

But they are interrelated with each other i.e. human error, road geometry and environments. For instance, in considering the road accident happened in Kata Fola site speed, deterioration of the road and existence of vegetation have a great contribution. In this driving accident, there was 7 deaths and 9 injures happened. The crash and its pattern are shown in the following figure 7.



Figure 7. Road traffic accident at Kata Fola and its pattern

On the other hand, for the accident happened on a Gulliso section, slope, speed, road side barrier, the alignment of the bridge and its width resulted in a head-on collision between vehicles. This resulted in a death of 9 people and the pattern of accident is shown in the following figure 8.

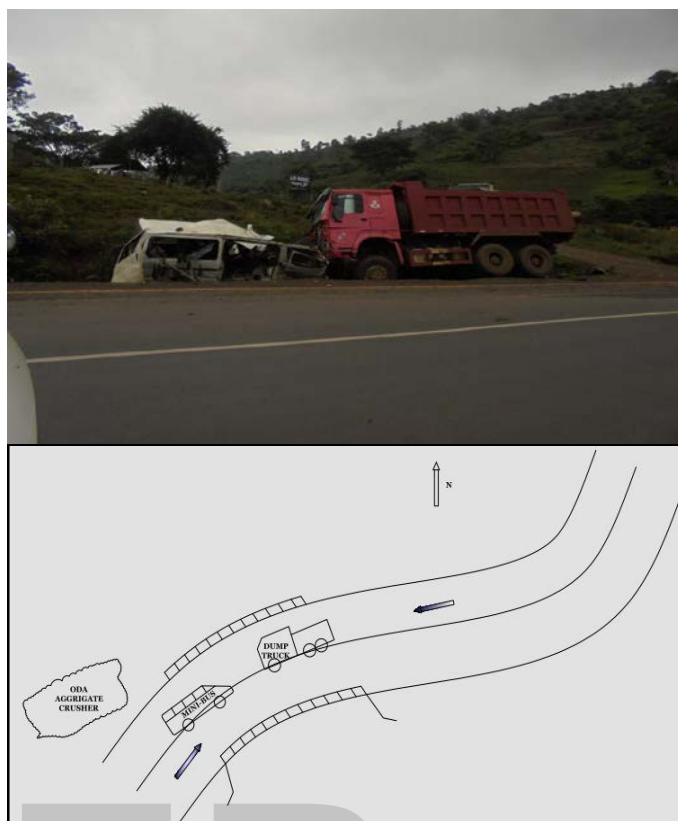


Figure 8. Road traffic accident at Gulliso and its pattern

Additionally, road crash happened in Dhaga Kaba and Dhokonnu area have similar patterns. Both sections are sloped roads with the absence of road side guardrails of the hills on one side. As the road is not flat, it causes difficulty in controlling the speed leading to overturn and fall.

The Accidents at Dhaga Kaba (Digga district) and Dhokonnu (Gobbu Sayyo district) revealed how human error, road condition and its environment are interrelated. In each section, there are different patterns of road accident and the illustrations can't generalize the whole hazardous sections. Besides these there are measures taken to minimize the frequency of road accidents in hazardous locations.

Most of all, the measures taken are installing road side traffic warnings which delivers information about the road geometry, slope, severity of the road section, speed limit, and existence of bridges, in addition to the existing road traffic signs. But the major causes of road crashes also include ignoring warning posts and road traffic regulations in addition to the other factors. Besides these measures taken there is also a daily activity in which the drivers are informed about the severity of the roads in hazardous sections.

All of these are not sufficient to minimize the damage of road accidents. These additional measures must be taken which enforce the drivers and improves the road environments. These measures are dependent on different factors such as location (urban and rural), causes of the road accidents at the section and road environment.

Based on this, the following list shows the possible remedies to be applied in each of the hazardous locations identified:

- Removal of obstruction/vegetation
- Installation of additional guardrail
- Installation of warning posts at the site
- Maintenance of road signs
- Removal of obstructions
- Maintenance of pavement surface and pavement marking
- Removal of road ride obstruction
- Installation of warning post which shows the existence of bridges
- Using guard rails instead of guide posts
- Speed breaker to regulate speed

## 4 CONCLUSION

The research project has identified the location of road traffic accident black spots in the Oromia region, East Wollega zone. For the identification of the hazardous locations, the road accident data was analyzed for the whole administrative districts by focusing on the sample population as they are exposed to high traffic volume.

To rank the road crash locations of districts in the sample population, prioritization based on the severity of road traffic accident was made as to the number of fatalities, slight injury, and serious injury. Based on the findings, the occurrence of road traffic accident decreases. But the loss of human life due to crashes increases as the number of districts with fatal accidents increased by 31.25%. Thus the occurrence of road traffic crashes is still resulting in a high number of deaths. Whereas, the amount of property damage due to traffic accidents is decreasing in a similar fashion with the number of the accidents. Therefore, it is directly proportional to the occurrence of the crashes and inversely related to the loss of human life. The district areas with high traffic volume, which cover about 41.17% of the total population, have the highest rate of fatal accident by 71.32%, high loss of property of 52% and a total road accident of 66.45%. Thus, exposure to high traffic volume results in high amount of road traffic accidents and its effects. Qajela, Katta Fola and Arjo road sections in Digga district, road section in front of Ethio telecom western regional office, bus station and Qera in Nekemte town, Gindo and Jalalle in Sibbu Sire district, Gulliso and Hadiyya-Mino Minch in Wayyu Tuka district, Bellam-Sorga in Guto Gidda district and Qejjo Michael in Gobbu Sayyo district are road traffic accident blackspot locations in the East Wollega zone. Out of these, the top five locations are Qajela, Gindo, Bellam-Sorga, Katta Fola and Gulliso road sections. The hazardous locations of the Zone like Qajela in Digga, Bellam-Sorga in Guto Gidda and Gulliso in Wayyu

Tuka districts have similar topographic features, such as mountainous area, and some of the hazardous locations are at horizontal curves, vertical curves and bridges.

Thus road traffic accidents are higher in mountainous areas, highly curved road geometries and bridge locations than the other sections of the road. The major road traffic crashes are grouped into driver's error, defects in road geometry and some environmental factors as well. These include speed, slope, ignoring warning posts, road deterioration, and traffic congestion and vegetation barriers along sight distances.

In order to make new drivers to those hazardous locations would drive safely, a follow up using checklists similar to the Digga's district should be strengthened. This is one way of minimizing fatalities due to the accidents, while all the vehicles should be enforced to be equipped with first aid tools to treat the victims instantly. The coverage of road traffic accident and its consequences are higher in districts with asphalt pavements than the others. Thus, high consideration should be given to such districts in controlling the traffic flow and road side environments, delivering information for pedestrians and drivers both in urban and rural areas. Regular follow up at identifying hazardous locations of road must be taken to manage the behavior of roadside environment, availability and maintenance of side posts and condition of pavements and road markings should be made. For sections with mountainous topographic features, risky curves and bridge locations, further study should be done on their alignments. This will help to find spots with the need for relocation of routes for further solution of the traffic problems related to the alignment selection.

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