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Cause and Remedial Measures of Road Traffic Accidents: A Case Study of Wolaita Zone, Ethiopia

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Abstract - *Transportation plays an advanced role in developing countries by facilitating social, economic and political activities, assuring the use of good governance and development, stiffening the agricultural and industrial services to reduce poverty and backwardness. Wolaita zone has been showing fast motorization and urbanization. But because of lack of road safety awareness, road safety action plan, road safety laws and enforcement, road infrastructure safety, vehicle safety standard inspection and lack of management of mixed traffic flow system there is enormous growth of road traffic accidents. The scale and the severity burdens of road traffic crashes are increasing adversely. This affects the economy of the country in general and the livelihood of individuals in particular. The current study is conducted to analyze the total rate of accident in wolaita zone, Ethiopia. The Accident data were collected from wolaita zone traffic police office. A Multiple Non Linear Regression equation is developed to estimate the influence of each contributing factors on the occurrence of accidents. From the analysis, it is observed that the influence of over speed and over takings are more leading in occurrence of accidents followed by failing to give priority and pedestrian factors. Motor cycle takes the highest share of accident occurrence followed by tracks in wolaita zone. The study provides alternative remedial measures to reduce various consequences involved in accidents.*

Key Words: wolaita zone, rate of accident, contributing factors, safety, multiple nonlinear regression.

1. INTRODUCTION

Road Transportation is versatile and flexible in nature. For this matter a large number of commodities and passengers are transported by road. The road traffic in many developing African countries of the world including Ethiopia is heterogeneous in nature. Different classes of vehicles with widely varying characteristics occupy the available road space. The vehicles that share the same roadway space include Motorized vehicles such as cars, buses, trucks, light commercial vehicles, motorized two-wheelers, motorized three wheelers, etc. and Non- Motorized vehicles like pedal cycles, hand carts, donkey drawn carts and horse drawn vehicles. Pedestrians also on several roads share of the road space. As a result the pedestrians constitute a significant proportion of fatal accident victims in the country. People travels from one place to another place either to work or to do business or to study or to enjoy to shopping or for any social affairs using various transport options. But because of lack of road safety awareness, road safety action plan, road safety laws and enforcement, road infrastructure safety, vehicle safety standard inspection and lack of management of mixed traffic flow system there is enormous growth of road traffic accidents. Globally the burden of road traffic crash is increasing day to day. According to 2015 Global status report on road safety of the road traffic injuries indicates that Road traffic accident rates in low and middle-income countries are more than double those in high-income countries. About 49% of all road traffic crashes are among motorcyclists, pedestrians and cyclists. The road crash fatality rate in Ethiopia was 23837 deaths per 100,000 inhabitant per year. The estimated road traffic death rate per 100 000 population is 25.3% and recorded as the highest death rate.

Out of all the accidents registered in Ethiopia, Addis Ababa accounts 60% on average and Wolaita zone accounts more on average [1] The burdens of the scale and the severity of road traffic crash are increasing adversely by affecting the economy of the country in general and the livelihood of individuals in particular. Therefore these paper tried to study the behavior of road traffic accident in wolaita zone and analyzed the model for the causes.

1.1 Objectives

1.1.1 Main Objective

The main objective of this research is to identify the major cause of road traffic accident of wolaita zone and to forward possible remedial measures.

1.1.2 Specific Objectives

The specific objectives of the study is

- To study the behavior of accident in wolaita zone
- To identify the possible cause for accident occurrence
- To analyze and model the trend of accident by multiple nonlinear regression

1.2. Statement of the Problems

According to the 2015 world health organization (WHO) report on the reality of road traffic crash around the world, globally 1.25 million people are killed per year and an estimated 3,400 people are killed per day. Road traffic accidents are the leading cause of death for young people aged 15–29 and 3 out of 4 deaths are among men. Almost half of all road traffic deaths are among the vulnerable road users which constitute of 22% pedestrians, 4% cyclists and 23% motorcycles. The road traffic crash was estimated to be the eighth leading cause of death globally and it was expected that by 2030 road traffic injuries will become the seventh leading cause of death globally [2].

The road traffic accident constitute major social, economic, developmental and health problems of developing countries. As WHO report, although low and middle-income countries have only half of the world's vehicles, they have 90% of the world's road traffic deaths. The African Region possesses only 2% of the world's vehicles but it contributes 16% to the global deaths. According to the 2018 Ethiopian News Network (ENN) report, Ethiopia has about 830,000 number of vehicles available on streets but the fatalities rate exceeds the world countries with about 1.2 billion of vehicles [3]. Wolaita zone is one of the fastest growing zones of Ethiopia. With further motorization, the number of road traffic crashes and the economic burden of road traffic injury and death are expected to grow. The present study expects to update the causes and engineering countermeasures. It is the hope of the authors that the finding could stimulate discussion and inform the responsible bodies in traffic safety policy formation.

1.3. About the Study Area

Wolaita zone is located at southern Nation Nationalities and peoples region at about 330 Km from Addis Ababa, Ethiopia. It is geographically located at 6051'' and 7035'' North Latitude and 37046'' and 3801'' East latitude. The topography of the zone is composed of undulating mountains, hills, plateaus and plains. The climate is stable with temperature variation of 240C to 300 C during the day and 160 C to 200 C during night. Wolaita zone has twelve special woredas and total area of 4,471.3 km2 or 438,370 ha. The zone is inhabited by over 1.9 million people. According to SNNPR statistical report the average population density of wolaita zone is over 285 people per square kilometer. This made the area as one of most densely populated areas in the country. As the 2009 Wolaita development association data, the total population of the zone is about 1,906,244. The zone has been showing fast motorization and urbanization. Currently about 10,600 vehicles are available on wolaita zone streets.

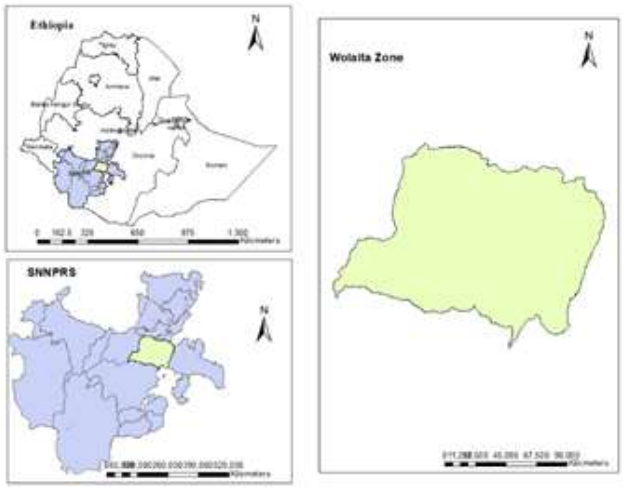

Figure 1: Administrative Map of Wolaita Zone

2. LITRETURE REVIEW

Road traffic accidents are a major global public health problem but most of it occurs in low- and middle-income countries including Ethiopia. Pedestrians and passengers of commercial vehicles are the most vulnerable in Ethiopia. Poor road network, 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 have been identified as key determinants of the problem [4]

As per Halkiyo et al. an empirical study on road accident using A Multiple Non Linear Regression equation was conducted and concluded that the major factors associated for the collision of vehicles over speed, overtaking, vehicle condition, poor road Geometric design, driver skills, negligence and behavior, absence of street lights, violation of traffic rules and regulations. From the analysis, the study concluded that the influence of traffic violations and over takings are more predominant in occurrence of accidents urban areas followed by road defects. The influence of vehicular defects and environmental factors is minimal [5]. As per Abegaz et al. a generalized ordered logit proportional odds model was used to examine factors that might influence the severity of crash injury. Model estimation result suggested that, alcohol use, falling asleep while driving, driving at night time in the absence of street light, rainfall, being a minibus or vans were found to be increased crash injury severity and speeding have varying coefficients for different injury levels, on sever and fatal crashes [6]. Fenta & Workie aimed to identify the major factors that affect the occurrence of traffic accidents using simple descriptive statistics (percentage), Chi-square and Binary logistic regression methods and concluded that majorities of accident were due to driver and pedestrian [7]. Segn (2007) made statistical analysis on collected accident data and indicated that increases in accident rates were highly associated with gradient and sharp curves [8]. Kuleno et al. used multiple non regression to conduct the analysis of motor cycle accident. The study concluded that more number of accidents is occurring due to minor drivers and motor cycle drivers followed by various traffic violations [9].

This study was conducted to explore the main causes of road traffic crash injury in wolaita zone and laid possible engineering solutions. We hope this base line will help policy makers and related stakeholder to improve road safety related to any road users.

3. RESEARCH METHODOLOGY

The study is conducted in wolaita zone, Ethiopia. In order to get supportive idea and worldwide information for related topic, internet research and google scholars browsing has been taken after suitable study area selection. The secondary data including the fatality, minor injury, major injury, property damage and related information including road characteristics, road surface condition, vehicle type and condition, weather conditions and accident location were gathered from wolaita zone traffic police department. They collect the data as prepared format and checklists. The generalized and report form data were collected from wolaita zone road and transport office. Analysis of the collected data performed by excel 2016 and the building of the Model estimation was done by using statistical software called SPSS.

4. DATA COLLECTION AND ANALYSIS

The following table shows the road traffic accident data collected from wolaita zone road and transport development directive and road traffic police office.

Table -1: The severity Road traffic accident data of wolaita zone from 2013-2017

No.	Woreda/Town	Severity of Accident				
		Fatality	Major injury	Minor injury	Property damage	Total
1	Sodo Town	39	110	86	38	273
2	Sodo Zuria Woreda	13	10	14	20	57
3	Areka Town	9	9	4	7	29
4	Boloso Sore Woreda	15	7	8	8	38
5	Boloso Bombe Woreda	2	-	-	-	2
6	Damot Sore Woreda	7	5	1	2	15
7	Damot Gale Woreda	31	20	42	27	120
8	Boditi Town	18	13	9	15	55
9	Humbo Woreda	19	12	6	27	64
10	Kindo Didaye Woreda	5	4	3	6	18
11	Damot Woyde Woreda	6	9	6	0	21
12	Damot Pulasa Woreda	1	3	2	2	8
13	Damot Ofa Woreda	9	3	-	1	13
14	Kindo Koysha Woreda	4	4	2	4	14
15	Duguna Fango Woreda	1	3	1	6	11
Total		179	212	184	163	738

The frequency of accident is varying in week days of zone. The following table shows the number of accident in week days from Monday to Sunday.

Table -2: The Magnitude of road traffic accident per year during 2013-201

No.	Woreda/Town Police Office	Years				Total
		2013/14	2014/15	2015/16	2016/17	
1	Sodo Town	144	60	46	25	273
2	Sodo Zuria Woreda	14	27	16	11	57
3	Areka Town	7	7	8	7	29
4	Boloso Sore Woreda	10	12	9	7	38
5	Boloso Bombe Woreda	-	-	-	2	2
6	Damot Sore Woreda	-	5	6	4	15
7	Damot Gale Woreda	36	45	22	17	120
8	Boditi Town	25	9	9	12	55
9	Humbo Woreda	28	22	8	6	64
10	Kindo Didaye Woreda	5	6	3	4	18
11	Damot Woyde Woreda	2	11	4	4	21
12	Damot Pulasa Woreda	-	5	2	1	8
13	Damot Ofa Woreda	4	3	4	2	13
14	Kindo Koysha Woreda	1	7	3	3	14
15	Duguna Fango Woreda	5	-	2	4	11
Total		277	215	138	108	738

Table -3: The total number of road traffic crash in week

Years	Total Number Of Accident In Zone Per Day							
	Mon	Tue	Wed	Thurs	Fri	Sat	Sun	Total
2013/14	43	35	63	54	30	32	20	277
2014/15	43	27	42	21	21	50	11	215
2015/16	19	22	25	18	20	27	7	138
2016/17	16	17	8	23	4	28	12	108

The number of accident because of each contributing factors for the road traffic accident in wolaita zone is listed in table 4 below.

Table -4: Major causes of road traffic accident in wolaita zone

Years	Season	Total Accident	Over Speed	Over Taking	Failure to give priority	Road Condition	Vehicle Condition	Pedestrian Factor	Environmental Condition
2013/14	1	92	29	23	17	1	5	7	3
	2	69	32	36	5	3	3	3	1
	3	54	19	13	15	1	1	11	1
	4	62	31	15	7	2	1	12	2
2014/15	1	44	21	9	8	2	2	2	0
	2	53	32	8	11	1	4	4	0
	3	57	10	14	13	1	1	9	1
	4	61	23	22	2	3	3	11	1
2015/16	1	36	11	10	4	1	2	6	1
	2	29	13	8	3	1	2	5	1
	3	31	20	5	7	1	0	7	0
	4	42	5	8	6	2	1	12	2
2016/17	1	15	7	2	4	1	1	1	0
	2	27	14	11	2	0	2	5	1
	3	35	11	15	3	1	0	7	0
	4	31	9	7	7	1	1	6	0

Different types of vehicles were involved in road traffic crash. The number of accident occurred due to each type of vehicle is described in the table 5 below.

Table -5: The type accident occurred and corresponding vehicles during 2013-2017.

Accident Type	Vehicle Involved In Accident Occurrence						
	Trucks	Bus	Truck Trailer	Motor Cycle	Bajaj	Others	Total
Death	16	8	4	131	9	3	171
Major injury	20	11	10	147	17	10	215
Minor injury	10	3	4	159	13	3	192
Property Damage	15	6	3	128	6	2	160
Total	61	28	21	565	45	18	738

As the collected data indicates from the main cause of road traffic accident in wolaita zone almost 37% was due to over speed, 26% was due to overtaking and lane changing, 14% was due to failing to give priority, 4% was due to the vehicle mechanical and technical problems, 14% was due to Pedestrian awareness problem and about 4% was due to road condition.

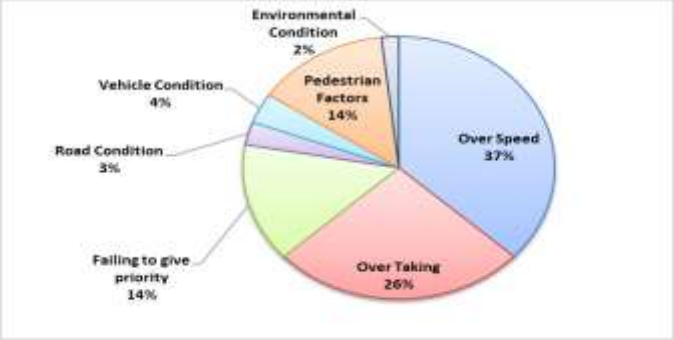

Fig -1: The rate of contributing factors

The frequency of accident occurrence in the zone for the past four years indicates the variation of rate of accident in week days.

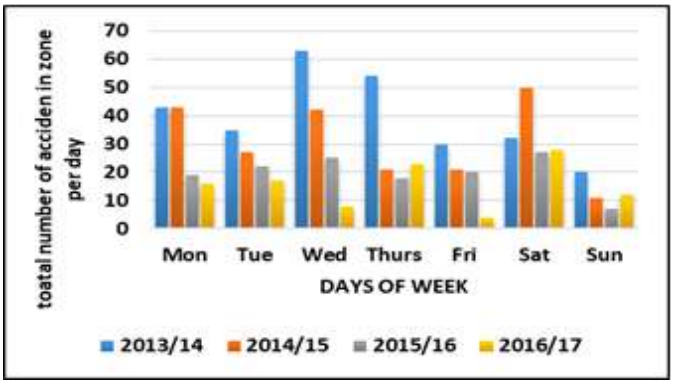

Fig -2: Accident per week

From the woredas and town of wolaita zone, Wolaita sodo town shares the highiest number of accident in Wolaita zone followed by Damot Gale Woreda. The magnitude of road traffic accident in all Woreda/towns were described in chart below.

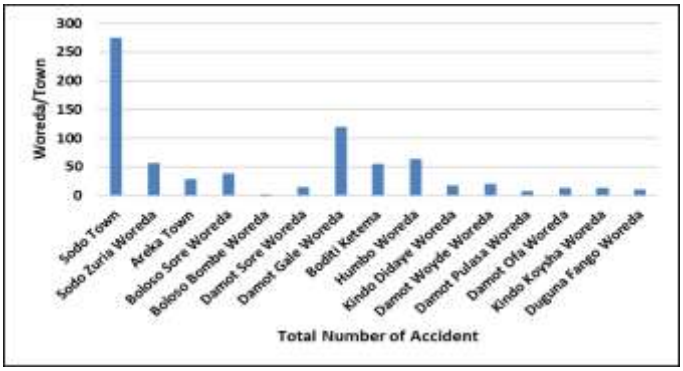

Fig -3: Rate of accident in woredas/Town

As the collected data indicates compared to other vehicles, Motor cycle takes the highest share of accident occurrence. The rate of accident occurred due to different type of vehicle is described below.

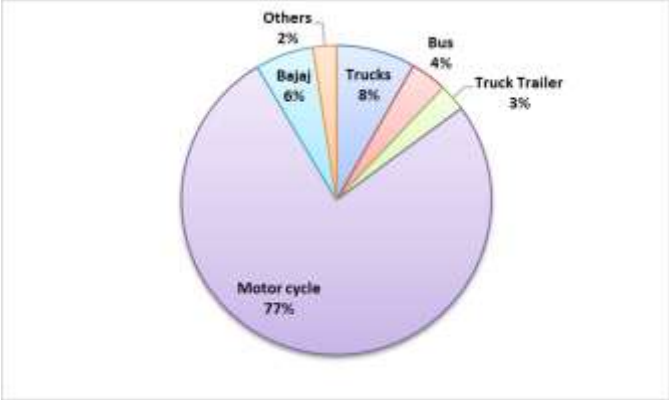

Fig -4: Accident and corresponding vehicles

5. MULTIPLE NON LINEAR REGRESSION ANALYSIS

Multiple Regression equation is a well-known statistical technique, which is used to fit a relationship between dependent and independent variables. In the case of the current study, the dependent variable is the rate of accident and the independent variables are the various contributing factors such as over speed, overtaking and lane changing, failing to give priority, vehicle mechanical and technical problems, pedestrian awareness problem and road condition. The following multiple nonlinear regression analysis was developed for the purpose of analysis.

Rate of Accident = $0.84447137+0.0510503*e^{OS}$ + $0.28469095*e^{OT}+0.30861598*e^{PL}+0.25177854*e^{RC}+0.18125182*e^{VC}+0.16118756*e^{PF}+0.03330983*e^{EC}$

Where OS is for over speed, OT is for over taking. FP For failing to give priority, RC for road condition, VC for vehicle condition, PF for pedestrian factors and EC for environmental conditions.
R^2 =0.98765745, Adjusted R^2 = 0.97685772 and F = 91.45
Above model fits the validation test and the analysis was carried out to observe the variation of total accident for various contributing factors.

6. CONCLUSIONS

Transportation plays an advanced role in developing countries by facilitating social, economic and political activities, assuring the use of good governance and development, stiffening the agricultural and industrial services to reduce poverty and backwardness. To preserve this good sketch of road transportation, road traffic fatalities, major injuries, minor injuries and property damage reduction and protection inquires big attention and effort.

The current study is conducted to analyze the total rate of accident in wolaita zone, Ethiopia. The accident data were collected from the records of wolaita zone traffic police office and wolaita zone road and transport directive. A Multiple Non Linear Regression equation is developed to estimate the influence of each contributing factors on the occurrence of accidents. Rate of accidents is taken as a dependent variable and the contributing factors such as over speed, over takings, failing to give priority, road condition, vehicular condition, pedestrian factors and environmental conditions are taken as independent variables. From the analysis, it is concluded that the influence of over speed and over takings are more leading in occurrence of accidents. From the survey analysis, it was concluded that the dominating factors for accidents in the zone are human factors 91%, road condition 4 % .vehicle mechanical and technical problems 3%, and environmental condition (2%). Motor cycle takes the highest share of accident occurrence followed by tracks in wolaita zone.

7. RECOMMENDATIONS

Giving awareness for the society about road traffic rules and regulation takes a lion's share in prevention and control of road fatalities. In wolaita zone road safety education is provided for the society and also student traffic clubs has been formed but there is lack of trained teachers and training materials. There is no road traffic safety courses in schools. Only Short period training give limited knowledge. In all Woreda/town administration of Wolaita zone, the number of motorcycle accident exceeds other vehicles by number 427 which means 77%. In order to control this, laws on helmet are enacted but the

enforcement was not strict. The laws were not enacted on additive drivers, drunk drivers and unlicensed drivers which are the main reason for accident. Speed breakers were provided at accident prone areas of road geometrical elements but standard traffic signs were not applied at appropriate distance. Speed limits were regulated but enforcement were not strict. Road surface condition and geometric design elements lacks road safety considerations. The laws and enforcement of vehicle safety standard consideration were not strict. However all accidents are reportable, the road crash death were not reported uniformly. The centrally aggregated road traffic crash data were weak and not published regularly. The reporting system was standardized as the prepared format/checklist but not computerized and also there is shortage of traffic police number. Because of Lack of management of mixed traffic flow system, invisible road markings and traffic signs and pedestrians walkways, Pedestrians constitute a significant proportion of road fatalities. Wolaita zone must give the priority for road traffic safety and must give attention to reduce the most contributing factors.

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