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Determinants of Road Traffic Accident Occurrences in Amhara Region: A Case Study from Debre Markos to Injibara Road Section

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Abstract: Ethiopia is one of developing countries with the worst road traffic accident records in the world and it ranks second among east African countries. Even if Determinants of road traffic accidents have a major health concern in the world, unlike developed or high-income countries, many developing countries have made very little progress towards addressing this problem. Nonetheless, there are ways to strengthen the reduction of injured persons that will help to lower the toll from road RTAs. The purpose of this paper is to elucidate ways to accomplish these goals in the context of along the road section from considering the Debre Markos-Injibara (150km) road as a cause study. The determinants will established mainly through Descriptive and Inferential analysis. Inferential analysis was carried out using STATA software v14 program (odds ration model regression) and results were generated. This implies that the proportion of variation in the dependent variable (i.e. road traffic accidents) explained by the independent variables (i.e. length of roads, road geometry, road users, presence of road safety, environment and speeding). Based on the results of priority value analysis, out of the 11 sections of the subject road; the Burie, around Finote Selam, Banja, and Finote Selam were highly prone to accidents and corresponding values as: 13, 10.79, 10 and 9.64 respectively. Based on the findings recommendations were proffered on how to reduce the phenomenon of traffic accidents in the study area.

Keywords: Road Traffic Accidents, Severity, Patterns, Outcomes, Determinants, Western Ethiopia

1. Introduction

The estimated deaths due to road traffic accidents occurrence of each year worldwide was 1.3million [16]. Road traffic crashes are the leading cause of death and disablement second only to HIV/AIDS for people under the age of 44 years [15].

According to the detailed analyses of global accident statistic by the United Kingdom (UK) [13], the change in road accident fatalities in the low and middle-income countries from 1965-85 was found increasing highly.

The social, economic, and political impacts of road traffic accidents are widespread all over the world. The loss of lives, damage to property, and the sorrow it leaves in human mind are profound though the degree varies [12]. Geographically, 35% to 70% of all crashes occur in urban areas and urban road networks contribute to a significant proportion of countries' national road traffic crash problem [5]. These make traffic accident the third major killer next to HIV/AIDS and Tuberculosis (TB) [12].

Road traffic accidents are a major but preventable global public health problem. Worldwide, the number of people killed in road traffic accidents. And Road traffic accidents appear to occur regularly at some flash points such as where there are sharp bends, potholes and at bad sections of the highways. At such points over speeding drivers usually find it difficult to control their vehicles, which then result to fatal traffic accidents, especially at night [3].

Road traffic accidents (RTAs) constitute major health, economic, and developmental challenges of developing countries, especially adversely affected sub Saharan African Countries [4].

In 1999, for instance, 750,000-880,000 people died in RTAs of which, about 85% of these occurred in developing countries [1, 5].

Generally sharp curves result in high accident rate than more gentle curves; especially accident rate increases below 20 m radius. Almost, all previous studies' conclusions indicated that rate of accident is high on horizontal curves, at intersection and bridges [8].

Despite government efforts in the road development, road crashes remain to be one of the critical problems of the road transport sector in Ethiopia [14].

A population growth rate of approximately 3% and estimated annual increases in the motor vehicle fleet of 10-15% is increasing upward pressure on road trauma suffered in Ethiopia [11].

In Ethiopia, the situation has been worsened as the number of vehicles has increased consequently due to increased traffic flow and conflicts between vehicles and pedestrians [9].

Every year, many lives are lost and huge property is destroyed due to road traffic accidents in Ethiopia. The Country has experienced RTAs of over the 83,960 in the past 4 years [6, 7].

Total summary of RTAs of the country increases year to year and In Amhara region has high RTAs (18,838) next to Oromia region (24,753) from other regions [2]. Therefore, various categories of RTAs are also involved in these road traffic accidents in this region, specifically along the Debre Markos - Injibara (150 Km) road.

2. Materials and Research Methods

2.1. Study Area

The Debre Markos - Injibara road is 150 km long located along the major primary road between Addis Ababa, the capital city of Ethiopia and Bahir Dar town located in the northwestern part of the nation adjacent to Lake Tana, the largest lake in the country and the source of the Blue Nile.

2.2. Study Design (Research Frame)

This study, in a broad sense, undertakes an analysis of road traffic accidents along the Debre Markos-Injibara. This research is an attempt to conduct a detailed investigation of accident phenomenon on the study road. Secondary data were collected from various sources, which contained information on crash severity (fatal, serious, slight and property damages), categories of road users affected, vehicles involved, and causes of crashes (defects-road geometry, human error, vehicle defect, or otherwise).

2.3. Sample Size & Sampling Procedure

Non-probability sampling techniques of purposive sampling were applied. All registered RTAs year of 2009 and the first 6 month of 2010 that were documented in police station registries between Debre Markos and Injibara towns were included in the sample. Besides, purposively selected traffic police commission officers who were used for key information for the RTAs data about the study area.

2.4. Study Variables

Independent Variables: Different factors that causes road traffic accidents such as road users related such as drivers, pedestrians and passengers, vehicle related such as vehicle type and vehicle service year, road related such as geometrical design elements, payment design element and road constructions materials, road user's sex and age etc.

Dependent Variables: Road Traffic Accidents (RTAs) and severity types such as: Fatal crash, Slight injuries, serious injuries and Property damage.

2.5. Data Collection Procedures

The research source considered both primary and secondary data. The research was conducted first by identification of the causes of traffic accidents through literature review and desk study on selected road project traffic accident data reports, documents, and manuals. Next, based on the above sampling areas and number of samples were identified.

This section of the study discusses how data were identified, extracted from the data source and collected (e.g. traffic police) and systematically presented by organizing and summarizing data using standard formats. Other field measurements and technical observations were done to gather data on the geometrical features of different intersections for capacity analysis. These included; number of lanes, lane width, configurations of lanes, grade, width of median, movement policy road right of way (ROW).

2.6. Data Processing and Analysis

Both descriptive and inferential statistics were used in the data analysis that means, after collecting the necessary information, data processing and interpretations were done using the binary Regression Model and descriptive methods.

The analysis was done; in the form of tabulation, charts, and graphs. Furthermore, analysis was done to understand the significance of the results and apply prioritizing values to identify the hazardous locations on the road commonly termed as black spots. For the identification of black spots, there is a wide range of methodologies available ranging from simple models based on actual accident count to advanced statistical models based to estimates. Among the methods, the logic of Quality Control Methods method is that a location is considered to be a black spot if its safety parameter shows higher values than the critical value [10]. Accordingly, the data that were used for identification of the black spot sections on the Debre Markos - Injibara roads were recent years of 2009 up to half of 2010. From the methods of identifications of black spot identifications; I apply the quality control method (Zegeer: 1982) of accident rate calculation and critical accident rates by using relative calculations.

3. Analysis, Result, Discussion and Interpretation

3.1. RTAs Severity on the Study Road

As shown in Table 1 and Figure 1 below; 160, 75, 42 and 66 were fatal, serous, slight and property damages data recorded in this study period respectively. From this recorded data, it was observed that fatality was the highest of the other types of RTA.

Table 1. *Road Traffic Accidents (RTAs) Severity on the Study Road.(Source Amhara police commission office).*

Types of RTAs Severity	Fatal	Serous	Slight	Property
Amount of RTAs severity	160	75	42	66
%	46.65	21.86	12.24	19.24
Total RTAs Severity			343	

Table 2 *Sex of Drivers vs. Types of Road Traffic Accidents Severity (Source Amhara police commission office).*

Sex	Types of severity				Total	%
	Fatal	Serious	Slight	Property		
M	133	64	39	62	298	86.88
F	0	3	0	3	6	1.75
Unknown	27	8	3	1	39	11.37
Total	160	75	42	66	343	100.0

The number of RTAs vs Types of RTAs severity by figure:

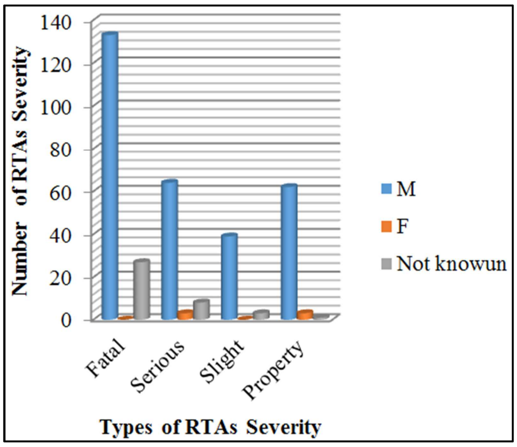

Figure 1. *Types of RTAs Severity.*

3.2. Determining the Magnitude of Determinates of Fatal RTAs on the Study Road

This section was done to examine the magnitude of major determinants of RTAs with special emphasis fatal RTAs severity; and analyzed by STATA Version 14. Binary logistic regression was used to assess associations between fata RTAs severity and independent variables. The writer used a binary logistics model given its mathematical simplicity. (See Table 3 below).

Based on the above regression result (p-values>0.05-0.1); the road user's age, driving experience, service year of vehicle and location of RTAs weren't statistically significantly associated with the fatality of RTAs in a bivariate analysis. However, In a logistic regression model results, magnitude of determinants on fatalities of RTAs it was found that; by causes of collision (over speeding: OR =1.105, failing to give priority for pedestrians: OR=1.852, excess loading: OR=2.951 and pedestrian errors: OR=1.265), by land use (around industrial area: OR=2.861 and religious area: OR=7.152, and, due to road geometry (straight up and down: OR =3.874, exactly reverse curve: OR = 2.530 and Juntel uphill: OR = 3.795) were statistically significantly associated with fatality of RTAs.

Table 3. *STATA software result of Binary/Odds Ratio) Regression Model.*

Explanatory Variables	Fatal FQ	Total FQ	Coefficient	Standard Error	t value (coefi/stdr)	p-value	Odds Ratio
Location of RTAs Severity vs Fatal							
Burie	19	34	-0.531	1.458	-0.360	0.778	0.588
Near Finote Selam	17	47	-0.668	0.729	-0.920	0.528	0.513
Banja/Tilili/	22	38	-0.449	1.458	-0.310	0.810	0.638
Finote Selam	14	28	-0.768	1.458	-0.530	0.691	0.464
Debre Markos	19	51	-1.289	1.458	-0.880	0.539	0.276
Gozamen	13	51	-1.840	1.458	-1.260	0.427	0.159
Injibara	11	18	-0.316	1.458	-0.220	0.864	0.729
Machakel	16	27	-0.393	1.458	-0.270	0.832	0.675
Dembecha	6	10	-0.362	1.458	-0.250	0.845	0.696
Near Dembecha	10	12	-0.262	1.458	-0.180	0.556	0.769
Guagusa Shikudad	13	27	Benchmark				
Light condition of RTAs vs Fatal							
Day light	116	269	-0.455	1.011	-0.45	0.731	0.634
Dawn	11	16	0.610	1.011	0.6	0.654	1.840
Dusk	1	5	-1.565	1.011	-1.55	0.365	0.209
Night with good light	7	15	-0.312	1.011	-0.31	0.81	0.732
Un specified	6	6	-0.178	1.011	-0.18	0.88	0.837

Explanatory Variables	Fatal FQ	Total FQ	Coefficient	Standard Error	t value (coefi/stdr)	p-value	Odds Ratio
Night with no light	15	22	0.341	1.011	0.54	0.201	1.407
Night with poor light	4	10	Benchmark				
Causes of RTAs Severity vs Fatal							
By driving left side	3	10	-0.612	0.091	-6.710	0.094	0.542
Failure to give for priority to driver	5	16	-0.553	0.091	-6.070	0.104	0.575
Overtaking problems	3	16	-1.231	0.091	-13.490	0.047	0.292
Failure to give priority to pedestrians	41	69	0.616	0.091	6.760	0.094	1.852
over speeding	83	179	0.100	0.091	1.100	0.057	1.105
Turing without rule	1	4	-0.864	0.091	-9.460	0.067	0.422
Excess loading	7	10	1.082	0.091	11.860	0.054	2.951
Pedestrian failure	5	10	0.235	0.091	2.580	0.236	1.265
Other	5	11	0.135	0.091	1.480	0.236	1.145
Not known	6	14	Benchmark				
Vehicle service year of RTAs severity vs Fatal							
Up to 1 year	13	20	0.140	0.444	0.310	0.806	1.150
1 -2 year	19	35	-0.308	0.444	-0.690	0.614	0.735
2 -5 year	54	138	-0.921	0.444	-2.080	0.286	0.398
5 -10 year	16	61	-1.513	0.444	-3.410	0.182	0.220
> 10 year	10	18	0.479	0.256	1.870	0.313	1.615
Unknown	48	71	Benchmark				
Experience of derivers of RTAs vs Fatal							
Have not license	4	9	-0.368	1.350	-0.270	0.830	0.692
≤ 1 year	14	31	-0.339	1.350	-0.250	0.843	0.712
1 -2 year	17	47	-0.713	1.350	-0.530	0.691	0.490
2 -5 year	35	101	-0.520	1.350	-0.390	0.766	0.595
5- 10 year	22	54	-0.733	1.350	-0.540	0.683	0.481
> 10 year	5	14	-0.845	1.35	0.626	0.575	0.429
Unknown	63	88	Benchmark				
Land us of RTAs vs Fatal							
Rural Village Area	67	136	0.329	0.314	1.050	0.485	1.389
Agricultural Area	12	42	-0.558	0.314	-1.780	0.326	0.572
Around School	8	13	0.828	0.314	2.640	0.230	2.289
Around Industrial Area	4	6	2.857	0.314	9.112	0.047	2.861
Around Religious Area	5	6	3.987	0.314	12.715	0.035	7.152
Around Market Area	7	14	0.358	0.314	1.140	0.458	1.430
Around Recreational Area	4	13	-0.453	0.314	-1.440	0.385	0.636
Around hospital Area	2	3	1.051	0.314	3.350	0.185	2.861
Around government office	13	23	0.620	0.314	1.980	0.298	1.860
Around Residential Area	31	68	-0.463	0.314	-1.476	0.395	0.646
Other	7	19	Benchmark				
Road users age vs Fatal							
below 7 years	5	13	-0.105	1.050	-0.100	0.937	0.901
7- 13 years	6	10	0.706	1.050	0.670	0.623	2.026
14-17 years	4	8	0.706	1.050	0.670	0.623	2.026
18-30 years	83	155	0.794	1.050	0.760	0.588	2.213
31-50 years	55	120	0.206	1.050	0.196	0.952	1.229
above 51 years	7	32	Benchmark				
Road Geometry of RTAs Vs Fatal							
Straight	101	238	-0.070	1.496	-0.050	0.970	0.933
Slight Upgrade	20	36	0.458	1.496	0.310	0.811	1.581
Highly Upgrade	2	9	-1.018	1.496	-0.680	0.620	0.361
Straight Up and Down	2	2	0.235	1.496	0.160	0.901	1.265
Slight Reverse Curve	14	24	0.571	1.496	0.380	0.768	1.771
Exactly Reverse Curve	2	3	0.928	1.496	0.620	0.037	2.530
Juntel Up Hill	3	4	1.334	1.496	0.890	0.054	3.795
Juntel Down Hill	15	23	0.427	1.496	0.286	0.811	1.581
Undefined	1	4	Benchmark				
Types of collision vs Fatal of RTAs							
Head on collisions	22	49	-0.299	0.164	-1.830	0.318	0.741
Front and Rear End collisions	1	17	-2.867	0.164	-17.540	0.036	0.057
Front and Side	6	14	-0.382	0.164	-2.340	0.257	0.682
Rollover	35	64	0.094	0.164	0.570	0.669	1.098
Collisions with Pedestrian	93	170	0.094	0.094	1.000	0.500	1.099
Fallen from Vehicles	2	4	Benchmark				

Although not statistically significant, experience of drivers such as have not license (OR=0.692) and less than one year (OR=0.712), Vehicle service year such as up to one year (OR=1.15) and greater than 10 year (OR=1.615), road users age such as from 18-30 years (OR=2.213) and 7-14 years (OR=2.026), Collision type such as collision with pedestrian (OR=1.099) and rollover (OR=1.098), and location of RTAs such as near Dembecha (OR=0.769) and Dembecha (OR=0.696) significantly associated with fatality of RTAs and also increased fatality of RTAs with relative to their categories.

3.3. Identification of Black Spot Areas on the Study Road

A location whether link or node that experiences abnormal crash frequency rate is considered as an accident black spot. The method also incorporates exposure data such as traffic volume and length of the road section to determine if the critical accident rate at particular location is significantly higher than the average for each factor. Accordingly, accident rate calculation and black spot identification were undertaken by using the Quality Control /Critical Crash Rate Factor Method (TRL 2000). The following two steps should be accomplished.

(i) Determination of Locations during Accident Rate

Accident location is determined on the basis of exposure data such as traffic volume; and length of the road section is being considered at rate per million vehicle kilometers (Uf) and it is calculated as follows;

For Junctions:

$$Uf = U \times 106 / (AADT \times 365 \times n) \quad (1)$$

For Road Sections:

$$Uf = U \times 106 / (AADT \times 365 \times n \times \quad (2)$$

Where

Uf = Injury accidents per million vehicle.-km

U = Number of reported injury accidents during the period n

n = Number of years

L = Section length (km

(ii) Determining the Critical Crash Rate

Critical crash rate factor method involves the following expression. The result provides the data for calculating critical accident rate (Rc). It is based on the assumptions that the crashes are approximated by Poisson Distribution.

$$\mathrm{Rc} = \mathrm{RA} + \text{Confidence level} * \sqrt{\frac{\mathrm{Ra}}{\mathrm{MEV}}} + \frac{1}{2*\mathrm{MEV}} \quad (3)$$

Where

Rc = Critical Accident Rate (accidents per million vehicles or accidents per million vehicle-km)

Ra = Average crash rate

MEV= Millions vehicle (km) during the analysis period

$$\mathrm{MEV} = \frac{\mathrm{AADT}*365*\mathrm{Y}}{1000000}$$

$$\mathrm{Rj} = \frac{\mathrm{fj}*10^6}{365.25*\mathrm{Y}*\mathrm{Lj}*\mathrm{AADT}}$$

$$\mathrm{Ra} = \frac{\sum \mathrm{fj}*10^6}{365.25*\mathrm{Y}*\sum \mathrm{Lj}*\mathrm{AADT}}$$

Where

Rj = Accident rate of site j(acc/Mveh-km)

Ra = Average accident rate (acc/Mveh-km)

Fj = Accident frequency at site j

Y = Period of analysis (year)

L = Section length of site j(km)

For Road Sections

$$\mathrm{Rc} = \text{Average Crash Rate} + \left[(\mathrm{k})\sqrt{\frac{\text{Average Crash Rate}}{365*\mathrm{Y}*(\mathrm{AADT})*\frac{\mathrm{Lj}}{100000}}}\right]\left[\frac{1}{2(365*\mathrm{Y}*(\mathrm{AADT})*\mathrm{Lj}/1000000}\right. \quad (4)$$

For Junctions

$$\mathrm{Rc} = \text{Average Crash Rate} + \left[(\mathrm{k})\sqrt{\frac{\text{Average Crash Rate}}{365*\mathrm{Y}*(\mathrm{AADT})/1000000}}\right]\left[\frac{1}{2(365*\mathrm{Y}*(\mathrm{AADT})/1000000}\right] \quad (5)$$

Where,

AADT =Average annual daily traffic for the spot (for an intersection, the sum of the volumes on all approach.

Y =Number of years being analyzed

L =Length of the segment in kilometer (for intersection L is 1).

K = Confidence level (95% confidence, k=1.645)

(iii) Compare the Location's Crash Rate with the Critical Crash Rate.

If the crash rate exceeds from the critical crash rate, classify the location as an accident Black Spot.

3.4. Ranking of Sites

For prioritizing the black spots, the ratios of accident costs by degree of severity were established by TRL. The weight given for fatal accident is 5, for serious injury is 3, for light injury and property damage are 2 and 1 respectively. The formula for estimating ranking of sites is stipulated as follows:

$$\mathrm{P} = \left[\frac{1*\mathrm{W}+2*\mathrm{X}+3*\mathrm{Y}+5*\mathrm{Z}}{\mathrm{D}}\right. \quad (6)$$

Where

P = Priority value;

W=Total number of property damages;

X =Total number of light injuries;

Y =Total number of serious injury;

Z =Total number of deadly injuries;

D = Total number of distance of the black spot section in kilometer.

The following accident segments were considered on the Study Road (see Table 4).

Table 4. *Acquired Data and Calculated Values Regarding Black Spot Segments on the Study Road.*

Accident segment Areas	Length KM	AADT	Accident Frequency	Individual Accident Rate (Acci/MVCH-km)	Average Accident Rate (Acci/MVch-km)	Critical Crash Rate (Rc)	Conditions
Banja	14	2,114	38	2.34	1.97	2.23	Black spot
Burie	9	2,114	34	3.26	1.97	2.23	Black spot
Debre Markos	18	1,736	51	2.98	2.40	3.76	Under
Dembecha	7	2,037	10	1.28	2.05	3.04	Under
F/selam	11	2,037	28	2.28	2.05	3.04	Under
Gozamen	16	1,736	51	3.35	2.40	3.76	Under
Guagusa Shikudad	15	2,114	27	1.55	1.97	2.90	Under
Injibara Town	9	2,114	18	1.73	1.97	2.90	Under
Machakel	17	1,736	27	1.67	2.40	3.76	Under
Near Dembecha	20	2,037	12	0.54	2.05	3.04	Under
Near F/selam	14	1,705	47	3.59	2.45	3.52	Black spot
Total	150	21,480	343				

Based on the values in Table 4 above, location/individual/crash rate is more than critical crash rate at the locations of Burie, Banja and near Finote-Selam. Therefore, it indicates that these locations were considered as black spots, and with their rank orders ranging for the segment section between 1-10. They are Burie, near Finote Selam, Banja (AroundTilili), Finote Selam, Debre-Markos, Gozamen, Injibara, Machakel, Guagusa Shikudad, near Dembecha, Dembecha town that ranked from 1-10 respectively (see Table 5).

Generally, ranking of accident spots helps to assess which place is to be given immediate attention. Quality control is the method used for identification of black spot segments in this road so that the accident frequencies of all the spot segments over this period are calculated. The logic of this method is that a location is considered to be a black spot if its safety parameter shows higher values (location's crash rate) than the critical value, and then ranking of accident spots based on calculated severity established by the TRL values.

Table 5. *Prioritized and Ranked RTAs Segments on the Study Road.*

Location of RTAs	Types of Severity				Prioritization						Rank
Severity	Fatal	Serious	Slight	Property	Z	Y	X	W	D	P	
Burie	19	2	3	10	95	6	6	10	9	13.00	1
near F/Selam	17	13	10	7	85	39	20	7	14	10.79	2
Banja/Tilili/	22	5	4	7	110	15	8	7	14	10.00	3
F/Selam	14	11	0	3	70	33	0	3	11	9.64	4
Debre Markos	19	15	9	8	95	45	18	8	18	9.22	5
Gozamen	13	7	11	20	65	21	22	20	16	8.00	6
Injibara	11	3	1	3	55	9	2	3	9	7.67	7
Machakel	16	8	3	0	80	24	6	0	17	6.47	8
Dembecha	6	4	0	0	30	12	0	0	7	6.00	9
Guagusa Shikudad	13	5	1	8	65	15	2	8	15	6.00	9
near Dembecha	10	2	0	0	50	6	0	0	20	2.80	10
Total	143	62	32	59	343				150		

4. Conclusions

Based on the findings of the research, this study concludes that:

Regarding the RTAs severity types, high fatality rates were observed at 46.65% of the total. Corresponding values in respect of: serious injuries, slight injuries and property damages were calculated at 21.86%, 12.24%and 19.25% respectively.

The study implied the existence of large differences in road traffic victims among drivers, passengers, and pedestrians. In this regard, the results of the research showed that pedestrians are more vulnerable to RTAs and further showed that male drivers, male passengers, and male pedestrians were the most affected compared to their female counterparts.

According to the findings of research, the most dangerous location or black spot segments were: Burie, Near Finote selam and Banja (around Tilili). Overall, rankings of 1-11 were established for: Burie, Near Finote selam, Banja (around Tilili), Finote selam, Debre Markos, Gozamen, Injibara, Machakel, Guagusa Shikudad, Near Dembecha Town and Dembecha Town respectively.

Based on inferential analysis result; the road user’s age, driving experience, service year of vehicle and location of RTAs were not statistically significantly associated with the fatality of RTAs in a bivariate analysis. However, magnitude of determinants on fatalities of RTAs it was found that caused by over speeding (OR =1.105), failing to give priority for pedestrians (OR=1.852), excess loading (OR=2.951) and pedestrian errors (OR=1.265) and land use such as around industrial area (OR=2.861) and religious area (OR=7.152) and due to road geometry such as fatalities straight up and down (OR =3.874), exactly reverse curve (OR = 2.530) and Juntel uphill (OR = 3.795) were statistically significantly associated with fatality of RTAs.

Finally, the study revealed that the major causes of RTAS severities were: over speeding, not giving priority to pedestrians, not giving priority to primary drivers, unlawful overtaking, excess loading, pedestrian failure to respect traffic rules, and driving on the left side. The respective numbers of RTAs were: 178, 69, 16, 16, 10, 10 and 10 which was aggregated to 343 crashes.

5. Recommendations

On the basis of the findings of the study and the conclusions, the following recommendations have been forwarded:

In the middle of Burie town, re-design of the geometric alignment and provide super elevation or make it to intersection by providing a roundabout by the island. In addition, at the location of 2 km apart from Burie town towards Injibara, re-design the geometric alignment and provide super elevation to reduce centrifugal force; also, remove trees and excavate the topography.

Traffic police should enforce drivers to drive with safe speed and to respect the driver rule otherwise punish them to minimize RTAs severity to this Road.

At the previous identified black spot locations, put black spot signs at all black spot location, and give awareness to road users and vehicle operators about black spot locations and put an appropriate traffic sign at all road sections.

As the study findings confirmed, the majority of the RTAs on Debre-Markos - Injibara road have been adversely affecting the surrounding communities; the extent to which they affect youths and young adults is overwhelming. Thus, safety education regarding RTAs should be given to societies, including pedestrians, drivers and traffic police by using schools, work areas, and even using mass medias within the required areas as a short-term solution. But, in the long-term, this should be included in the school curricula, and widely addressed at national level through mass Medias, including the private Medias.

The analysis of the study verifies that driver deficiencies are among the dominant causes of RTAs. The young, and less experienced drivers are responsible for most of the accidents. Therefore, drivers' trainings and testing should be revised; a minimum time of driving experience should be imposed before a license is issued to a driver. In addition, there should be additional prerequisite for drivers with regard to their educational background and good behavior, maturity of their ages, ample driving experience, free from any addiction like chewing chat, alcoholic drinks, free from criminal acts as well as offending and frequent violation of traffic regulations.

The scarcity of traffic signals such as traffic lights and their frequent technical failure creates chaos at squares and junctions leading to the incidence of traffic accidents. Therefore, in addition to the maintenance of the existing ones, the expansion of traffic lights to other accident-prone squares and junctions should receive immediate response.

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