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Full Length Research Paper

Traffic Accident Causes and Its Countermeasures on Addis Ababa-Adama Expressway

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Abstracts

Road traffic accident is one of the most common reasons of deaths and injuries in the world. Ethiopia is among the leading countries in road traffic accident. The study was conducted to identify the major causes of road traffic accident specifically focusing on Addis-Adama expresssway, to project causes of traffic accident on the expressway and propose possible counter measures, and to provide empirical evidence on the feasibility of an existing solution to a problem.. Both descriptive and inferential statistical analyses were used to identify causes of road accident. Multinomial probit regression model and accident severity value were used to assess the causes of traffic accident and identify the black spot region of expressway. The study used secondary data collected from Ethiopian Toll Road Enterprise. The study revealed that on average about 417 crashes were reported since September 2014 to February 2016. As a result of these crashes over 672 accidents were registered in the expressway that caused 285 human injuries and 387 property damage. Of the total human injuries, 37 were fatal, 65 and 183 were serious and slight injuries, respectively. Factors like Day of the Week, Collision Types, Types of Vehicles and Plate Number Region were major causes of traffic accident. From four black spot regions on the expressway, most of the accidents were occurred at main gate. On the basis of the findings, all roads users, policy makers and road traffic regulators were expected to consider those factors to minimize accident on Expressway and since most of the accidents were occurred at main gate, it is important to install Rumple Strip (speed breaker) at a range of minimum stopping site distances at entrance and exit of main gate.

Keywords: **Accident, Accident Cost, Black spot, Crash, Collusion, Determinant Factor**

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Introduction

Road traffic accident was global problem affecting all part of society usually occur as a result of factor associated with traffic system. To date, road safety has received insufficient attention at the national and regional levels. As a result, traffic accidents are increasing dramatically from time to time. According to World Health Organization report that road fatalities were estimated at a toll 1.1 million in 2010

and this figure is expected to reach 1.3 million in 2020 worldwide. Some important global facts of road traffic accidents show that over 1.2 million people have been killed every year due to road crashes, and between 20 and 50 million suffer non-fatal injuries. In most regions of the world this epidemic of road traffic injuries is still increasing (WHO, 2009). Study reports indicated that burden of disease, alcoholic drink, technical failures, over speeding and others are identified as some of the major causes of traffic accidents (WHO, 2004). The same reports estimated that road traffic crashes expected to be the 3rd leading cause of death worldwide by the year 2020 if rigorous and remarkable actions are not taken. The reports also show that 90% of road casualties were in low and middle-income countries. Trend shows that the total number of people killed in road crashes in developing world continues to increase (WHO, 2009).

Considering the above facts, many researchers have come out with the causes and effects of traffic accidents. Africa has one of the highest road traffic death rates in the world, with little difference in rates between those countries categorized as low-income (32.3 deaths per 100,000 populations per year). Whereas the range of fatalities per 100,000 populations in countries of African region is not very wide, 70% of all the deaths occurred in ten countries that account for 70% of the regional population: Democratic Republic of Congo, Ethiopia, Ghana, Kenya, Madagascar, Mozambique, Nigeria, South Africa, and Tanzania (WHO, 2009). Reports of the WHO indicated that the economic costs of road crashes and injuries are estimated to be 1% of Gross Domestic Product (GDP) in low-income countries (WHO, 2009). According to (William Eckersley *et al*., 2010) report on the road traffic crashes cost of developing countries reaches between 1–2% of their gross domestic product.

Ethiopia is one of developing country with high traffic accident costing around 0.8% - 0.9% of the GDP for the past consecutive years (Ethiopian Federal Police Commission, 2008). Road traffic accident in Ethiopia is a serious problem. The death rate presently stands near 70 per 10,000 vehicles. To curb the problem, strong interventions and strategies are expected to deal with the challenges so as to reduce its impact by 50% at the end of 2020.In this regard, considering the importance of road safety, the Ethiopian government has requested the World Bank and its Global Road Safety Forum to review the road safety management capacity of the country. This review was used for the development of national decade strategy for road safety. Despite all these efforts the challenges of road traffic accident still increasing from time to time. This indicatestudies made on the sector are not sufficient to address the challenges (Ethiopia Ministry of Transport, 2011).

The recent road safety record of Addis Ababa-Adama expressway is also alarming the severity of the situation and calling for an integral effort of all pertinent stakeholders to reverse the trend. Data collected from Ethiopia Toll Road Enterprise indicated that, on average, about 417 road crashes were reported in the past one and half years that leads around 672 traffic accidents. There have been no assessment made on the accident level of the road and no research has been conducted to identify the causes of road traffic accidents before. As a result, the road segment needs to be considered for an in-depth investigation due to its highest rate of traffic accident record during this short period of time. This research was, therefore, conducted to identify the major causes of road traffic accident specifically focusing on Addis-Adama expresssway and to provides empirical evidence on the feasibility of an existing solution to a problem.

Materials and Methods

Data Type, Source and Method of Collection

The study site was Addis Ababa-Adama Expressway that start from Tulu Dimtu customs checking point ends on the east side of Adama that connects Adama Awash road. Expressway has a total length of 76.3 kilometers. Traffic accident data have been collected and recorded by the traffic patrol of Ethiopian Toll Road Enterprises. Both qualitative and quantitative data were used to identify causes of traffic accidents. Daily traffic accident data that was collected through the Ethiopian Toll Road Enterprises is used for the study. Overall, the data covers a period of one and half years (September 2014 to February 2016), all traffic accident related collected data since the expressway started its operation were used.

Variables Definition

Depending on the objective of the study and type of data collected from the Enterprise, the study identified dependent and independent variables. The dependent variable was Traffic Accident (TA). Independent variables identified for this study includes Days of the week (DW), Hourly Accident Distribution (HAD), Time of Day (TD), Accident Causes (AC), Collusion Types (CT), Vehicle Types (VT), Plate Number (PN) and Vehicular Direction of Flow (VDF). This variable can be expressed categorically in terms of variables like Fatality, Serious Injuries, Light Injuries, and Property Damage. Each categorical variable were not overlapped in case one accident never represent others.

Method of Analysis

The study used Statistical Package for Social Science (SPSS) software to analyze the data. Both descriptive and inferential statistical analyses were used to identify causes of road accident. Descriptive analysis was used to examine the relationships between variables like accident causes, hourly vibration, and time of day, types of vehicle, collision type, plate number and direction of flow with accident frequency. Results were reported using graphs, charts, tables. Inferential statistical analysis was used to examine the cause and effect relationship between variables. In this case, Severity index and regression model were used in the study. Severity index is expressed by the number of fatalities per crash or the number of injuries per crash. Crash severity index was used for assessing the level of severity between accident variables. It fills the gap created on accident frequency, which expresses only the number of accidents registered on the expressway. Unlike accident frequency, crash severity index provide the severity of each crash relative to accidents registered during a specific time. Mathematically, rash Severity index was calculated according to (Karl-Olov, 2001) as follow:

$$\text{Seveity Index (SI)} = \frac{\text{Number of Injuries}}{\text{Total Number of Crash}} \text{ or } \frac{\text{Number of Death}}{\text{Total Number of Crash}} \quad \text{..... (1)}$$

Causes of accidents and their severity were further analyzed using accident cost, accident severity and multinomial probit regression model analyses were used.

Accident Cost

In order to identify the weighted value for accident severity of Addis Ababa-Adama expressway, it is important to define the cost of accident in Ethiopia. Analysis cost of road accident developed by (Murad Mohammed, 2011) for Ethiopia has been used. As a result, based on accident cost developed by incorporating changes due to inflation which is accounted 10% per annum, average increase in wages or real changes in GDP for the past six (6) years(2010-2016) are used to estimate cost of severity. Accident Cost (AC) describes the combined effect of number and severity of accidents. Thus, annual average accident cost (ACa) was expressed in terms of Birr/year or $/year, which was calculated using the following formula (World Bank/IMF, 2003).

$$ACa(F + SI + LI + PD = \frac{A(F) * MCA(F) + A(SI) * MCA(SI) * A(LI) * MCA(LI) + A(PD) * MCA(PD)}{t}$$

Where: ACa = Annual Average Accident Cost; A= Number of accident; MCA=Mean cost per accident; t=Period of time under review; F=Fatality; SI=Serious Injuries;LI=Light Injuries; PD=Property Damage.

Accident Severity

Black spot analysis was made for traffic accident using rate quality control method (Kent Sjölinder *et al.*, 2001). To prioritize those black spots in Addis Ababa-Adama Expressway, the ratios of accident costs to degree of severity were estimated using accident cost developed for Ethiopia. As a result, approximately the weight value for fatal accident is 15, for serious injury is 8, for slight injury and property damage are 3 and 1, respectively on Addis Ababa-Adama Expressway. To come up easy identification of black spot, the research preferred to use severity value for each road section number j was calculated (Kent Sjölinder *et al.*, 2001).

$$S_J = 15F_j + 8SI_j + 3LI_j + PD_j \quad \text{..... (2)}$$

Where: S_J = Severity Value; F_j = Number of Fatality (Death); SI_j = Number of Serious Injuries; LI_j = Number of Light Injuries; PD_j = Number of Property Damage

The result of the above model can be divided by a suitable value, the number of accidents. The relative severity value is then $Q_j = S_j / A_j$ (Kent Sjölinder *et al.,* 2001) which means severity (S_j) per accident (A_j). The average value of severity per accident (Q_{avg}) was estimated with:

$$Qave = \frac{\sum_{i=1}^{n} S_j}{\sum_{i=1}^{n} A_j} \quad \text{..... (3)}$$

The variance (δ^2) of the severity value was estimated with: (Kent Sjölinder *et al.*, 2001)

$$\delta^2 = \frac{1}{n}\sum_{i=1}^{n}(Q_i - Q_{avg})^2 \quad \text{..... (4)}$$

On the basis of the above severity computation, the location of black spot is found if: $Q_j > Q_c$, where; the critical severity value (Qc) (Kent Sjölinder *et al.*, 2001)

$$Q_c = Q_{avg} + k\,\dot{\alpha}\sqrt{\delta^2} - 0.5/Lj \quad \text{..... (5)}$$

At Lj is 1km and $k\,\dot{\alpha} = 1.282$ should be used, $\dot{\alpha} = 10\%$ (90% of confidence level).

$$Q_c = Q_{avg} + 1.282\sqrt{\delta^2} - 0.5 \quad \text{..... (5.1)}$$

Multinomial Probit Regression Model

By considering the nature and properties of data collected (nominal, polytomous and continuous nature), multinomial probit regression model used to assess the determinants of accident. Practically, when a dependent variable had more than two categories and the variable was really nominal, it's advisable to use multinomial probit regression model (Fernando Rajulton, 2011). Multinomial Probit Regression Model uses several possible categories that the dependent variable can fall into polytomous.

The model assumes that there are a series of observation (dependent variable) A_i for i=1, 2…6, Along each observation, A_i, there is a set of 8 observed values HD_1, ….., DF_8 of explanatory variables. The output A_i is categorically distributed data, which was analyzed using the following regression equation (William H. Greene, 2012).

$$A_i \backslash TD_i \ldots\ldots\ldots\ldots DF_i \approx \text{catagorical}\,(p_{i1}\ldots\ldots\ldots\ldots p_{in}),\ \text{for } i=1,2,\ldots\ldots\ldots\ldots\ldots,n$$

Multinomial probit is often written in terms of a latent variable model as stated below.

$$A_i^{1*} = \beta_{1*} TD_i + \varepsilon_1$$
$$A_i^{2*} = \beta_{2*} B_i + \varepsilon_2$$
$$\ldots\ldots\ldots\ldots$$
$$A_i^{8*} = \beta_{8*} DF_i + \varepsilon_8$$

Where;

$$\varepsilon \sim N(0, \Sigma)$$

In order to predict the severity of accident, it is possible to express the model William H. Greene 2012):

$$A_i = \begin{cases} 1 & if\ A_i^{1*} > A_i^{2*} \dots\dots\dots A_i^{4*} \\ 2 & if\ A_i^{2*} > A_i^{1*}, \dots\dots\dots A_i^{4*} \\ 3 & if\ A_i^{3*} > A_i^{1*}, \dots\dots\dots A_i^{4*} \\ 4 & if\ A_i^{4*} > A_i^{1*}, \quad \dots\dots\dots A_i^{3*} \end{cases}$$

Based on the above relationships, the model that helps to predict road traffic accident can be defined as a predicting variable A. The relationship of the variables was analyzed using probit model adopted (William H. Greene 2012) as follow.

$$A = \beta + \beta_1 HD + \beta_2 TD + \beta_3 DW + \beta_4 TV + \beta_5 CT + \beta_6 AC + \beta_7 PNR + \beta_8 DF + \varepsilon$$

Where: A=Dependent (predicted) variable (Accident); β=Constant; β_i= Intercepts; for i = 1, 2, 3…… ε - Error term; HD=Hourly Distribution; TD=Time of Day; DW=Day of the Week; TV= Types of Vehicle; CT= Collusion Type, AC= Accident Cause, PNR= Plate Number Region, and DF=Direction of Flow were independent variables.

Model Specification Test

In order to check the appropriateness of the variables and validate the applicability of the model, different tests were made on the model. Accordingly, interdependency between crash variables was tested using chi-square and identified that accident were dependent on variables like Hourly distribution, types of vehicles, collusion type and plate number region. In addition, multicollinearity test was made using correlation coefficient and learned that the relationship between most of the variables are not significant.

Multicollinearity Test

Multicollinearity test was made using correlation coefficient and learned that the relationship between most of the variables are not significant, with a coefficient of less than 0.8 indicating the variables can be used for further analysis. Subjected to information from analysis relatively strong relationship was observed between accident location and direction of traffic flow (0.527), plate number region and types of vehicles (0.369). However, the ranges are still within the traditional tolerable limit and the variables can be used for estimation.

Chi-square test

A chi-square (x^2) test can used to determine if observed data indicates that two variables were dependent in much the same way that the test can be used to determine goodness of fit (Mindrila Diana, 2013).

Result and Discussion

Crash accidents

A total of 417 traffic crashes were reported from September 2014 to February 2016 (within 2 and half years). As a result of these crashes over 672 accidents were registered in the Expressway. Out of these accidents human injuries accounted for 285 and 387 property damage. Of the total human injuries, 37 were fatal, 65 and 183 were serious and slight injuries, respectively. Accident frequency analysis was made to identify the characteristics of the accidents and identify which variable was more responsible for the occurrence of crash relative to total accident frequency. Accident frequency provides rough estimation for exhibiting crash promoting factor. The following descriptions provide the level of accidents distribution.

A. Causes of Accidents

Analysis results of the study indicated that the major causes of traffic accidents were associated with unethical driving (problem with over speed, sight distances, phone usage during driving, drug usage and *etc.*) behaviors that caused 59.8% of the total accidents (Table 1).

Table 1: Causes of accidents related variables

Accident causes	Frequency	Percent
Unethical Driving	402	59.8
Technical Problem	251	37.4
Sleeping Problem	19	2.8
Total	**672**	**100.0**

B. Hourly Variation of Accident

There was variation of accidents in 24 hours of the day. As indicated in Table 2, large number of accidents was recorded in the Afternoon local time between 6:01-12:00 AM with a percentage of 49.6%.

Table 2: Hourly traffic accident frequency

Timely Variation (Local time)	Frequency	Percent
0:01-6:00	150	22.3
6:01-12:00	333	49.6
12:01-18:00	102	15.2
18:01-24:00	87	12.9
Total	**672**	**100.0**

C. Level of Traffic Accidents over Days of the Weeks

The frequency of accident high Monday to Friday within followed by Weekend (Table 3). Time contributed greatly to the occurrences of accident in the road crashes. Week had significant relationship with the level of accident. Days from Monday to Friday had negative and significant effect on passenger fatal injuries of expressway at P-value of 0.05 (Table 9). As a result, an increase in day of the week particularly Monday to Friday decreases the level of fatal accident and vice versa. This shows that, the level of fatal accident was relative to serious injuries, slight injuries and property damage were high at the weekend.

Table 3: Daily traffic accident frequency

Day of the week	Frequency	Percent
Monday - Friday	490	72.9
Weekend	182	27.1
Total	**672**	**100.0**

D. Traffic Accidents Time

Analysis made on the effect of brightness towards traffic accident indicated that large numbers of accidents were registered during day time (Table 4).

Table 4: Time of day related accident frequency

Time of Day	Frequency	Percent
Day Time	483	71.9
Night Time	189	28.1
Total	**672**	**100.0**

E. Accident Distribution over Types of Vehicles

Type of Vehicle had their impact on accident severity. The study site had four categories of vehicles. The most frequently caused accidents were Automobiles accidents (Table 5). The types of vehicles involved in Addis Ababa-Adama Expressway were a significant predictor of accident. The parameter estimate for pickup and medium truck indicates a positive and significant effect on

passenger fatal injuries. At indicated in Table 5, Automobiles, Minibus and Bus, Pickup and Medium Truck had positive and significant effects on passenger slight injuries (P<0.05). As a result, an increase of pickup and medium truck on the expressway increase the level of fatal accident. At the same time, an increase in Automobiles, Minibus and Bus, Pickup and Medium Truck on the expressway increases the level of slight injuries.

Table 5: Accident frequency over types of vehicles

Types of Vehicles	Frequency	Percent
Automobiles	187	27.8
Minibus and Bus	186	27.7
Pickup and Medium Truck	164	24.4
Truck and above	135	20.1
Total	**672**	**100.0**

F. Collision Type Related Variables

As indicated in Table 6, collisions due to vehicle to vehicle accounted for about 35.7 percent. The result of the regression equation revealed that a collusion type has significant effect on accident at P-value of 0.05 (Table 6). These showed that collusion types seem significant in determination of accident. In case, crash vehicle to vehicles had negative and significant effect on passenger fatal injuries of expressway. Car overthrow had positive and significant effect on passenger serious injuries of expressway. Meanwhile, on passenger slight injuries, crash vehicle to vehicle had negative and car overthrow positive significant effects on expressway. As a result of decrease in crash vehicle to vehicle increases the level of fatal and slight injuries and vice versa. Concomitantly, an increase in car overthrow increases the level of serious and slight injuries in the expressway.

Table 6: Collusion types accident frequency

Collusion Type	Frequency	Percent
Crash Vehicle to Vehicle	240	35.7
Car Overthrow	226	33.6
Crash Vehicle to Static objects	206	30.7
Total	**672**	**100.0**

G. Vehicular Plate Number Region Related Accident Frequency

Based on the analysis of collected data, traffic accident was high for plate region Addis Ababa (AA) (Table 7). The result of the regression equation revealed that a Plate Number Region had significant effect on accident at P<0.05). These showed that plate number region seem significant in determination of accident. In case, plate number region Addis Ababa (AA) had negative and significant effect on passenger fatal, serious and slight injuries of the expressway whereas, plate number region Oromia (OR) had negative and significant effect on passenger fatal and serious injuries. As a result, decrease in plate number region Addis Ababa (AA) increases the level of fatal, serious and slight injuries of the expressway and vice versa. Concomitantly, a decrease in plate number region Oromia (OR) increases the level of fatal and serious injuries.

Table 1: Plate number region related accident frequency

Plate Number Region	Frequency	Percent
Addis Ababa (AA)	325	48.4
Oromia (OR)	181	26.9
Ethiopia (ET)	166	24.7
Total	**672**	**100.0**

H. Vehicular Plate Number Code Related Accident Frequency

As per the result of the study, traffic accident was high for plate code 3, which accounted for 70.5% (Table 8).

Table 8: Vehicle code accident frequency

Plate number code	Frequency	Percent
1	5	0.7
2	157	23.4
3	474	70.5
4	27	4.0
5	9	1.3
Total	**672**	**100.0**

Black Spot Accidents

Using the criteria developed above around 70 road sections were demarcated for severity of accident and black spots analysis within 1km interval. On the basis of the criteria, road sections which had relative severity value greater than severity critical value was considered as black spot and used for further treatment. Hence, out of the 70 road sections define for black spot analysis, four (4) road sections were fulfilled the criteria and identified for further treatment.

According to black spot identification criterion, the road chainage ranges 13+001-14+000, 20+001-21+000, 35+001-36+000 and 68+001-69+000 had the highest relative severity value compare to its critical severity value. This implies that these road sections were the most risky area and dangerous road for users. Most of black spot locations were straight. As a result, the problem related to accidents happen on those road section were not related to geometry problem rather than unethical driving mainly over speed followed by technical problem (vehicular condition) and other contributory factors like provision of traffic calming devices and reckless driving. Particularly on chainage 20+001-21+000 during rainy season longitudinal slope followed with horizontal curve that made traversal runoff on the road section. In spite of this, the movement of vehicles lead accident in this particular station result the presences of over speed that made slippery nature (reduce friction) between asphalt surface and tire of the vehicles ordered to overthrow. Tulu Dimtu toll gate whose chainage 1+001-2+000 accounted around 26.3% that followed by chainage 59+001-60+000 and 29+001-30+000 that accounted 7.13% and 2.2% of total crash, respectively.

Mostly, the sevier as well as high number of accident registered on straight road section. Likewise drainage (ditch) across the span of road in both side cannot covered with precast as a result most probable Sevier accident can be increases due to insufficient provision of precast cover over ditch. Even if the occurs of accident at night time was low with respect to flow of traffic. Further to reduce the occurrences of accident on the expressway; it is sensible to install straight light on the road side and medians.

Empirical Relationship between Accident

Multinomial probit regression analysis result indicated that there were relationships between traffic accident and its potential determinants. Cause-effect analysis results of variables indicated in Table 9, shows that Day of the Week (DW), Collision Types (CT), Types of Vehicles (TV) and Plate Number Region (PNR) had significant effect on traffic accident at P-value of 0.05. The remaining determinant factors were considered in the study was removed from the model as they were found insignificant on traffic accident on the Expressway. For more information about coding and explanatory variables refer. The empirical analysis results of the study showed that the various relationships between accident and its determinant.

Table 9: Parameter Estimated Coefficient

Parameter Estimates									
Accident[a]		B	Std. Error	Wald	df	Sig.	Exp(B)	95% C I for Exp(B)	
								Lower Bound	Upper Bound
Death	Intercept	-1.606	1.030	2.428	1	.119			
	[DW=1]	-.717	.381	3.539	1	.060	.488	.231	1.030
	[DW=2]	0[b]	.	.	0	.	.	.	.
	[CT=1]	-1.115	.480	5.391	1	.020	.328	.128	.840
	[CT=2]	-.751	.467	2.583	1	.108	.472	.189	1.179
	[CT=3]	0[b]	.	.	0	.	.	.	.
	[TV=1]	1.375	1.028	1.790	1	.181	3.957	.528	29.671
	[TV=2]	1.817	1.009	3.245	1	.072	6.153	.852	44.433
	[TV=3]	2.213	.922	5.763	1	.016	9.142	1.501	55.679
	[TV=4]	0[b]	.	.	0	.	.	.	.
	[PNR=1]	-2.250	.581	14.976	1	.000	.105	.034	.329
	[PNR=2]	-1.402	.738	3.608	1	.058	.246	.058	1.046
	[PNR=3]	0[b]	.	.	0	.	.	.	.
Series Injuries	Intercept	-.485	.297	2.663	1	.103			
	[CT=1]	-.508	.382	1.769	1	.184	.602	.285	1.272
	[CT=2]	.647	.330	3.851	1	.050	1.910	1.001	3.645
	[CT=3]	0[b]	.	.	0	.	.	.	.
	[PNR=1]	-1.940	.345	31.605	1	.000	.144	.073	.283
	[PNR=2]	-1.737	.362	22.987	1	.000	.176	.087	.358
	[PNR=3]	0[b]	.	.	0	.	.	.	.
Slight Injuries	Intercept	-2.162	.526	16.892	1	.000			
	[CT=1]	-.494	.263	3.544	1	.060	.610	.365	1.021
	[CT=2]	.838	.249	11.294	1	.001	2.312	1.418	3.769
	[CT=3]	0[b]	.	.	0	.	.	.	.
	[TV=1]	2.221	.445	24.966	1	.000	9.219	3.857	22.033
	[TV=2]	2.558	.489	27.345	1	.000	12.914	4.950	33.690
	[TV=3]	1.536	.438	12.301	1	.000	4.647	1.969	10.963
	[TV=4]	0[b]	.	.	0	.	.	.	.
	[PNR=1]	-.853	.332	6.591	1	.010	.426	.222	.817
	[PNR=2]	-.255	.411	.385	1	.535	.775	.346	1.734
	[PNR=3]	0[b]	.	.	0	.	.	.	.

a. The reference category is: Property Damage.
b. This parameter is set to zero because it is redundant.
Where: CT=Collision Types; DW=Day of the Week; TV=Types of Vehicles; PNR=Plate Number Region

As a result, the expressway needs to focus on those factors so as to minimize the risk of accidents. On the basis of the above findings, the model that will help to determine the significant level of accident can be expressed using the following Traffic Accident predicting equation.

$$A = \beta + \beta_1 DW + + \beta_2 CT + \beta_3 TV + \beta_4 PNR + \varepsilon$$

Where: CT=Collision Types; DW=Day of the Week; TV=Types of Vehicles; PNR=Plate Number Region

Conclusion and Recommendations

Conclusion

Despite small number of vehicles operating, the level of crash accident recorded in Ethiopia made the country one of the top in the world. Similar record was observed on the newly constructed Addis Ababa-Adama Expressway. Traffic accident was higher on working days (Monday to Friday) of the week mostly between 6:01 to 12:00 AM local time. Unethical behavior of drivers, over speed, sight distances, phone usage during driving, drug usage *etc.* were the main causes of all crash accidents. Day of the Week, Collision Types, Types of Vehicles and Plate Number Region highly determine the accident.

Recommendation

The recommendation of this study will help the Ethiopia Toll Road Enterprises, policy makers and road user to focus on selected area of emphasis so as to minimize the level of accident on Addis Ababa-Adama Expressway. On the basis of this study finding, study recommend following:

- ✓ Accident frequencies were high at the main gates. As a result, Ethiopian Tool Road Enterprise should revise the gate condition and implement technical amendment to minimize frequency of accident. Since most accidents have been occurring at entrances and exits, it is important to install Rumple Strip (speed breaker) at a range of minimum stopping site distances from entrances and exit gate in a way that reduce accident frequency.

- ✓ Unethical behavior of drivers made the accident to be worst. Therefore, it needs training for drivers to ensure ethical behavior among those using the road, which may include enhancing personal driving capacity. Especial focus should be given for those drivers operating on public transport vehicles with a code 3.

- ✓ Even if fatality and human injuries were low relative to the size of the road service, it is advisable to use speed control technology like RADAR installation along the road way and others scientific based mechanism which helps to monitor speed of vehicles and implement punishment on those violating speed limit during exit.

- ✓ Most of the collusion was registered as a result of crash vehicle to vehicle. It is important to reconsider the speed limit of the Expressway in relation to the advanced vehicular performance checking technologies.

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Statement of Declaration

I declare that the research entitled "Accident Causes and Countermeasures on Addis Ababa-Adama Expressway" is my original work and it hasn't been presented for the award of any other similar titles by other researchers. I declare that there is no conflict of interest regarding this work

Reference

Asrat Y (2015). Descriptive Analysis of Road Traffic Crash. Addis Ababa.

Bhat P, Hebbani L, RamaV A and Kolhar P (2013). Accident Prediction Modelling for an Urban Road of Bangalore.IJRET.

Elvik R (2005). The Handbook of Road Safety Measures. London: Elsevier Ltd.

Ethiopia Ministry of Transport (2011). National Road Safty Council. National road safety strategic plan of Ethiopia 2011-2020. Ethiopia.

Ethiopian Federal Police Commission (2008). Road Safety in Ethiopia Case Study. UNECA.

Fernando Rajulton (2011). Logit, Probit and Tobit, Models for Categorical and Limited Dependent Variables.

Kamal I and Hafeez A (2008). Accidents black spots on highways and their low cost remedial measures;. University of Engineering and Technology, Taxila, Pakistan.

Karl-Olov Hedman H (2001). Road Improvement and Traffic Safety Project. Ankara.

Kent Sjölinder and Hans Ek S (2001). Road Improvement and Traffic Safety Project. Ankara: General Directorate of Highways.

Mindrila D (2013). The Basic Practice of Statistics (6th ed.). New York.

Murad Mohammed (2011). Costing of Road Accidents in Ethiopia. MSc Thesis, Addis Ababa University. Addis Ababa.

Rokytová J (2000). Black Spots Treatments on Routes in Rural Areas. Transport research centre, Brno, the Czech Republic.

Ross silcock partnership (1994). Towards safer Roads in developing countries, Guide of planner and Engineers. England.

Rui Garridoa A(2014). Prediction of road accident severity using the ordered probit model. 17th Meeting of the EURO Working Group on Transportation , Sevilla, Spain.

Samson B (2006). Analysis of Traffic Accident In Addis Ababa Traffic Simulation. Addis Ababa.

Segni G (2007). causes of road traffic accident and possible counter measures on Addis Ababa-Shashemene roads. Addis Ababa

Sonowal A(2009). A Statistical Analysis of Road Traffic Accidents. Dibrugarh City, Assam, India.

Sweedler BM (1995). The worldwide decline in drinking and driving. In: Kloeden CN, McLean AJ,eds. Proceedings of the 13th International Conference on Alcohol, Drugs and Traffic Safety.

Transport Research Board (1987). Designing Safer Roads. Special Report 214, National Research Council, Washington, D.C.

Walmsley DA (1998). Accidents on Modern Rural Dual-carriag way Trunk Roads, TRL 335,. England.

William Eckersley(2010). Khat, Driver Impairment and Road Traffic injuries: A View from Ethiopia. Bull World Health Organ.

William H. Greene (2012). Econometric Analysis. Boston.

Workshop P. W. (n.d.). Retrieved from cce.oregostate.edu/sites/cce.oregostate.edu/files/pw.

World Bank/IMF (2003). Final Report of IMF/World Bank Economic Analysis and Forecast on Africa. Newwork.

World Health Organization (2004). The global burden of disease. Geneva

World Health Organization (2009). Global status report on road safety. Geneva.