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ANALYSIS OF CRASH CAUSATIVE FACTORS ON SELECTED RURAL HIGHWAYS IN ONDO STATE, SOUTH-WEST NIGERIA

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Abstract:
The accident data and the causative factors on selected two-lane rural roads which are Akure-Owo (AO1) and Akure-Ondo (AO2) linking Akure, the capital of Ondo State Nigeria between 2012 to 2017 was collected from Federal Road Safety Corps Sector 19.3 Akure Command. Accident causative factors such as Driver (X_1), Vehicle (X_2), Roadway(X_3) and Environmental factors (X_4)contributing to road crashes was analyzed using Microsoft Excel (2010) and SPSS (22). The data was used to formulate a predictive model of vehicular accident.The descriptive analysis shows that X_1, X_2, X_3 and X_4 accounted for 80%, 16%, 4% and 1% respectively on AO1; and 87%, 10%, 2% and 1% on AO2; X_1 and X_2were statistically significant at 5% confidence level. In order to promote safety along these roads, speed limit and speed zoning should be enforced while adequate training should be done before driver's license are issue. Also, thorough inspection of vehicles should be carried out by relevant agency to ensure that vehicles are roadworthy and free from mechanical deficiency.

Key words:
Vehicular Accident; Causative Factors; Driver; Speed; Enforcement

INTRODUCTION

Road transportation is the most common mode of transportation in developing countries like Nigeria; the outstanding advantage of road transport is that it provides door to door services and is most suited for carrying goods and people to and from rural areas which are not served by rail, water and air transport. However, the increase in road transportation has also placed a considerable burden on people's health ranging from road crashes, vehicle emission and

environmental pollution among others. Road traffic accident occur when a vehicle collides with another vehicle, pedestrian, animal, road debris, or other stationary obstruction, such as a tree or utility pole [2]. According to [14], road traffic injuries place a heavy burden, not only on global and national economies but also on household finances. Many families are driven deeply into poverty through death as a result of road crash and the added burden of caring for members disabled by road traffic injuries. Worldwide, an estimated 1.27 million people are killed on road crashes each year and as many as 50 million are injured, projections indicated that these figures will increase by about 65% over the next 20years (i.e. year 2030) unless there is new commitment to prevention (W.H.O, 2010). Road traffic injuries are the leading cause of death among young people, aged 15–29 years while, 91% of the world's fatalities on the roads occur in low-income and middle-income countries [2].

Accidents have become a normal and re-occurring phenomenon along Akure-Owo (AO1) and Akure-Ondo (AO2) road and many lives have been lost on these routes as a result of road crashes. [3] assert that one of the frequent accidents occurring route with high accident rate and fatalities in Nigeria is Akure – Owo two lane rural road. Figure 1.0 showsAO1 and AO2 in Ondo State, Southwest Nigeria. The two lane undivided rural roads are very important to social economic development ofNigeria and Ondo State in particular. AO1 serves as a link to both the Eastern and Northern part of Nigeria, goods and services are transported to and from the Northern part with 2 axle loads and 3 axle loads through AO1.

Analysis of the causative factors that influence accident frequency will provide an insight into the germane factors that significantly contribute to the occurrence of crashes along highways which, will improve the roadway design and enhance accident prevention measure; thus, provide safer driving environment.

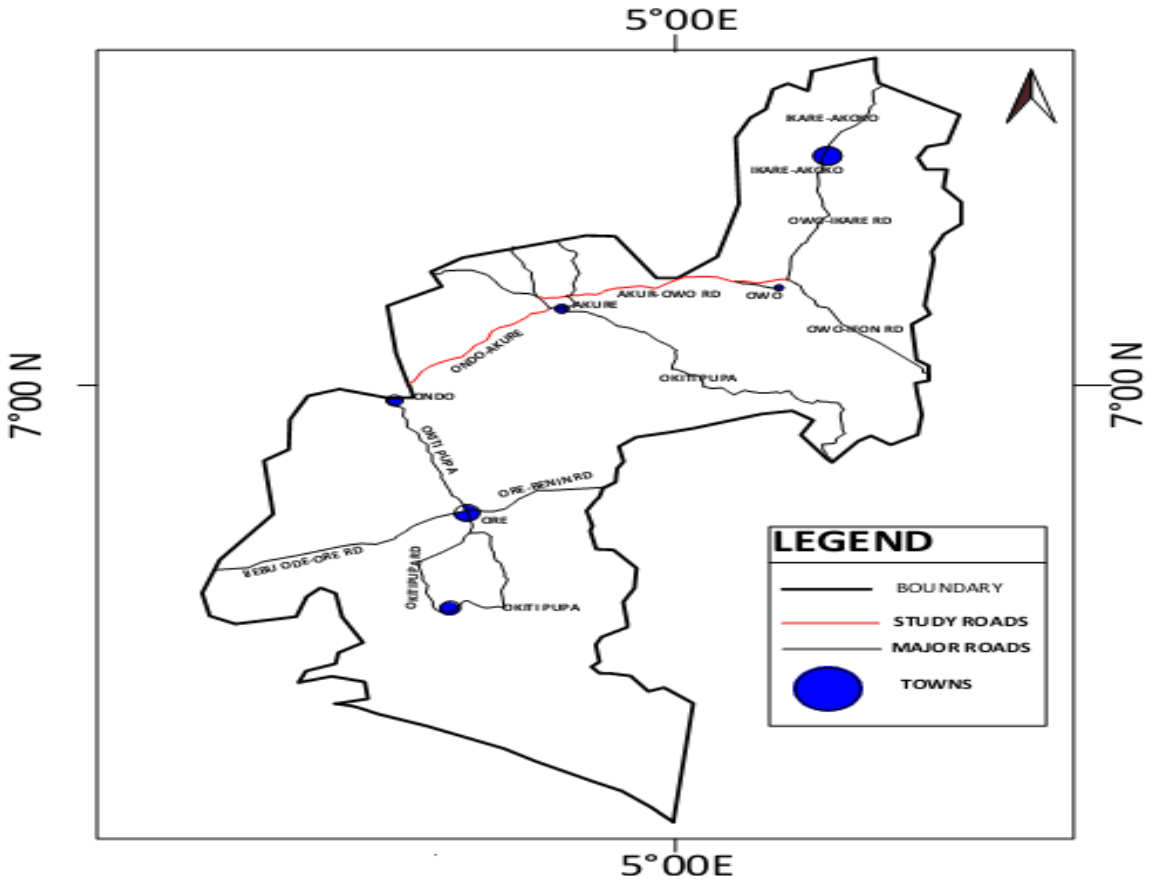

Fig. 1 *Road Network Map of Ondo State Showing the Two Selected Rural Road*

1 LITERATURE REVIEW

A road accident refers to any accident involving at least one road vehicle, occurring on a road open to public circulation, and in which at least one person is injured or killed (National Institute of Statistics and Economic Studies, saved 2017). Road accident is one of the major problems for most communities in developing countries Nigeria inclusive, where 90% of the world road accident fatalities occur [13]. According to [9], road accidents resulting in deaths of the road users (Passengers, Drivers or Pedestrians) may be fatal, or minor when it is not severe enough as to cause substantial hardship. However, the road traffic injuries (RTI) are a major cause of morbidity and mortality worldwide, but especially in low-and-middle income countries like Nigeria [6]. Regrettably, transportation by road is the most used in Nigeria.

Several factors had been adduced to be the causes of road crashes while in other researches models has been formulated using identified causative factors. [5] opined that the factors influencing road accidents/crashescan be grouped into following:

i. Vehicle related factors: this may be due to inherent design limitations or defects to lack of maintenance, failure of components like brakes, tires and lighting. Visibility, speed and vehicle lighting are also important.
ii. Road related factors: this includes pavement design and conditions, horizontal curves, insufficient lane and shoulder width, vertical curves.
iii. Road user related factors: psychological factors of the users, alertness and intelligence, patience of driver, drivers experience and age.
iv. Environmental related factors: rain, reduced visibility, bad weather etc. heavy fog and mist and heavy rain also plays important role

Consequently, [10] assert that the number of crashes is affected by three factors namely the road environment, the condition of vehicles using the road system, and the skills, concentration and physical state of road users.

In the research by [2], they examined road traffic accident problems in Nigeria and the causes of accidents and their general preventive measures. He also asserts that most of the crashes on Nigeria roads were caused by driver, vehicle and roadway factors [1], studied the trend of road accident in Kogi State Nigeria from January, 1997 to December, 2010. They formulated the model equation 3 using a univariate time series data collected from the Federal Road Safety Commission (FRSC).

It was found that there is no seasonal variation but trend which shows steady increase in Kogi State accident rate.

$$Y=22.062 + 0.252T3$$

Where: Y - the seasonal index,
T - the period

Crash-prediction modeling techniques such as linear regression, poisson and negative binomial regression models among others can be used to assess road safety during highway planning and design. [4] developed a multivariate analyses in equation 1and 2 which relate crash rates to an infrastructure coefficient, the results showed a significant correlation between highway infrastructure quality and crash rates.

$$CR_{(PCA)}=0.98 \text{ x exp}-0.403 \text{ x } (IC_{PCA}) \quad (1)$$

$R^2 = 0.56$

$$CR_{(AHP)}=1.00 \text{ x exp}-0.401 \text{ x } (IC_{AHP}) \quad (2)$$

$R^2 = 0.56$

Where: CR - crash rate,
IC_{PCA}-infrastructure coefficient for principal component analysis,
IC_{AHP}- analytic hierarchy process respectively,
R^2- correlation coefficient.

[11] formulated a model for predicting crash rate of truck on vertical curves using negative binomial regression; with traffic and geometric characteristics as independent. The result showed that as the steepness of the curve increases, truck crash rate increases; thus, the increase in the steepness of the curve reduces the stopping sight distance and differential speed. [7] developed accident prediction models for Akure – Ondo carriageway, using multiple linear regressions with the fatality (F) as dependent variable; while, the independent variables are the number of people killed in the accident (X_1), the number of people injure (X_2), the number of people involved in the accident (X_3). They stated that drivers' behavior such asnon-adherence to traffic rules, poor maintenances of road and over-speeding were responsible for crashes occurrence along this highway.

Accordingly, [12] opined that human factors such as visual acuteness, driver fatigue, poor knowledge of road signs and regulations among others accounted for 90% of road crashes while 10% was due to mechanical and environmental factors. [8] used time series analysis for modeling and detecting seasonality pattern of auto-crash cases in Osun State Nigeria from 2006 to 2012. This result was corroborated by Least Squares trend shown in equation 3. He affirmed that high prevalence of vehicular accident occur in the month of October, November, and December respectively.

$$X_t = 223.3016 - 6.025725_t \quad (3)$$

Where: X_t- a sequence of accident,
6.025725_t *- source of randomness*

3 RESEARCH METHODOLOGY

The crash database from 2012-2017 was collected from Federal Road Safety Corp (FRSC), Ondo State Sector 19.3 command. The crash data base contained descriptions of the causative factors which were classified into Driver factors, Vehicle factors, Roadway factors and Environmental factors.

***Driver Factors*:** Factors such as speed violation, dangerous driving, loss of control, wrongful overtaking, route violation, over loading, drink- driving, sleeping on steering, use of phone are classified under drivers factors.

Vehicle factors: Factors such as tyre burst, break failure, defective steering, electrical fault, defective horn and any other vehicular condition which resulted to the crash are classified under vehicle factors.

Roadway factors: Factors such as bad road, potholes, road obstructions and any other condition related to road that resulted to crash were grouped under road factors.

Environmental factors: Related conditions such as poor weather, smoke, rain, fog, mist, are in no small measure contribute greatly to the rate of road traffic accident, crashes occurred as a result of this factor as reported in the crash data were collated and classified as environmental factor.

4 RESULTS AND ANALYSIS

Figures 2 and 3 shows the fatality trend along AO1 and AO2.The analysis of variables factors (Driver factors, Vehicle factors, Roadway factors and Environmental factors) contributing to road crashes was carried out, the analysis of the crash data shows overall 11% decrease in crash and 22% decrease in fatality trend from 2012 to 2017along AO1 while, there is 20 % and 30% decrease in crash and fatality trend in AO2.

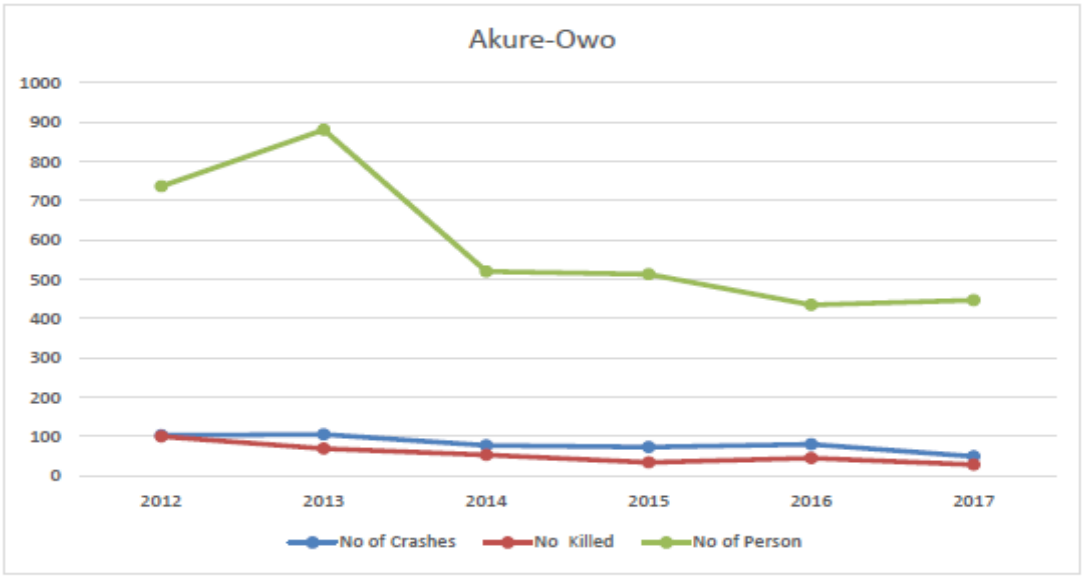

Fig. 2 *Crash Data for Akure-Owo Road from 2012-2017*
Source: Author, 2017

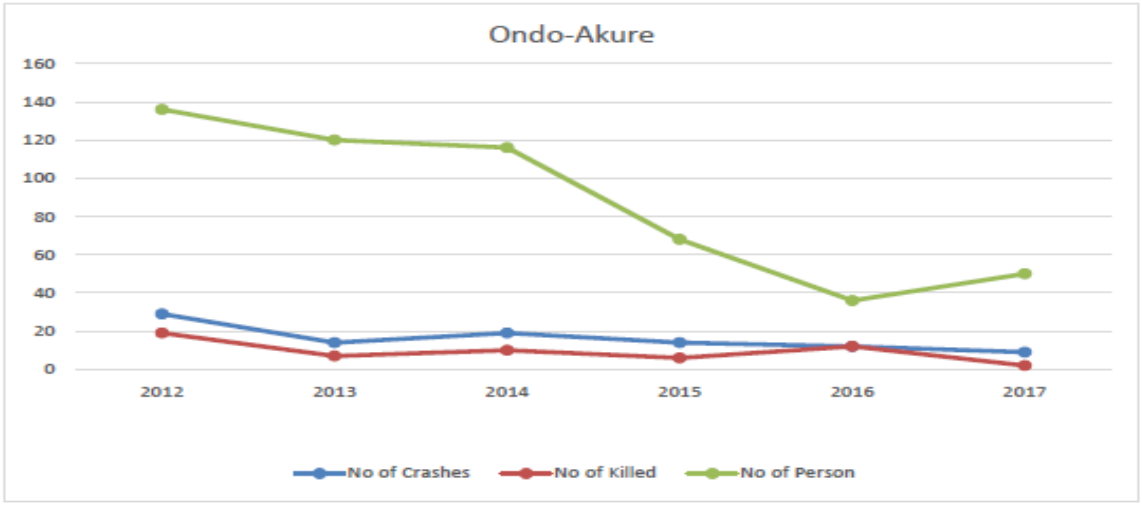

Fig. 3 *Crash Data for Akure-Ondo Road from2012-2017*
Source: Author, 2017

The analysis of the crash data for the study roads shows that 487 crashes occurred between 2012 to 2017and 3,533 people were involved in the accidents, 329 persons were killed onAO1. Also, 97 crashes occurred on AO2 route, 526 passengers were involved and 56 people killed. The analysis revealed that driver and vehicle factors account for 80%and 16% respectively of the crashes on the two highways. This shows that more than 90 percent of crashes along the routes are caused by these two factors. Driver factors such as speed violation,

dangerous driving, loss of control, route violation and wrongful overtaking were the major causes of road accidents on these two highways as shown in Figure 4, meanwhile, vehicle factors which include tire burst, break failures and mechanical deficiency are also contributing to road crashes along these study roads as depicted in Figure 5 while roadway and environmental factors have minima influence on crashes.

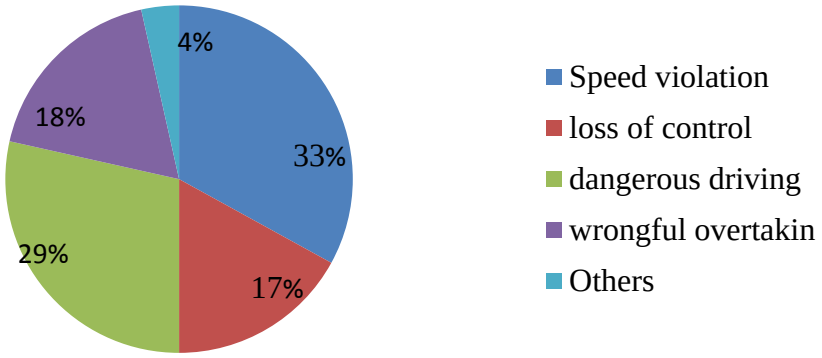

Fig. 4 *Behavioural Factors of Driver which Resulted to Crashes on the Study Roads*
Source: Author, 2017

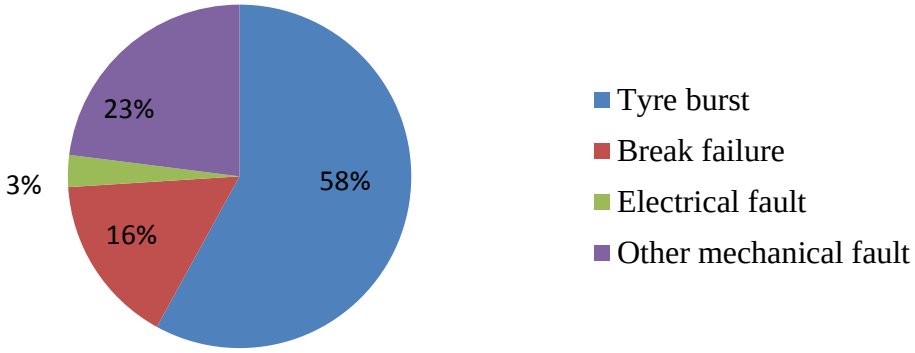

Fig. 5 *Vehicle Factors which Resulted to Crashes on the Study Roads*
Source: Author, 2017

Figures 6 and 7 is the crash distribution by the type of vehicle involvement, the total number of 696 vehicles involved in crash between 2012-2017on AO1. This comprise of 76 motor bikes (11%), 372 cars (52%), 112 buses (17%) and 136 Trucks/ Trailer (20%). The analysis shows that cars and trucks are more prone to crashes along AO1. On the other hand a total of 115 vehicles were involved in crash along AO2 which comprises of 18 motor bikes (16%), 67 cars (58%), buses 15 (13%), trucks/trailer 15 (13%).

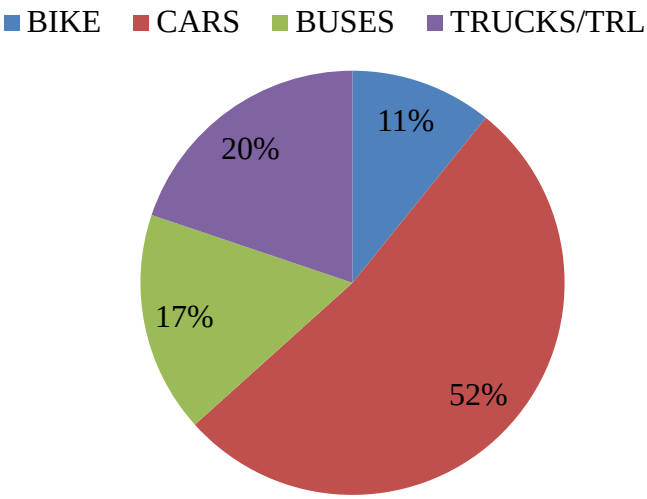

Fig. 6 *Crash Frequency Distribution by Vehicle Involvement along Akure-Owo*
Source: Author, 2017

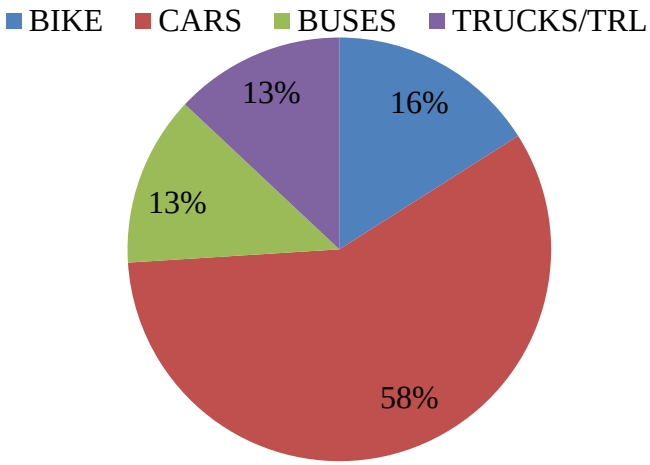

Fig. 7 *Crash Frequency Distribution by Vehicle Involvement along Akure-Ondo*
Source: Author, 2017

4.1 Crash Prediction Model

The crash data was modeled using multiple linear regression model given by:

$$Y_i=\alpha+\beta_i X_i+\beta_j X_j+...+\beta_{ij} X_{ij}+e_i \quad (4)$$

Where: Y_i*-value of the ith case of the dependent scale variable,*
X_i*- number of predictors,*
β_j *- the value of the jth coefficient,*
X_{ij} *- value of the ith case of the jth predictor,*
e_i *- error in the observed value for the ith case.*

The dependent variable is number of crash (y) while the explanatory variables (independent variables) are driver factors (x_1), vehicle factors (x_2), and roadway factors (x_3). Tables 1 and

2 are the regression coefficients for AO1 and AO2; Table 3 is the summary of the model for AO1 which gives the adjusted R^2 of 94% while Table 4 is the model summary for AO2 which gives the adjusted R^2 of 96.9%.

Tab. 1 *Regression Coefficient for Akure-Owo Model (AO1)*

Y	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Driver's factor	0.9639155	.0128812	74.83	0.000	.9084962	1.019343
Vehicle Factor	1.189419	.060712	19.59	0.003	.9281967	1.450642
Road Factor	1.139368	.0434796	26.20	0.001	.9522902	1.326446
_cons	-.0090591	.160284	-0.06	0.960	-.6987056	.6805874

Source: Author, 2017

Tab. 2 *Regression Coefficient for Akure-Ondo Model (AO2)*

Y	Coef.	Std. Err.	t	P>t	[95% Conf. Interval]	
Driver factor	0.9082278	.0919085	9.88	0.010	.5127777	1.303678
Vehicle factor	.3132911	.4065994	0.77	0.052	-1.436165	2.062747
_cons	3.322785	1.383433	2.40	0.138	-2.629646	9.275215

Source: Author, 2017

Tab. 3 *Model Summary for Akure-Owo Road (AO1)*

Model 1	R	R Square	Adjusted R	Root mean square
	0.994	0.988	0.940	0.262

Source of Variation	Some of Square	Degree of Freedom	Mean Square	Prob>F
Regression	86079.196	3	28693.065	0.00
Residual	0.137294962	2	2 .0686	
Total	86079.3333	5	5 17215.866	

Source: Author, 2017

Tab. 4 *Model Summary for Akure-Ondo Road (AO2)*

Model 2	R	R Square	Adjusted R	Root mean square
	0.997	0.984	0.969	0 .617

Source of Variation	Some of Square	Degree of Freedom	Mean Square	Prob>F
Regression	48.4373418	2	24.2186709	0.015
Residual	.762658228	2	.381329114	
Total	49.2	4	12.3	

Source: Author, 2017

The models obtained for the AO1 and AO2 using Statistical Package for Social Science (SPSS 22) are:

$$y_{AO1}=-0.0090591+0.9639x_1+1.189x_2+1.1394x_3 \quad (5)$$

$$y_{AO2}=3.322785+0.9082278x_1+0.313291x_2 \quad (6)$$

5 CONCLUSION

The adjusted R^2 of 94% and 96.9% was obtained for AO1 and AO2 respectively, this value means that 94% and 96.9% of the variation for model 1 and 2 in the number of crashesalong the routes has been explained by theregression line. It proves that the regressed model does providea good fit to the independent variable.

This implies that 94% and 96% of the crashes that occurred along the two highways was accounted for by driver, vehicle and roadway factors. However, driver's factor as shown in Table 3 and 4 was statistically significant and had positive additive effect of 0.9639 and 0.9082 to have caused the accident along AO1 and AO2 routes which is statistically significant at α=0.05 level of significance ($p< 0.05$). Roadway factor is significant for AO1 with additive effect of 1.139368 but not significant for AO2 and was not included in the second model.

The findings from this study revealed that driver and vehicle factors are very significant to the occurrence of crashes along the two study roads. In view of these findings and to achieve a desire result of reducing road crashes on these routes, this study hereby recommends the following:

i. Drivers and other road users should be properly trained and evaluated before being certified to drive in all the highways, and strict enforcement of road traffic laws on offenders, in addition to that sensitization of drivers on effect of dangerous driving, wrongful overtaking and speed violation is required in all the motor parks.
ii. Proper inspection of vehicles by vehicle inspection officers to ensure that vehicles are roadworthy: tyre and break should be given strict inspection to checkmate the use of expire tyre and defective break.
iii. Enforcement of speed limit to reduce and to checkmate over speeding by the drivers.

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