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EMPIRICAL ANALYSIS ON ROAD TRAFFIC CRASHES IN ANAMBRA STATE, NIGERIA: ACCIDENT PREDICTION MODELING USING REGRESSION APPROACH

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ABSTRACT: *Road traffic crashes in Anambra State Nigeria was considered in this paper, secondary data were mainly used, and was sourced from the office of the Federal Road Safety Corps; Policy, Research and Statistics Department RSHQ Abuja. Regression Analysis was applied on the data, with the aim of identifying how well a set of independent variables (Mechanical Fault, Reckless Driving and Over-Loading) is able to predict Road Accident in Anambra State, indicating, the best predictor of Road Accident in the state, knowing if Overloading is still able to predict a significant amount of the variance in Road Accident when Mechanical Fault and Reckless Driving is controlled for and to develop an accident prediction model. The result shows no violation to the assumptions of Normality, Homoscedasticity, Independence, Linearity, Multicollinearity and Outliers. The three predictors significantly predicted road accident { F(3,9) = 14.132, p-value =0.001 < 0.005 }, $R^2_{adjusted}$= 0.767; 76.7% , of the total variance in road accident cases was explained by the model, Mechanical Fault made the strongest unique significant contribution to explaining road accident cases when the variance explained by all other variables in the model is controlled for (βeta value = 0.841, p-value = 0.001), Reckless driving made less of a contribution (βeta value =0.591, p-value = 0.004), while overloading did not make a significant contribution to the prediction of road accident when the variance explained by other variables in the model is controlled for (βeta value = 0.173, p-value = 0.228). The developed prediction model is;* ***Number of Road*** *Accident = 6.407 + 1.300Reckless Driving + 1.959Mechanical Fault + 0.733Overloading*

KEYWORDS: Empirical Analysis, Road Traffic Crashes, Anambra State, Nigeria; Accident Prediction Modeling, Regression Approach

INTRODUCTION

Deaths from road traffic accidents in Nigeria were ranked among the highest in the world (Adeniyi, 1985). Accidents can occur at any traffic speed, but fatality of these accidents differs, depending on the speed at which they occur. The contribution of death resulting from road traffic accident to total death rose from 38.9% in 1967 to 58% in 1974 (Adeniyi, 1985). Vehicular crashes have gotten to an unbearable level that road accidents must be attacked with all seriousness in order to minimize its fatality. In a bid to combat road accident in Nigeria, many efforts have been made by the government since 1913 with the establishment of Federal Road Safety Corps (FRSC) (Adeniyi, 1985). FRSC was charged with the responsibility of maintaining safety on Nigeria roads. Road 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 (Atubi, 2009b). Cases of fatal road traffic accidents are reported almost daily on the major highways in Anambra State. Various categories of vehicular traffic are also involved in these fatal road traffic accidents in the state. Research in this area have focused on cases of road traffic accidents, collation of road traffic accident statistics and impact assessment of road safety campaign (OECD), 1994), Becker, 1996; C.B.N., 1997; Gozias et al, 1997 and Odero et al, 2003). At the local level research in this area are concentrated on the effects of land use and human factors on road traffic accidents (Onokala, 1995; Ogunjumo, 1995 and Omojola, 2004). In Nigeria today, hardly a day goes by without the occurrence of a road traffic accident leading to generally increasing incidence of morbidity and mortality rates as well as financial cost to both society and the individual involved. Information on some of these traffic accidents get to the news rooms of media houses and are aired while majority goes unreported. Nigeria has the highest road accidents rate as well as the largest number of death per 10,000 vehicles. Sheriff, M.A. (2009). One may be tempted to believe that the level of awareness on the causes of road traffic accidents is very low among Nigerians. Put differently, Nigerian roads have become killing fields without protection for their users. Travelers heave a sigh of relief if they make their destinations. Eze, B. (2012). Contrary to the general belief that Nigerians posses very low level of awareness on the causes of road traffic accidents, previous research has shown that Nigerians know quite a lot about what could cause road traffic accidents. Asalor, J.O. (2010). Nigeria has the status of a developing country where road facilities are grossly inadequate to carter for the teeming population of road users. The discovery of oil in Nigeria came with its own problems. Prior to the 'Oil boom' in Nigeria, road accidents were rather rare. The oil boom brought along with it an increase in disposable income of the people which in turn increased vehicle ownership and brought about 'rapid' industrialization. This undoubtedly calls for improved road network accessibility. Roads were therefore built albeit without dire attentions to standard. These developments were not matched by adequate measures and control. Sheriff, M.A. (2009). Consequently, the roads grew to be a death trap for Nigerian citizens and road users. This is significant when the fact that majority of these injuries and deaths can be prevented. It becomes worrisome with the fact that the incidence is increasing. Eze, B. (2012). Effective interventions include designing safer infrastructure and incorporating road safety features into land-use and transport planning; improving the safety features of vehicles. To a very large extent, it is not entirely the poor deplorable condition of Nigerian roads that causes incessant road traffic accidents but a large proportion can be attributed to the carelessness and negligence of its road users. Thus, the primary objective of the study is to identify how well "Mechanical Fault", "Reckless Driving" and "Over-Loading" is able to predict "Road Accident" in Anambra State, indicating, the best predictor of Road Accident in the state, to know if Overloading is still able to predict a significant amount of the variance in Road Accident when Mechanical Fault and Reckless Driving is controlled for and to develop an accident prediction model for the road segment using regression technique.

METHODOLOGY

To achieve the set objectives, some models were reviewed and applied which includes;

Multiple Linear Regression Model

Was used to determine how well a set of explanatory variables (mechanical fault, reckless driving, and over loading) is able to predict the response variable (number of road accident), which variable in the set of explanatory variables is the best predictor of road accident and whether an explanatory variable is still able to predict the response variable when the effect of another explanatory variable are controlled for.

$Y = x\beta + e_i$

$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ \ldots + e_i$

where $i = 1,2, \ldots, n$

Y is the Outcome Variable

$\beta_0, \beta_1, \ldots, \beta_n$ *are the parameters of the model*

$x_1, x_2, \ldots, x_n$ *are the predictors*

Estimation of Model Parameters

$Y = x\beta + e_i$

$e_i = Y - x\beta$

$e^i e = (Y - x\beta)^2 = (Y - x\beta)^{'} (Y - x\beta)$

$e^i e = Y^{'}Y - Y^{'}X\beta - X^{'}Y\beta + X^{'}X\beta^2$

$e^i e = Y^{'}Y - 2X^{'}Y\beta + X^{'}X\beta^2$

$\Sigma (e^i e) = \Sigma (Y^{'}Y - 2X^{'}Y\beta + X^{'}X\beta^2)$

$\Sigma\delta(e^i e) / \delta\beta = - 2X^{'}Y + 2X^{'}X\beta = 0$

$:- 2X^{'}X\beta = 2X^{'}Y$

$X^{'}X\beta = X^{'}Y$

$\hat{\beta} = (X^{'}X)^{-1} X^{'}Y$

Correlation Coefficient 'r' and Coefficient of Determination

This was used to know the strength of the relationship between the variables.

$$r = \frac{n\sum x y - \sum x \sum y}{\{(\sum x^2 - (\sum x)^2) - (n\sum y^2 - (\sum y)^2\}^{1/2}}$$

Data Analysis and Result

Table 1:*Descriptive Statistics*

Descriptive Statistics			
	Mean	Std. Deviation	N
Road Accident	39.83	5.044	18
Reckless Driving	9.44	2.431	18
Mechanical Fault	10.33	2.401	18
Over Loading	2.06	1.259	18

Table 2: *Correlation*

		ROAD ACCIDENT	RECKLESS DRIVING	MECHANICAL FAULT	OVER LOADING
Pearson Correlation	ROAD ACCIDENT	1.000	.347	.636	.372
	RECKLESS DRIVING	.347	1.000	.178	.220
	MECHANICAL FAULT	.636	-.178	1.000	.344
	OVER LOADING	.372	.220	.344	1.000
Sig. (1-tailed)	ROAD ACCIDENT	.	.079	.002	.064
	RECKLESS DRIVING	.079	.	.240	.190
	MECHANICAL FAULT	.002	.240	.	.081
	OVER LOADING	.064	.190	.081	.
N	ROAD ACCIDENT	18	18	18	18
	RECKLESS DRIVING	18	18	18	18
	MECHANICAL FAULT	18	18	18	18
	OVER LOADING	18	18	18	18

Table 3: *Tests of Normality*

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
ROAD ACCIDENT	.177	18	.142	.920	18	.130
RECKLESS DRIVING	.184	18	.111	.926	18	.165
MECHANICAL FAULT	.113	18	.200*	.944	18	.340
OVER LOADING	.299	18	.000	.759	18	.059

Table 4: *Extreme Values(Outliers)*

			Case Number	Value
Mahalanobis Distance	Highest	1	3	6.96580
		2	15	5.13626
		3	9	5.11165
		4	5	4.67143
		5	7	3.83288[a]
	Lowest	1	16	.40219
		2	1	.85861
		3	2	.95270
		4	6	.96624
		5	8	1.31107

a. Only a partial list of cases with the value 3.83288 are shown in the table of upper extremes.

Critical X^2 value at an alpha level of 0.001 using the number of independent variables as degree of freedom

Table 4b: *Tabachnic and Fidell (2001) Table*

No. of Independent Variables	Critical Value	No. of Independent Variables	Critical Value	No. of Independent Variables	Critical Value
2	13.82	4	18.47	6	22.46
3	16.27	5	20.52	7	24.32

Source: Extracted and adapted from a table in Tabachnic and Fidell; originally from Pearson, E.S. and Hartley, H.O (Eds) (1958). Biomerika tables for statisticians (vol. 1, 2nd Edition). New York: Cambridge University Press.

Table 5: *Test of Homogeneity of Variances*

Levene Statistic	df1	df2	Sig.
1.731	4	9	.227

Table 6: *Model Summary*

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.908[a]	.825	.767	2.699	1.816

a. Predictors: (Constant), Overloading, Reckless Driving, Mechanical Fault

b. Dependent Variable: Number of Road Accident

Table 7: *ANOVA*

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	308.762	3	102.921	14.132	.001[a]
	Residual	65.546	9	7.283		
	Total	374.308	12			

a. Predictors: (Constant), Overloading, Reckless Driving, Mechanical Fault

b. Dependent Variable: Number of Road Accident

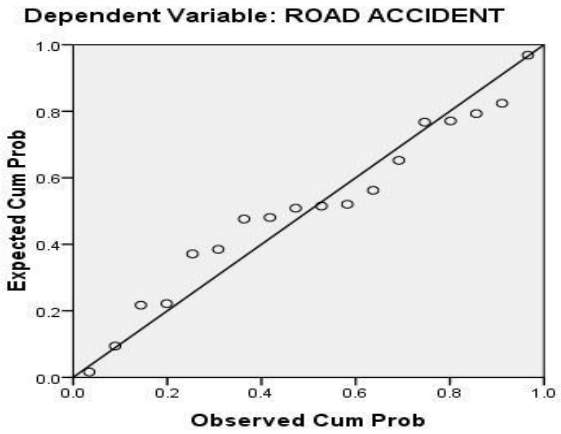
Table 8: *Coefficients*

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations			Collinearity Statistics	
		B	Std. Error	Beta			Zero-order	Partial	Part	Tolerance	VIF
1	(Constant)	6.407	5.588		1.146	.281					
	Reckless Driving	1.300	.332	.591	3.920	.004	.233	.794	.547	.857	1.167
	Mechanical Fault	1.959	.410	.841	4.777	.001	.715	.847	.666	.628	1.591
	Overloading	.733	.710	.173	1.033	.328	.500	.326	.144	.691	1.447

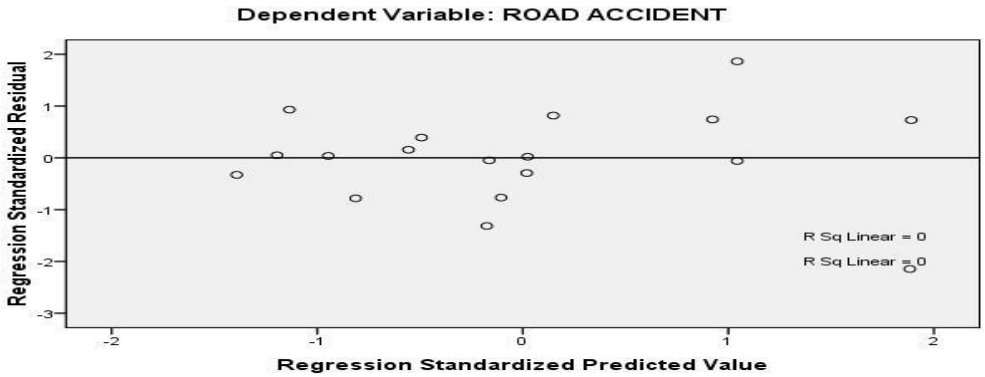
a. Dependent Variable: Number of Road Accident

Number of Road Accident = 6.407 + 1.300Reckless Driving + 1.959Mechanical Fault + 0.733Overloading

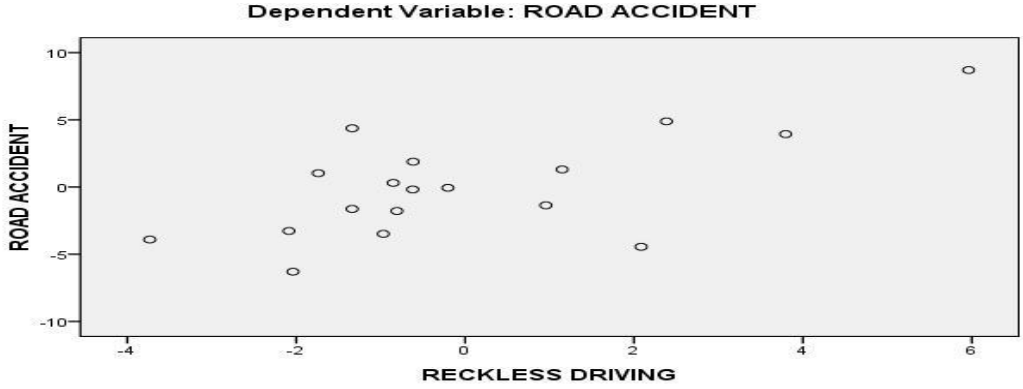
Normal P-P Plot of Regression Standardized Residual

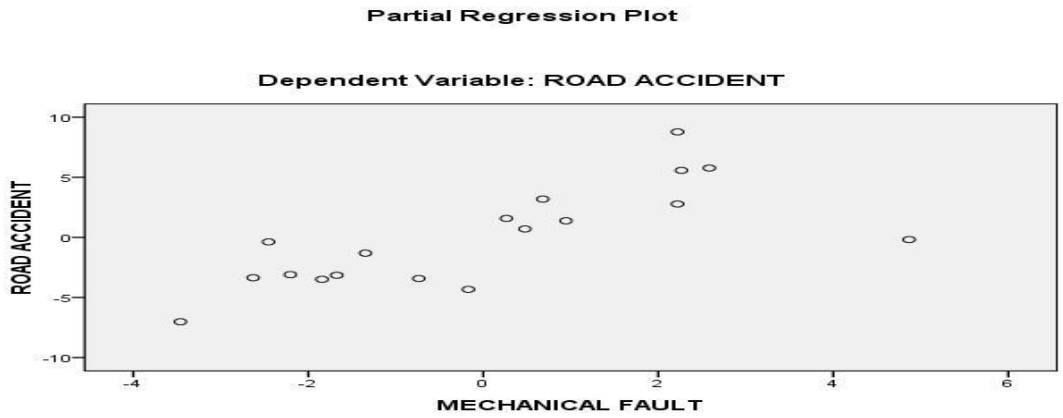


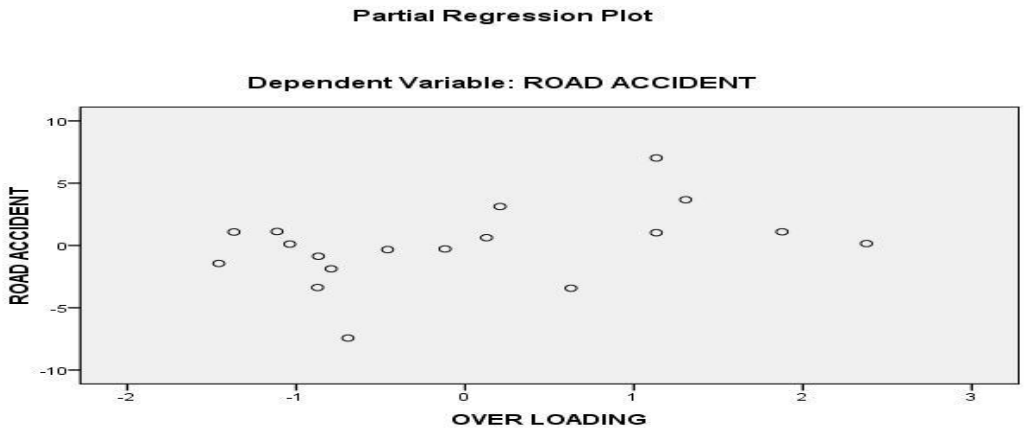
Scatterplot



Partial Regression Plot







Regression Analysis was performed on the data to find out how well "Mechanical Fault", "Reckless Driving" and "Over-Loading" is able to predict "Road Accident" in Anambra State, indicating, the best predictor of Road Accident in Anambra State and to know if Overloading is still able to predict a significant amount of the variance in Road Accident when Mechanical Fault and Reckless Driving is controlled for, the data showed no violation to the assumptions of **Normality** {(From Visual Inspection of the Normal P-P Plot of Regression Standard Residual) and from *Shapiro-wilk p-values (P-value for Road Accident = 0.130, p-value for reckless driving = 0.165, p-value for Mechanical Fault = 0.340, p-value for Over loading = 0.059)}*, **Homogeneity of variance** (From Visual Inspection of the Scattered Plot of Regression Standard Residual against Regression Standardize predicted value also from *Levene's Statistic = 1.731, p-value = 0.227>0.05*)**, Independence** (*Durbin-Watson statistic = 1.816 > 1.5*), **Linearity** (Visual Inspection of the Regression Partial Plots), **Multi-Collinearity** (Tolerance > 0.1, Variance Inflator Factor < 10, r (between the independent variables) < 0.7), **Outliers** (Mahalanobis Distance < $X^2_{0.001,3}$ = 16.27). The analysis Show that the three predictors (Reckless driving, Mechanical Fault and Over loading) statistically significantly predicted road Accident, F(3,9) = 14.132, p-value =0.001 < 0.005, $R^2_{adjusted}$= 0.767; 76.7% of the total variance in Road Accident is explained by the model. Mechanical Fault made the Strongest statistically unique significant contribution to explaining Road Accident

when the variance explained by all other variables in the model is controlled for (βeta value = 0.841, p-value = 0.001), Reckless Driving made a less of a contribution (βeta value = 0.591, p-value = 0.004) while Overloading did not make a significant unique contribution to the prediction of Road Accident (βeta value = 0.173, p-value = 0.228) when the variance explained by all other variables in the model is controlled for.

CONCLUSION AND RECOMMENDATION

The three predictors (Reckless driving, Mechanical Fault and Over loading) statistically significantly predicted road Accident, as 76.7% of the total variance in Road Accident was explained by the model. Mechanical Fault made the Strongest statistically unique significant contribution to explaining Road Accident when the variance explained by all other variables in the model is controlled for, Reckless Driving made a less of a contribution while Overloading did not make a significant unique contribution to the prediction of Road Accident when the variance explained by all other variables in the model is controlled for. Therefore, the Government of Anambra State should organize seminars, lectures and talk-shows enlightening Motorists on Engine maintenance, the importance of checking their Carburetor water gauge, engine oils, break fluid e.t.c. At the same time enlightening them on how to use the Highway and the dangers of reckless driving. The Government should also set up Government Owned Driving Colleges to tutor both the theoretical and practical usage of Vehicle, and issues drivers license and/or vehicle permit only to graduates from such colleges, as this would greatly reduce the production of unprofessional drivers in the state, hence reducing road accident. Finally, Government should construct more pedestrian bridges to avoid pedestrians crossing the highway as this would greatly reduce accident cases in the state.

REFERENCES

Adeniyi A., (1985), “Provision of Mass Transit in Nigerian Cities”, - Transportation in Nigerian for national development, Federal Road Safety Corps, Nigeria.

Asalor, J. O. (2010). Towards Improved Road Safety in Nigeria. Technical Report No. Rts/00/82/011, Faculty of Engineering, University of Benin.

Atubi, A.O. (2009b) “Urban Transportation: An Appraisal of Features and Problems in the Nigerian Society”. International Journal of Geography and Regional Planning. Vol. 1, No. 1, Pp. 58-62.

Backer, W. (1996) “Impact Assessment of Road Safety Campaign” Transportation Review. 16 (4): 345-355.

Central Bank of Nigeria (1997) Annual Report and Statement of Account for the Year Ended 31st December, CBN, Abuja.

Eze, B (2012) Road Traffic Accidents in Nigeria: A Public Health Problem.

Gozias, J.C.; Matsouki, E.C. and Yannis, G.D. (1997) “An Analysis of Factors Affecting Road Safety: The Greek Experience” Journal of Transportation Geography 5 (3): 325-316.

Odero, W. Khayes, I.M. Meda, P. M. (2003) Road Traffic Accident in Kenya: Magnitude, Causes and Status of Intervention. Injury Control and Safety Promotion, 10, Pp. 53-61.

OECD, (1994) Managing the Environment: the Role of Economic Instrument. Paris .

Ogunjumo, A. (1995) En Evaluation of Nigerian Airways' and Foreign Management Consultants' domestic Operations: 1974-1986: The Nigerian Journal of Economic and Social Studies, Pp. 34 (1).

Onokala, P.C. (1995) The Effect of Land use on Road Traffic Accident in Benin-City, Nigeria. Journal of Transport Studies, Vol. 1, No. 1, Pp. 34-44.

Omojola, A.S.(2004) "Transport and Communication" in Kayode, M.O. and Usman, Y.B. (eds) Nigeria since Independence. Vol. 2, Ibadan; Heinemann. Pp. 132-152.

Sheriff, M. A. (2009). Traffic Education and Safety in Nigeria, Nitours Journal Vol. II, Kano.