A STUDY OF ACCIDENT FATALITY ON AKURE-OWO HIGH WAY USING LOGISTIC REGRESSION

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Abstract

Road Traffic Crash (RTC) is a major concern of government in Nigeria. This is because it is a regular occurrence in the country. The Akure-Owo highway is a Federal highway which is a segment of a major road linking two very important cities in Nigeria. The cities are Lagos, a port city and the commercial capital of Nigeria in the south west and Abuja, the nation's capital city. The busy nature of the road makes it prone to Road Traffic Crashes (RTC). This research work examines the occurrence of RTC on the highway and the accompanied fatalities. Test of associations were used to determine the relationships between occurrence of accidents and causes and months of the year. Also relations between fatality and causes and months of the year were examined. A logistic regression model was also fitted with fatality as dependent variable and causes of accidents and months of the year as independent variables. It was discovered that the occurrence of accidents can be related to months but months and causes of accidents are independent. Also fatality is independent of both causes and months of the year.

***Key words**: Road Traffic Crash, Transport infrastructure, Highway, Accidents*

1.0 Introduction

Road accident is a major problem facing the transport sector in Nigeria. The country is ranked among the countries of the world where road accident is a common occurrence. The problem became so serious in the 1980s that the military government of Gen. Ibrahim Babangida established the Federal Road Safety Commission (FRSC) as a separate organ of government charged with the responsibility of improving safety on our roads. The FRSC was established first by a military decree in 1988, and later amended and passed by Act of Parliament in 2007, and has the critical mandate to prevent accident and loss reduction on all public roads across the country. How far the commission has been able to accomplish this mandate cannot be easily determined. Figures available, both locally and internationally, point to the fact that very little

success has been achieved in this regard. Nigerian roads are still regarded as death traps by both local and international organizations. In the National Mirror of Monday, June 25, 2012, the Corps Marshal and Chief Executive of FRSC, Osita Chidoka, was quoted as saying that Nigerian roads was second worst in the world. According to the report by the United Nations, Nigeria is currently ranked 191 out of 192 countries of the world with unsafe roads.

Road Traffic Crash is a worldwide problem. Recently The United Nations General Assembly has dedicated 2011.—2020 as a "Decade of Action on Road Safety" for dedicated intervention by governments to bring down the estimated rise in Road Traffic Crashes (RTC) by 50 per cent (Osita Chidoka, National Mirror 2012). Traffic accidents are a world-wide economic and public health problem (Ghazwan 2011). According to the World Health Organization (WHO) Global Status Report on Road Safety (2009), road traffic injuries will rise to become the fifth leading cause of death by 2030 from its present level of 9^{th} and over 90% of the world's fatalities on the roads occur in low – income and middle-income countries, which have only 48% of the world's vehicles. The World Health Organization estimated that 1.17 million deaths occur each year world-wide due to road traffic accidents. A breakdown of the figures however indicates that about 70% of the deaths occur in developing countries (Atubi, 2012).

The reason for high accident rate in Nigeria can be attributed to a number of factors. They include the poor transport infrastructure in the country. Road is the main mode of transporting both human and goods, and this has resulted in over-utilization of most highway segments in the country. As a result of this there are congestions on most highways and in some cases, total breakdown of traffic flows. In some cases, motorists have been found to sleep on the highway. Other factors are poor skills and lack of discipline on the part of drivers. In addition to this, roads deteriorate very fast as a result of poor construction and excessive traffic, exceeding the design capacity of most of the roads. Portholes and ditches are common all over our highways. Also broken-down vehicles are not cleared on time from the highways, obstructing the view of motorists. All these and a lot more are some of the reasons why experts believe Nigerian roads are among the deadliest in the world.

Several authors have worked on the problem of RTC in Nigeria. Arosanyin, et al. (2012) examined the level of compliance with some basic road traffic regulations among commercial motor cyclists using descriptive statistics and phi coefficient. Sangowawa et al (2012) observed school environments around some selected schools for road safety features such as location of school, presence of child crossing and speed limit road signs, and presence of traffic calming devices (road bumps and zebra crossing). They found that around most of the schools observed, the municipality compromised the pupils' safety. This work models fatality incidence on a highway segment in the country, using logistic regression model. I consider fatality as a dependent variable that can be determined by the causes of accidents and also the months of the year the accident occurs. The month is of particular interest because of the belief that accidents occur more in some months than others.

1.1 The Akure-Owo Highway.

The Akure-Owo highway is a Federal highway linking Akure, the capital of Ondo state, with Owo, a medium-size town in the state. Apart from this, the highway lies along the major highway that links Lagos, the commercial capital of Nigeria, to Abuja, the nation's capital city. Most travelers from the south-western part of the country take the highway to the Northern part. Also heavy-duty and articulated vehicles, transporting goods from the port city of Lagos to the north pass through this highway segment. As a result, the highway segment experiences heavy vehicular traffics on a daily basis. Accidents are a regular occurrence on the highway segment and these poses great danger to the users of the road.

This paper focuses on analyzing fatality data on the highway segment using logistic regression. The method estimates the chance of occurrence of fatal accidents on the highway segment, considering the various causes of accidents as recorded by the Federal Road Safety Commission over the years. The paper is organized as follows: Section 2 contains the logistic regression methodology, section 3 deals with the analysis of the data, section 4 is on the discussion and findings while section 5 concludes the work.

2.0 LOGISTIC REGRESSION

Regression method is concerned with describing the relationship between a response variable and one or more explanatory variables. Often the outcome variable is discrete, taking on two or more possible values. In such a case, logistic regression model is appropriate. The goal of logistic regression is to find the best fitting and most parsimonious model to describe the relationship between an outcome variable and a set of independent variables. The main difference between logistic regression and linear regression models is that the outcome variable in logistic regression is binary or dichotomous (Chao-Ying et al., 2002). Generally logistic regression is well suited for describing and testing hypotheses about relationships between a categorical outcome variable and one or more categorical or continuous predictors (independent) variable. Sometimes the response (dependent) variable is not a numerical value. Instead it is a designation of one of two possible outcomes: alive or dead, success or failure, yes or no (Bayaga 2010).

Let Y denote the response variable and x the explanatory variable. The expected value of Y given x, written as $E(Y/x)$, is denoted by the quantity $\pi(x)$ and is given by

$$\pi(x) = \frac{e^{\beta_0+\beta_1 x}}{1+e^{\beta_0+\beta_1 x}} \quad (1)$$

The logit transformation is used to express $\pi(x)$ as a linear function of β_0 and β_1. The logit transformation is given by

$$g(x) = \ln\left(\frac{\pi(x)}{1+\pi(x)}\right) = \beta_0 + \beta_1 x \quad (2)$$

The logit, $g(x)$ is linear in its parameters, may be continuous and may range from $-\infty$ to $-\infty$, depending on the range of x (Hosmer and Lemeshow 2000).

The probability of Y happening is denoted by E(Y/x) and it is equal to π(x). $E(Y/x)$ follows the binomial distribution. We can express the value of the outcome variable given x as $Y = \pi(x) + \varepsilon$, where ε is an error term. Since Y takes only the values 1 or 0, ε will take on the values 1 - $\pi(x)$ and - $\pi(x)$ respectively, with the respective probabilities $\pi(x)$ and 1 - $\pi(x)$. Hence ε has a mean of zero and variance of $\pi(x)$ (1- $\pi(x)$).

The parameters β_0 and β_1 are estimated by the method of maximum likelihood. Let $\hat{\beta}_0$ and $\hat{\beta}_1$ denote the estimated values of the parameters. Then the Odds Ratio (OR) is estimated by $\widehat{OR} = e^{\beta}$.

The odds ratio is usually the parameter of interest in logistic regression. Inferences about the odds ratio are based on the distribution of $ln(\widehat{OR}) = \hat{\beta}_1$, which tends to follow a normal distribution (Hosmer and Lemeshow, 2002). A 100(1-α)% confidence interval for the odds ratio is given by

$$e^{\left(\hat{\beta}_1 \pm z_{(1-\alpha/2)} se(\hat{\beta}_1)\right)} \quad (3).$$

2. DATA ANALYSIS

The research focuses on the fatality of accidents on the Akure-Owo highway. Being a segment of a major highway in Nigeria, one will be interested in the fatality of road traffic accidents on this segment. A logistic model provides a good method of modeling the odds of fatal accident on the highway. The causes of accidents and the months the accidents occurred were used as the independent variables. Causes can be grouped into two; those that are attributed to the drivers of the vehicles and those that cannot be attributed to them. Causes that can be attributed to drivers among the causes of road traffic accidents identified by the FRSC include dangerous driving (DGD), wrongful overtaking (WOV), speed violation (SPV), loss of control (LOC), and route violation (RTV). Those that may not be attributed to drivers include mechanical deficiency (MDV), tire burst (TBT), obstruction (OBS) and robbery attack (RAT).

Two Hundred and sixty eight observations were obtained as record of accidents on the highway segment from the Federal Road Safety Commission (FRSC) in the period 2006 – 2011. Of this number, 212 were caused by drivers of the vehicles following the classification above, while 56 were as a result of other causes. Also, 86 accidents were fatal while 182 were non-fatal. On a monthly basis, the number of accidents for the period ranges from 11 in the month of January to 41 in the month of December (Table 1), making a minimum monthly average of about 2 road crashes and a maximum monthly average of about 4 road crashes.

The Chi-square test for equal number of RTC per month is significant at 0.2%, showing that RTC varies according to months of the year (Table 2). From the bar chart in figure 1, we can see that the months of March and December are more prone to RTC. On the other hand, the test of independence between fatality and months shows that fatality is independent of months of the year with a significance probability of .178.

(a) Causes

	Frequency	Percent
Others	56	20.9
Driver	212	79.1
Total	268	100.0

(b) Monthly number

	Frequency	Percent
January	11	4.1
February	15	5.6
March	32	11.9
April	23	8.6
May	21	7.8
June	21	7.8
July	22	8.2
August	24	9.0
September	18	6.7
October	19	7.1
November	21	7.8
December	41	15.3
Total	268	100.0

Table 1: Frequencies of monthly number of accidents and causes of accidents for the period 2006 – 2011

	Month
Chi-Square(a)	29.672
df	11
Asymp. Sig.	.002

Table 2: Chi-square test Statistics for the Monthly Distribution of RTC between 2006 and 2011

The causes of RTC were also examined against months and fatality. It was discovered that causes attributed to drivers account for about 80% of RTC and about 84% of fatality on the highway (Table 3). The causes and months, and also causes and fatality are independent. These show that the behavior of drivers on the highway has nothing to do with the month of the year and fatality does not depend on what causes the crash

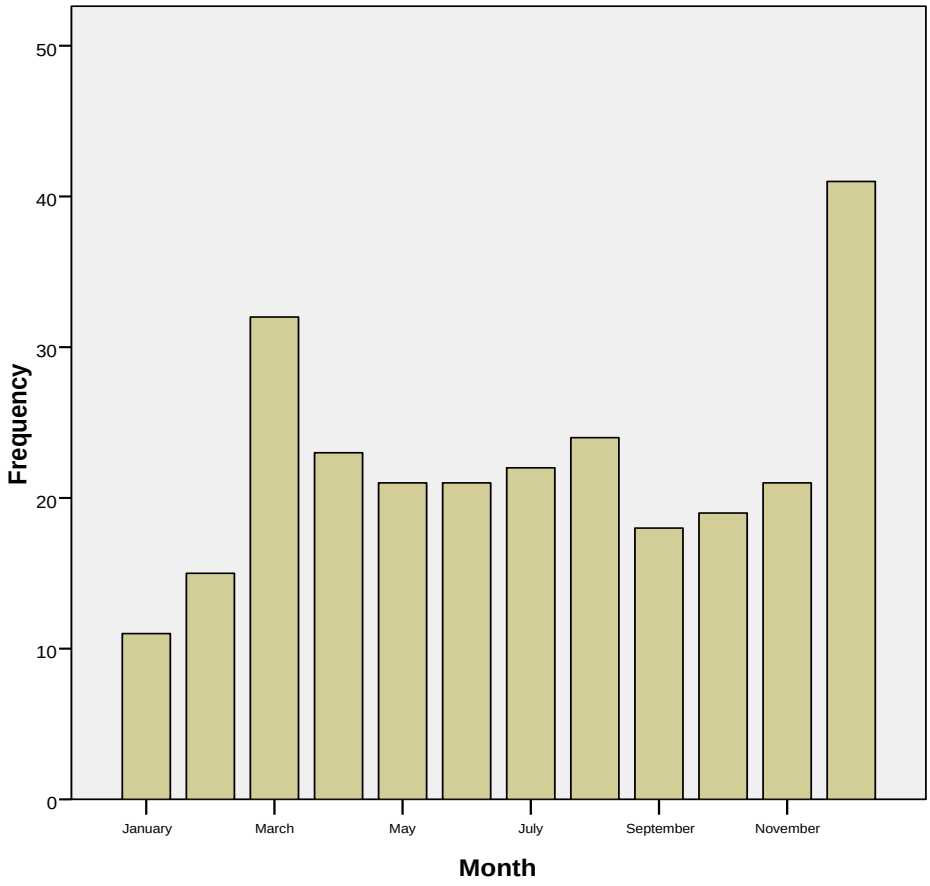

Figure1: Bar Chart of monthly Frequency of RTC in the Period 2006 – 2011

Fatality		Causes		Total
		Others	Driver	others
Not Fatal	Count	42	140	182
	% within Fatality	23.1%	76.9%	100.0%
Fatal	Count	14	72	86
	% within Fatality	16.3%	83.7%	100.0%
Total	Count	56	212	268
	% within Fatality	20.9%	79.1%	100.0%

Table 3: Fatality and Causes Cross-tabulation

A logistic regression model was fitted to the data using fatality as the dependent variable and causes and months as the independent variables. The result shows that both independent variables are not significant. The constant term is significant and gives the odds of fatality on the highway as 0.473 (Table 4).

	B	S.E.	Wald	df	Sig.	Exp(B)
Constant	-.750	.131	32.822	1	.000	.473

Table 4: Intercept only model

3,0 DISCUSSION OF RESULTS

Since the two independent variables are not significant we can say that neither causes nor months of the year can be used in predicting the odds of fatality on the highway based on the data available with the FRSC for this period. This is in line with earlier result that fatality on the highway is independent of causes and months of the year.

The intercept only model appears to be the best fit for the data. It gives odds of .473. The odds of fatality on the highway segment are rather too high. The probability of fatal accident was found to be 0.321. In other words, the chance of fatality on the highway is about 3 in 10 RTC.

4.0 CONCLUSSION

We have seen that months of the year and causes have no significant effect on fatality on the highway, but months do affect the occurrence of RTC. Drivers are mainly responsible for RTC on the highway and a focus on drivers' training and behavior on the highway might help to reduce the occurrence of RTC. Causes and months of the year are independent meaning drivers' behavior does not depend on the month of the year.

The binary logistic model of fatality on the highway segment turns out not to be a good fit using causes of accidents and months in which the accidents occur as independent variables. This means we cannot determine the odds of fatality from knowing the cause of an accident on the highway, or from knowing the month in which the accident occurs. However, what would have been of more interest to researchers is the evaluation of some of the safety measures employed by the FRSC to improve safety on the highway. Such measures include the use of seat belts, possession of safety items such as fire extinguishers, triangles etc. The FRSC does not provide

data on such things, making the evaluation of their safety measures impossible. For instance, data on whether the driver used safety belt or not could be a good fit for the model, and we could use the data to evaluate the effectiveness of the safety measures. If an accident was caused by obstruction, was there a triangle warning sign? Data on some of these measures will make it possible for researchers to draw good conclusions on the effectiveness of the commission's activities on the highway.

5.0 RECOMMENDATIONS

Good, correct and accurate statistics is essential for safety improvement on our roads. It is not possible to improve safety without improving the quality of data collected on the highways. This is because good data will point out the areas where attention should be focused for safety to improve. The FRSC in Nigeria is the main source of data on RTC in the country. The information contained in their data base is not sufficient to properly assess their performances on the highway. RTC is still a major concern in the country, many decades after the establishment of the commission. This may indicate that their effectiveness on the highway is doubtful. Some of the safety measures, such as seat belt, use of triangle, fire extinguisher etc, for which motorists are harassed on the highway can easily be assessed for effectiveness if data are available on them. The FRSC should therefore look into their data collection method and improve on it.

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