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Development of a Predictive Model for Road Traffic Accident Involvement in Southwest Nigeria: A Case Study of Ekiti, Osun, and Oyo State

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ABSTRACT: Road traffic accidents (RTAs) are critical global issue, resulting in over 1.3 million deaths annually, with the burden disproportionately affecting low and middle income countries like Nigeria. Thus, the objective of this paper is to develop a predictive model for Road Traffic Accident Involvement in Southwest Nigeria: A Case Study of Ekiti, Osun, and Oyo States using appropriate standard methods after collecting accident data from relevant agencies for a period of ten years (2014-2023). The results indicate a strong correlation between accident cases and the number of people involved, with fatal and minor accidents having the most significant effects. The model explains 75.5% of the variance in accident outcomes, offering insights into predictive trends that can inform road safety interventions. The study highlights the importance of data-driven approaches in mitigating RTAs and improving road safety management in the study region. Recommendations include stricter traffic law enforcement, enhanced road maintenance, and safety education initiatives to reduce the frequency and severity of accidents in the region.

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Road traffic accidents (RTAs) remain a significant global issue, contributing to over 1.3 million fatalities annually, with a notable concentration in low- and middle-income countries (World Health Organization, 2021). In Nigeria, RTAs are prevalent, particularly in the Southwest region, where road networks serve as critical arteries for economic activities. Despite various interventions, the incidence of accidents continues to rise, exacerbating road safety concerns and imposing socio-economic burdens on affected communities (Olugbemiro, 2019).Southwest Nigeria, comprising six states—Ekiti, Osun, Oyo, Lagos, Ogun, and Ondoare not exempt from this growing problem. The region has a history of high vehicular traffic, largely due to its position as a hub for commercial and social activities. Ekiti, Osun, and Oyo states, in particular, are pivotal in this study due to their geographical and socio-economic significance within the region. These states also serve as key transit points for inter-state trade and travel, further intensifying the volume of road traffic (Adefolalu *et al*2018).Given the alarming increase in road traffic accidents, this study seeks to explore the relationship between the accidents cases such as fatal, serious, or minor and the number of people involved in these incidents over a ten-year period (2014-2023). Using

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data sourced from the Federal Road Safety Commission (FRSC), the study employs multiple linear regression models to analyze the impact of various accident cases on the number of people affected. By developing and validating predictive models, this research aims to provide insights that can inform policy decisions and improve road safety management in the region.

According to the World Health Organization (WHO), over 1.3 million people die annually due to RTAs, with millions more suffering non-fatal injuries that often lead to long-term disabilities (WHO, 2021). While high-income countries have seen improvements in road safety due to better infrastructure and stricter enforcement of traffic regulations, low- and middle-income countries bear the brunt of the global road traffic burden, accounting for over 90% of all fatalities (WHO, 2018). The disparity is largely attributed to inadequate road infrastructure, poor vehicle standards, and ineffective traffic regulation enforcement. In the context of Africa, road traffic injuries are among the leading causes of death, particularly in sub-Saharan countries like Nigeria. Studies show that factors such as rapid urbanization, increased motorization, poor road maintenance, and a lack of effective safety measures contribute to the high incidence of road accidents in the region (Agbonkhese *et al.*, 2013; Odero, 2020). For instance, Odero (2020) points out that in many African countries, road safety policies are either non-existent or poorly implemented, leading to a significant rise in accidents as motorization increases.Nigeria has one of the highest road traffic accident rates in Africa, with over 30,000 deaths reported annually (Oluwasola *et al*., 2020). The Federal Road Safety Commission (FRSC) reports that major causes of RTAs in Nigeria include speeding, reckless driving, poor road conditions, and lack of vehicle maintenance (Oyeyemi and Ojedokun, 2020). According to Agbonkhese *et al*, (2013), speeding alone accounts for over 50% of road accidents in Nigeria, while other factors like dangerous overtaking and the use of unsafe vehicles further exacerbate the problem. Southwest Nigeria, which includes states like Ekiti, Osun, and Oyo, experiences a significant share of the country's RTAs due to its dense road networks and high traffic volumes. Adebayo and Oke (2017) noted that Southwest Nigeria's economic significance, coupled with rapid urbanization, and has increased the strain on its transportation infrastructure, leading to higher accident rates. The region's roads are often characterized by poor maintenance, inadequate signage, and dangerous driving practices, all of which contribute to frequent accidents (Adefolalu *et al* 2018). In addition, the socio-economic role of these states as hubs for trade and commerce means that the roads are heavily utilized, further increasing the likelihood of accidents. Several studies have identified key determinants of road traffic accidents, particularly in developing countries. These determinants can be broadly categorized into human, vehicular, and environmental factors. Human factors include behaviors such as speeding, alcohol consumption, and driver fatigue, which are widely recognized as major contributors to RTAs (Damsere-Derry, 2019). In Nigeria, human error is estimated to contribute to about 90% of all road accidents (FRSC, 2020).Vehicular factors include vehicle conditions such as brake failure, tire blowouts, and other mechanical issues that can lead to accidents. Poor vehicle maintenance, the use of old and unsafe vehicles, and overloading are common in Nigeria, further heightening the risk of accidents (Alhassan and Salifu, 2021). Environmental factors such as road conditions, weather, and visibility also play a significant role. Studies have shown that poor road infrastructure, such as potholes, lack of guardrails, and inadequate lighting, are major contributors to the high rates of road accidents in Nigeria (Adefolalu *et al*., 2018).In recent years, statistical models have been increasingly applied to analyze and predict road traffic accidents. Multiple linear regression (MLR) is a commonly used technique in road traffic accident analysis because it helps establish relationships between dependent variables (e.g., number of people involved in accidents) and independent variables (e.g., accident types like fatal, serious, and minor). Several studies have successfully applied MLR models to analyze traffic accidents, identifying key predictors and enabling targeted interventions (Ogunbanjo *et al*, 2019).For example, Ogunbanjo *et al*. (2019) utilized MLR models to predict accident severity based on factors such as road conditions, vehicle types, and driver behavior. Similarly, Alhassan and Salifu (2021) applied regression models to understand the relationship between road characteristics and accident rates, concluding that improving road quality could significantly reduce accident occurrences. These studies underscore the importance of data-driven approaches to road safety management and the utility of statistical models in formulating policies and interventions. Hence, the objective of this paper is to develop a predictive model for road traffic accident involvement in Southwest Nigeria: A Case Study of Ekiti, Osun, and Oyo States.

MATERIALS AND METHODS

Description of the study area: This study covers three selected state (Ekiti, Osun and Oyo state) in southwest Nigeria. Southwest Nigeria roughly falls within the latitudinal and longitudinal coordinates of 6°N to 9°N and 2°E to 6°E respectively. It stretches along the

Atlantic seaboard from the international border with the Benin Republic in the west to the South-South in the east with the North-Central to the north. The region also boasts of rich historical civilization some of which persists till today. For instance, the ancient cultures of the powerful Oyo and Ife empires have not faded despite Western influence in Nigeria. South-West Nigeria is a mostly Yoruba-speaking region in Nigeria. However, there are different language dialects, even in the same state. The region comprises six states which include Lagos, Ogun, Oyo, Osun, Ondo and Ekiti State.

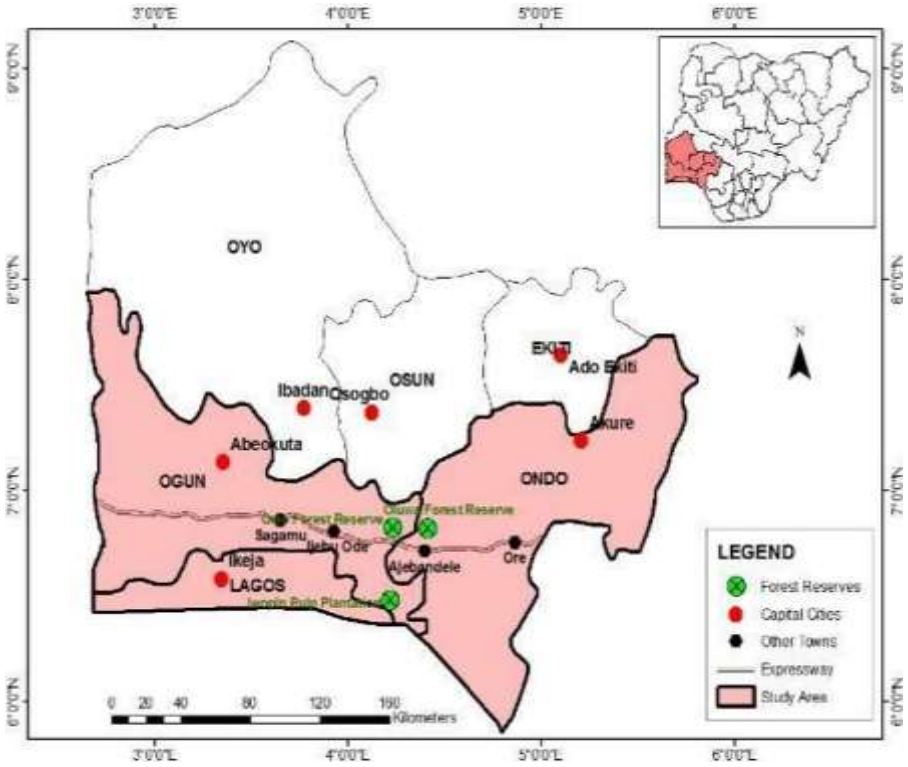

Fig.1: map of Nigeria showing the study location
Source: National Bureau of Statistics, 2022

Data collection and analysis: This study used secondary dataset comprises of accident records sourced from Federal Road Safety Commission for the period of ten years (2014-2023) to know the number of people involved in road accidents corresponding with accident cases (fatal, serious and minor) in each of the three selected state. Multiple Linear Regression was applied to the secondary data collected to know the relationship between the number of people involve in road accident and the accident cases (Minor, Fatal and Serious) and the data were used for model development, validation and performance evaluation.

Model development and Validation: This study considers the different cases of accident (Minor, Fatal and Serious) as the explanatory variables (Independent variables) to predict number of people involve in road traffic accidents (as a dependent variable). Also, the study performs the Residual Analysis where the modeled and estimated results were checked for normality, homoscedasticity, and multicollinearity. The multiple linear regression equation is shown in Equation 1.

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + ei \quad (1)$$

Where: Y= total number of people involve in road accident (dependent variable); X_1= fatal cases of road accident; X_2 = Serious cases for road accident; X_3 = minor cases of road accident; b_1 = the slope for the fatal cases; b_2 = the slope for the Serious cases; b_3 = the slope for the Minor cases; a = the intercept

RESULT AND DISCUSSION

Model validation and model fitting of road accident: Table 1 shows the total number of people involved in road accidents from 2014 to 2023, categorized by fatal, serious, and minor cases. Over the years, the total number of people involved increased, peaking in 2021 and 2022, before sharply declining in 2023. Fatalities remained relatively stable, while serious injuries steadily rose, peaking in 2022. Minor injuries saw

smaller fluctuations but increased in later years, also dropping in 2023. The decline in 2023 across all categories suggests possible improvements in road safety or other external factors contributing to fewer accidents and injuries.

Table 1: data presentation on the number of people involved in road accident and accident cases for the three selected State (Ekiti, Osun, and Oyo)

Year	Total Number Of People Involved In Accident	Fatal	Serious	Minor
2014	2989	185	191	13
2015	3218	165	200	14
2016	4142	157	238	24
2017	4017	149	241	22
2018	3787	159	250	13
2019	3907	138	275	26
2020	3957	172	318	63
2021	5442	194	304	75
2022	5481	167	436	78
2023	3047	131	369	52

Source: Federal Road Safety Corps, 2023

Fig.2 illustrates the total number of road accidents from 2014 to 2023, showing fluctuating trends. Accidents increased steadily from 2014, peaking in 2016, followed by a gradual decline until 2019. However, there was a sharp rise in 2021, with the highest number of accidents recorded in 2021 and 2022. Notably, 2023 saw a significant drop in accidents, falling to the lowest level since 2015. This sharp decline suggests improvements in road safety or other external factors influencing the reduction in incidents.

R is the strength of the correlation between the total number of people involved in road accident and the cases (Fatal, serious and minor) which indicate that there is a strong correlation/ association between the total number of people involved in road accident and the accident cases with 0.842. and the *R* Square explains how much of the variance in the dependent variable is explained by the independent variable in which the value *R* Square = 0.755 indicates that 75.5% of the variance in total number of people involve in road accident is explained by the cases (fatal, serious and minor) and the Adjusted *R* Square adjusts *R* Square on the basis of the sample size with the Adjusted *R* Square value 0.733 which is very similar to the *R* Square 0.755

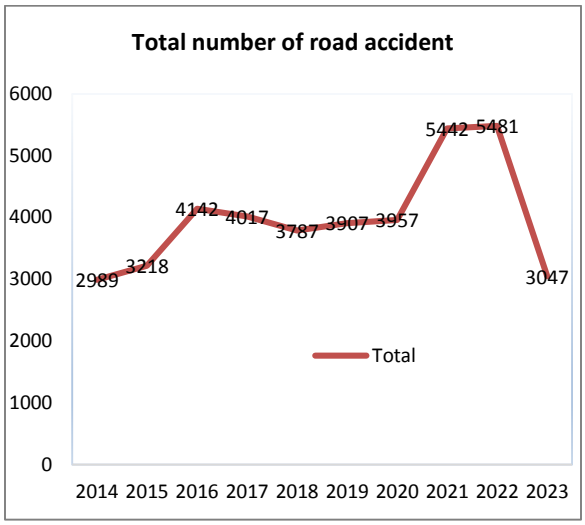

Fig. 2: trend of accident between 2014 to 2023
Source: Author computation 2024

From table 3, the Sig. Value in the anova determine whether our regression model predicts the dependent variable better than we would expect by chance. Our Sig. value of 0.0161 is less than 0 .05, indicating that our regression model is significant as well as showing a significant relationship between the total numbers of people involve in road accident and the cases of road accident.

Table 2: model validation

Model summary
R = 0.842
R squared = 0.755
Adjusted R squared = 0.733
Standard Error = 718.1322

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Table 3: ANOVA model fitting

Model		Sum of Squares	Df	Mean Square	F
Regression	3796564.302	3	1265521.434	2.454	0.0161
Residual	3094317.798		515719.633		
Total	6890882.100	9			

Table 4: coefficient estimation

	Estimate	Std. Error	t value	Pr(>|t|)
(Intercept)	350.893	4582.247	0.077	0.041
Fatal	14.319	19.835	0.722	0.038
Serious	2.889	9.435	0.306	0.017
Minor	13.611	28.087	0.485	0.0455

The Coefficients table gives the value for the regression equation $\hat{Y} = a + b_1X_1 + b_2X_2 + b_3X_3$ which can be used to predict dependent variable (Total number of people involve in road accident) from our independent variable (Cases of road accident).

Total number of people involve in RTAs =350.893 + 14.319 Fatal + 2.889 Serious + 13.611 Minor

The model above indicates that as one unit increment in the cases of fatal accident there will be an increment in the total number of people involve in road accident with 14.319 while the serious cases and minor cases are held constant also as the number of serious cases increase by one unit there will be an increment in the number of road accident by 2.889 while holding fatal and minor cases constant as well as the minor cases increases by one unit there will be an increment in the number of road accident by 13.611 while holding serious and fatal cases constant

Multicollinearity: The collinearity statistics with the VIF <10 and the Tolerance > 0.1 as shown in table 5 shows that there is no present of multicollinearity between the cases of road accident

Table 5: collinearity Statistics

	Tolerance	VIF
Fatal	0.383	2.614
Serious	0.205	8.106
Minor	0.210	8.002

Normality test: The Normal P-P Plot and the histogram of standardized residual for the dependent variable (total number of people involved in road accident) as in Fig. 3 and 4shows that the normality assumptions test was met.

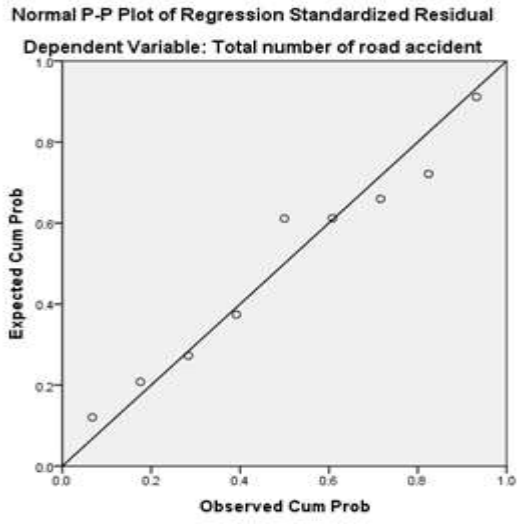

Fig. 3: normal P-P Plot

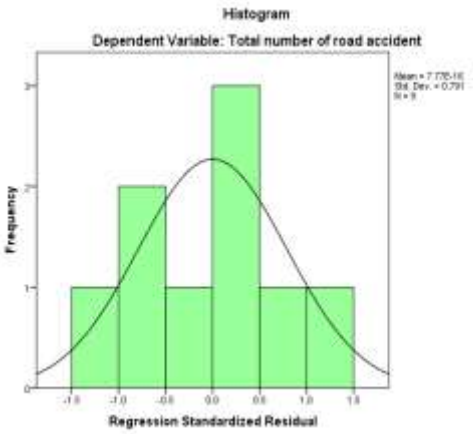

Fig. 4: histogram of standardized residual.

Homoscedasticity: The assumption of homoscedasticity using the scatter plot of standardized residuals versus standardized predicted values with the absence of any pattern as shown in Fig. 5 shows that the data set satisfies the homoscedasticity assumption.

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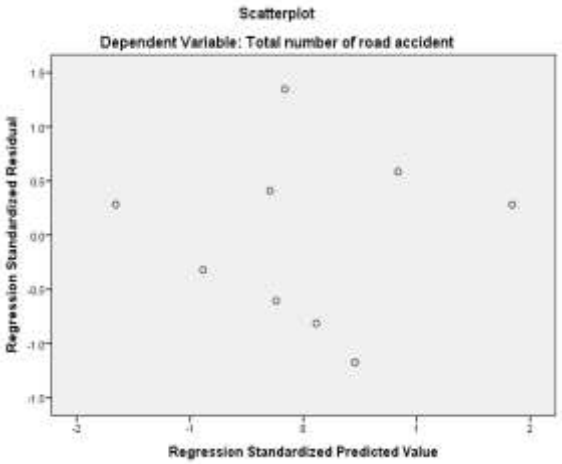

Fig. 5. Scatter plot of standardized residuals.

Conclusion: This study successfully developed a predictive model for estimating the number of people involved in road traffic accidents in the study region. The findings highlight the urgent need for targeted interventions to reduce the frequency of road traffic accidents in the region. It is recommended that policymakers implement measures such as stricter enforcement of traffic laws, enhanced road maintenance and public awareness campaigns that promote safe driving practices. The model developed can inform future road safety initiatives, ultimately aiming to reduce road traffic accidents (RTAs) and improve the overall safety of Nigeria's road networks.

Declaration of Conflict of Interest: The authors declare no conflict of interest.

Data Availability Statement: Data are available upon request from any of the authors.

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