

ROAD ENVIRONMENT AS PREDICTOR OF ROAD TRAFFIC ACCIDENTS INVOLVING HEAVY-DUTY AUTOMOBILES IN NORTHEAST NIGERIA

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Abstract

This study examined road environment as a predictor of road traffic accidents involving heavy-duty automobiles in northeast Nigeria. Survey research was adopted for the study through a structured questionnaire. 235 FRSC, Traffic Police, VIOs and Drivers were sampled for the study. Regression analysis was used to test the hypothesis with the help of SPSS v.25 software. The results indicated that road signs system, natural road environment, and road conditions significantly influence road traffic accidents involving heavy-duty automobiles in Northeast Nigeria. Consequently, it was recommended that the Federal Government should provide an adequate and functional road signs system on Northeast Nigeria highways.

Keywords: Road Environment, Traffic Accidents, Heavy-Duty Automobiles

INTRODUCTION

Northeast Nigeria is a vast and extensive region which extends from Lake Chad in the Northeast corner to beyond Toro near Jos in the south-west corner, and from Jama`re bordering Kano in the north-west corner to Wukari in the south-east (Iweze, 2020). The region is blessed with fertile land and inhabited by people of different ethnic groups and shares common international boundaries with Niger to the west and north, Republic of Chad to the Northeast and Cameroon to the south-east. The people in the region share almost similar socioeconomic, cultural, linguistic empathies with nationals of the neighboring countries dating back to the pre-colonial era. Notwithstanding, due to mutual cooperation that still exists among the border communities, people travel across all parts of the region for business and other things. Commodities movements to Northeast Nigeria from the sea-ports in southern Nigeria are mostly handled by road transport (Abbas et al, 2019). Abbas et al. further maintained that up to 90% of all other inter-states movements of goods (predominantly farm produce) take place by roads with the help of heavy-duty automobiles (loosely called trailers). Also, there is abundant use of construction vehicles (tippers and related vehicles) for construction purposes, these make the roads in the region congested with traffic and consequently cause Road Traffic Accidents (RTAs) involving Heavy-duty automobiles.

Heavy-duty automobiles are primarily used for long-haul transportation and for carrying heavy loads. They are categorized into class 4, 5 and 6 according to their Gross Vehicle Weight Ratings for trucks (GVWR) (Soard, 2017 and Murray, 2020). It was found that their large size and weight represents a great danger to other vehicles and their passengers, and results in the complexity of any road accident involving them (Fathalla et al, 2017). On the other hand, Northeast Nigeria is blessed with abundant of this kind of vehicles, especially in Bauchi, Gombe and Yobe states. Despite meaningful number of vehicles plying the highways in the region, it was reported that majority of the roads were constructed around 1990s with a larger proportion of them currently deteriorated because of poor maintenance and overstretched use due to traffic congestion (Adeniran et al, 2016; Oroleye, 2019). These make the entire roads' environment uncomfortable yet risky for motorists.

Road environment is viewed as an inventory of aspects that are relevant for the safety of road users with attention to road signs system, road design, natural road

environment (comprising of weather and other natural phenomenon), and overall road condition (European Road Safety Observatory (ERSO, 2020). International Road Federation (IRF, 2021) further detailed that road environment can include road condition, road sign, road marking, nature-strip, zebra pedestrian crossing, pedestrian crossing with lights, children's crossing, traffic lights, and railway crossing. Unconducive road environment was found to have various negative effects on vehicles especially heavy-duty automobiles (Lankarani et al., 2014). The major effect being fatal RTAs which have become a menace in Northeast Nigeria.

Onokala (2015) viewed RTA as an unexpected and unpleasant event that causes loss or injuries to passengers, vehicles and other mobile or immobile facilities along a road. RTAs have serious implications for the lives of those involved as well as financial costs, and also involve the risks of death. Onokala further averred that RTAs may be classified as minor when the injuries are minor, serious when the injuries caused involve hospitalization, and fatal when death is involved. World Health Organization (WHO, 2019) and United Nations (UN, 2018) labelled RTA as a major cause of death and disability in both developed and developing countries of the world.

Statement of the Problem

Carnage arising from RTAs feature prominently in the causative index of risks on road transport in Northeast Nigeria. Hardly any day passes without news or stories of road mishaps on the major highways in the region. The human wrecks that are found in the hospitals as well as horrifying road crash data from the Nigeria Police and the Federal Road Safety Corps (FRSC) are clear evidences (Iweze, 2020). Onyemaechi et al (2016) reported that every year over 39,000 Nigerians die from road traffic accidents. Also, in 2018 Global Status Report on Road Safety, the World Health Organization (WHO) estimated road traffic fatalities in Nigeria at 39,802, while the estimated rate per 100,000 deaths stood at 21.4 (Faajir et al, 2016; W.H.O., 2019). The report linked significant percentage of RTAs involving heavy duty automobiles to Bauchi, Borno and Yobe states of Northeast Nigeria. Studies have indicated that major causes of RTAs are human factor, vehicle factor and road environment (Saxena, 2017; Topolšek et al 2019; Riaz et al 2018; Hu et al., 2020; Ullah et al, 2021). It is based on this, that the researchers determined the road environment as predictor of road traffic accidents involving heavy-duty automobiles in Northeast Nigeria.

Purpose of the Study

The purpose of the study is to examine road environment as predictor of road traffic accidents involving heavy-duty automobiles in Northeast Nigeria. To ascertain the relationship between the two antecedents.

Hypothesis

This null hypothesis tested at 0.05 guided the study;

Ho: Road environment does not significantly predict road traffic accidents involving heavy-duty automobiles in Northeast Nigeria.

Literature Review

Road signs system (Highway Code)

According to Makinde and Opeyemi in Ezeifeke and Ogbogu (2021) the road signs systems convey messages in words or symbols and are erected to regulate, warn, or guide motorists, pedestrians and other road users. Ferko, Stažnik, Modrić and Dijanić (2019) added that road signs system help regulate the traffic flow, provide significant information for visual traffic control and alert drivers on potential and extraordinary dangerous road conditions, which is especially important during night and in low visibility conditions. It is important and mandatory to install road traffic signage along the road section (Saad, Adnan & Sulaiman, 2021). The installed road signage will attract and alert road users to be more careful when driving. However, despite the road signs that are visible on the roads, accidents still occur due to violation of the traffic rules as represented by the signs. This incessant road mishap calls for serious questions on the effectiveness of the road signs as a means of information dissemination to the road users.

Numerous studies have indicated significant relationship between that road sign system and RTAs. For instance, The United Kingdom's Traffic Safety Foundation in Ferko et al. (2019) reported that traffic signs are factors contributing to increased safety on seven out of ten analyzed roads, leading to an 87% reduction in the overall number of the injured. In another development, Riaz and Shahid (2018) stated that well and timely recognized traffic signs in reduced visibility conditions (night, dusk, twilight) can warn drivers about the upcoming danger, to prevent the occurrence of traffic accidents and to increase the safety. More so, Lankarani et al. (2014) posited that traffic signals and signs are

universally accepted interventions which are effective in reducing RTAs related injuries and deaths. According to them, the crashes occurring in highway resulted from the lack of appropriate road repair and installing suitable traffic signs system. Lastly, Ezeibe et al. (2019) reported that the deficit of traffic signs in strategic and numerous accident black spots on the highways is the major cause of road accidents in Nigeria.

Natural road environment

In the field of road traffic accidents, natural road environmental factors involve light in the scene of crash (i.e., daytime, night time, sunrise and sunset), weather conditions such as clear, foggy, snowy, rainy, stormy, cloudy, and dusty, place of crash are all included (Pisano, Goodwin & Rossetti n.d; Lankarani et al., 2014; Bijleveld & Churchill, 2019). Also, roadway surface (like; dry, wet, freezing and snowy, sandy, muddy, and oily) are other factors of importance (Lankarani et al., 2014). Growing body of studies have reviewed the relationship between natural road environmental factors and the RTAs.

Peter, et al. (2017) reported that road design that is, road geometry and conditions, greatly have significant influence or impact on incidences of road accidents, frequencies and severity whose magnitudes are evidently aggravated by intervening variables such as topography, wet weather, traffic volume and speeding on highway. Likewise, Islam, Alharthi and Alam (2019) stressed that climate change, especially hazardous weather (e.g., wind speed, precipitation, rain, snow, temperature, fog, etc.) can increase the number of road accidents. Also, Jaroszweski and McNamara (2014) and Lankarani et al (2014) in their separate studies, reported positive linear relationship between rainfall amount, wet pavement and the number of road accidents. In the same vein, Islam, et al (2019) confirmed that rain increased accidents significantly due to loss of vehicle control and lower visibility. Lastly, Zou, Zhang and Cheng (2021) confirmed that rate of RTAs in rainy days is significantly higher than that in sunny days and can also increase the rate of mishap casualties.

Road condition

Ahmed (2013) and Peter, Mang'uriu and Diang'a (2017) revealed that road condition has an effect on crash risk because it determines how road users perceive and interact with the road environment. In this sense, the roadway provides instructions to the road users on what they should be doing. Peter, et al. (2017) reported that only 17% of road accidents are contributed by human and road environment while 83% is contributed

by road condition (road design, general nature of the road and maintenance standards). These findings, pointed out that road condition being a probable essential variable accountable for high incidences of road crashes and carnage along black spots on the highways.

According to Peter et al. (2017), road condition has number of variables that affect both the traffic speed, flow and road safety of motorway or highway. These variables include carriage width in meters, curvatures whether horizontal, transition or vertical measured in degrees, shoulder width and type, road margin or road side features and border lines. Also, Ahmed (2013) averred road condition variables influence road traffic accidents. Likewise, Oroleye (2019) and Jamal et al. (2019) in their separate studies confirmed that road condition variables have significant influence on road traffic accidents.

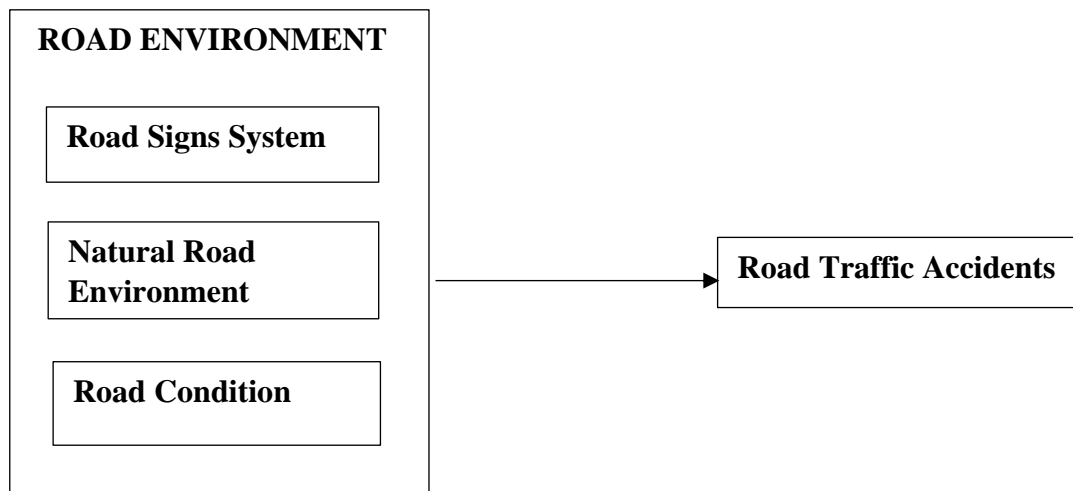


Figure 1: Model of the Study

METHODS

This study used a survey research design to ascertain if road environmental condition can be used as predictor of road traffic accidents involving heavy-duty automobiles in Northeast Nigeria. The design is considered suitable because the authors collected information from respondents which described and explained their attitude, knowledge and behavior about RTAs in Northeast Nigeria. This study collected and analysed quantitative data from FRSC personnel, VIOs, Traffic Police and Drivers. Hence, a survey method was considered appropriate for this study.

The population of the study comprised of 639 Federal Road Safety Corps (FRSC) personnel, 82 Traffic Police, 262 Vehicle Inspection Officers (VIOs) and 1662 drivers (those registered with National Union of Road Transport Workers, NURTW and Petroleum Tanker Drivers, PTD only) in Northeast Nigeria, making a total of two thousand six hundred and forty five (2645). The researchers adopted stratified and proportionate sampling for this study. The sample size for this study was 235. This sample size was drawn from the population based on the table established by Adam (2020). According to the table, population of 2645 should have sample size of 235 at 95% level of confidence. Then, using proportionate allocation, the sample sizes for different strata were: FRSC (57), Traffic Police (7), VIOs (23) and Drivers (148) which is in proportion to the sizes of the strata viz., 639: 82: 262: 1,662 respectively.

The study adapted instrument from the existing studies related to this study, this was done because Sekaran and Bougie (2016) recommended that a researcher can adopt or adapt measurement from the existing studies relevant to the current research. The instrument, comprising three constructs adapted from prior studies, was used in this study. The three constructs have 23 items as adapted from previous studies. In this study, the Likert scale was adopted for all the items, and respondents were asked to indicate their responses to each item on a five-point scale. This is because Dawes (2008) states that a five or seven-point scale is likely to produce better results.

The content validity of the instrument for this study was carried out. To ascertain this, the researchers gave the copies of the questionnaire to four experts in the field of research in four tertiary institutions in Northeast Nigeria that are offering automobile technology education. This is in line with the suggestion of Kothari (2004) that content validity of the instrument is established by experts' judgment. The suggestions of the experts which include: adjustments in the introductory aspect, amendments of some items of measurements were taken into account and improved the measurement instrument for final use.

In order to ascertain the reliability of the instrument of this study, a trial test was conducted in North-west Nigeria which is not part of the study area. The data generated from the pilot survey was subjected to statistics analysis using Cronbach Alpha. The Cronbach alpha coefficient of 0.77 was obtained. This result suggested that the instrument

is reliable based on the recommendation given by Hair et al. (2017). According to Hair et al. Cronbach alpha coefficient of at least .70 is considered satisfactory and acceptable.

Inferential statistical tool of multiple regression was used to test the hypothesis of the study using SPSS version 25. A multiple regression is a statistical tool for ascertaining the influence of multiple independent variables on a single continuous dependent variable (Tabachnick & Fidell, 2013). A null hypothesis with a p -value of less than 0.05 was considered rejected while a null hypothesis with a p -value of 0.05 and above 0.05 was accepted.

RESULTS

Ho: Road environment does not significantly predict road traffic accidents involving heavy-duty automobiles in Northeast Nigeria. The data that was used in testing this hypothesis was analysed and presented in Table 1.

Table 1. Model Summary of Regression Analysis between Road Environment and Road Traffic Accidents Involving Heavy-Duty Automobiles

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.972 ^a	.877	.855	.38202

a. Predictors: (Constant), Road environment

The regression analysis in Table 1 indicates a strong relationship ($R = .972$) between road environment and road traffic accidents involving heavy-duty automobiles in Northeast Nigeria. The model explains a significant portion of the variance in accidents (R Square = .877), suggesting that road environment is a substantial predictor. The adjusted R Square (.855) accounts for potential overfitting, and the standard error of the estimate (.38202) represents the accuracy of predictions made by the model. These findings contradict the null hypothesis, indicating that the road environment significantly predicts heavy-duty automobile accidents in the region. 1b shows the significance of the regression model

Table 2. Summary of Regression Analysis between Road Environment and Road Traffic Accidents Involving Heavy-Duty Automobiles

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	3.936	1	3.936	66.973	.000 ^b
	Residual	10.799	74	.146		
	Total	14.736	75			

a. *Dependent Variable: Road Traffic Accidents*

b. *Predictors: (Constant), Road environment*

Table 2 regression analysis indicates a significant relationship between road environment and road traffic accidents involving heavy-duty automobiles. The regression model explains a substantial portion of the variance in accidents ($R^2 = 0.267$), with a highly significant F-statistic ($F = 66.973$, $p < 0.001$). This suggests that variations in the road environment significantly predict the occurrence of accidents involving heavy-duty vehicles, highlighting the importance of considering road conditions in accident prevention strategies.

Table 3. Summary of Regression Analysis between Road Environment and Road Traffic Accidents Involving Heavy-Duty Automobiles

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	.103	.763		.204	.000
	Road Traffic Accidents	.924	.178	.725	7.194	.000

a. *Dependent Variable: Road environment*

Table 3 regression analysis indicates a significant relationship between road traffic accidents involving heavy-duty automobiles and the road environment. The coefficient for road traffic accidents (.924) suggests that for every unit increase in road traffic accidents, there is a corresponding increase of .924 units in the road environment, with a standardized coefficient of .725. This relationship is statistically significant ($t = 7.194$, $p < .001$), implying that changes in road traffic accidents have a substantial impact on the road environment.

DISCUSSION

The finding of this study is in line with that of Riaz and Shahid (2018) who found that road traffic signs in reduced visibility conditions (like: night, dusk, twilight) can warn drivers about the upcoming danger and can also prevent the occurrence of traffic accidents. Also, the finding is in tandem with that of Lankarani et al. (2014) and Ezeibe et al. (2019) who in their separate studies reported that absence of traffic signs system in strategic and numerous accident black spots on the highways is the major cause of road accidents.

Also, the finding coincides with that of Peter, et al. (2017) who reported that natural road environment (i.e., weather related factors) has significant influence on incidences of road accidents. The finding, is in agreement with that of Islam, Alharthi and Alam (2019), Jaroszweski and McNamara (2014) and Lankarani et al (2014) in their separate studies, which reported positive linear relationship between rainfall amount, wet pavement and the number of road accidents. In the same vein, Islam, et al (2019) and Zou, Zhang and Cheng (2021) reported similar finding with this study, that rate of RTAs in rainy days is significantly higher than that in sunny days and can also increase the rate of mishap casualties.

Lastly, the finding of this study is in agreement with that of Ahmed (2013) and Peter, Mang'uriu and Diang'a (2017) who revealed that road condition has an effect on crash risk. Also, the finding is in line with that of Ahmed (2013) averred road condition variables influence road traffic accidents. Likewise, Oroleye (2019) and Jamal et al. (2019) who found in their separate studies that road condition variables have significant influence on road traffic accidents.

Conclusion

Despite significant efforts by FRSC personnel and other stakeholders in road administration, still RTAs persist in Nigeria. Findings from this study indicated that all the three parameters of road environment significantly influence RTAs involving heavy-duty automobiles. On the other hand, there is abundance of these kinds of vehicles in Northeast Nigeria. Therefore, all hands must be on deck to reduce the rate at which RTAs involving heavy-duty automobiles occurs.

Recommendations

Based on the findings of the study, the following recommendations were proffered:

1. In a matter of urgency, the Federal Government of Nigeria through Federal Ministry of Works should provide adequate and functional highway codes and road markings on highways in Northeast Nigeria. Furthermore, Road Safety Education should be fully integrated into schools' curriculum in order to educate potential road users on rudiments of Highway Code and driving safety.
2. FRSC should collaborate with NURTW and PTD in order to educate drivers on dangers of driving during adverse weather conditions.
3. The Federal Government of Nigeria through Federal Ministry of Works should quickly repair all accident prone areas and killer black spots on highways in order to reduce the rate of RTAs in Northeast Nigeria.

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