

ORIGINAL RESEARCH

Road Traffic Accidents along Kaduna-Zaria Highway, Kaduna State, Nigeria

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ABSTRACT

Kaduna-Zaria Highway is one of the roads in Nigeria with high accident incidents. The road is approximately 80 km starting from Queen Amina Fly over Bridge Kawo, Kaduna to Dogarawa, Zaria. This study assessed the causes of accidents on the road with a view to leveraging Artificial Intelligence Technology to combat or reduce it. Data was collected from Federal Road Safety Corps Commands, (Kaduna, Birnin Yero and Zaria) and substantiated by 357 respondents randomly selected at accident hotspots. Questionnaire was used to get responses from road users and fifteen (15) factors listed as the causes of road traffic accidents on the road were identified as obtained from the FRSC. Among the 15 factors identified, three which are: speed violation with 0.943038 relative importance index, reckless and dangerous driving with 0.898734 and dangerous overtaking with 0.89557 were found to be the leading causes. To curb road traffic accident on this important road that link not only the two towns, but also Kano, Katsina, Sokoto, Zamfara and Kebbi States, it was recommended that Artificial Intelligence should be deployed in road traffic management in the study area.

Keywords: AI, Hotspot, Highway, Road Traffic Accidents

Introduction

Road transportation is the movement of people and goods by road using vehicles such as cars, buses, trucks, tricycles and or motorcycles. It is a vital component of transportation infrastructure and plays a crucial role in the economic and social development of a region (World Bank, 2020). One of the negatives associated with road transportation is road traffic accident.

Road Traffic Accidents (RTAs) on the other hand, are a major public health concern globally, resulting in significant loss of life, injury and economic burden (World Health Organization, 2018). In Nigeria, the Kaduna-Zaria highway is notorious for its high incidence of RTAs,

accounting for a significant proportion of road traffic crashes in the country (Federal Road Safety Corps, 2020). The road is a major transportation hub connecting not only the two towns, but also people going to Kano, Katsina, Jigawa, Zamfara, Sokoto and Kebbi States. However, it has a high rate of RTAs due to factors such as speeding, reckless driving, and inadequate traffic management (Li, et al, 2020). The highway's design and infrastructure also contribute to the high incidence of RTAs with inadequate lighting, lack of pedestrian crossings and poor visibility, Zhang, 2019).

To stabilize and reduce to about 50% the forecasted level of road traffic fatalities around the world by the year 2030 is the overall goal of the decade (UN, 2020). Road traffic accidents is an issue of great concern and is estimated to be one of the greatest single causes of human death which in turn is having a bad effect on our society and economy today. Among all forms of accidents, the road traffic accident claim human lives the most and tend to be the most serious problem worldwide, human lives are lost on a daily basis by this phenomenon, it has been estimated that about 1.35 million people are killed by road traffic accidents yearly worldwide, while the number of persons injured could be as high as 50 million (Kuo et al., 2016).

Despite the above-mentioned problems, road transportation is an important component of the economy of every nation impacting on the development and welfare of the people; this is because transportation provides information, raw materials, finished goods and services to the general public. Road transportation is important to nations and individuals by facilitating the movement of goods, services and people, thereby enabling access to information, jobs, market, education, health, and recreational facilities, which in turn have direct and indirect positive impact on the health and wellbeing of the populace (Rodrigue, 2020).

To get the maximum benefits of road transportation, effective management of road traffic is necessary and one of the ways to do this is through the Artificial Intelligence (AI). This is what this study intends to achieve.

Methods and Materials

Study Area

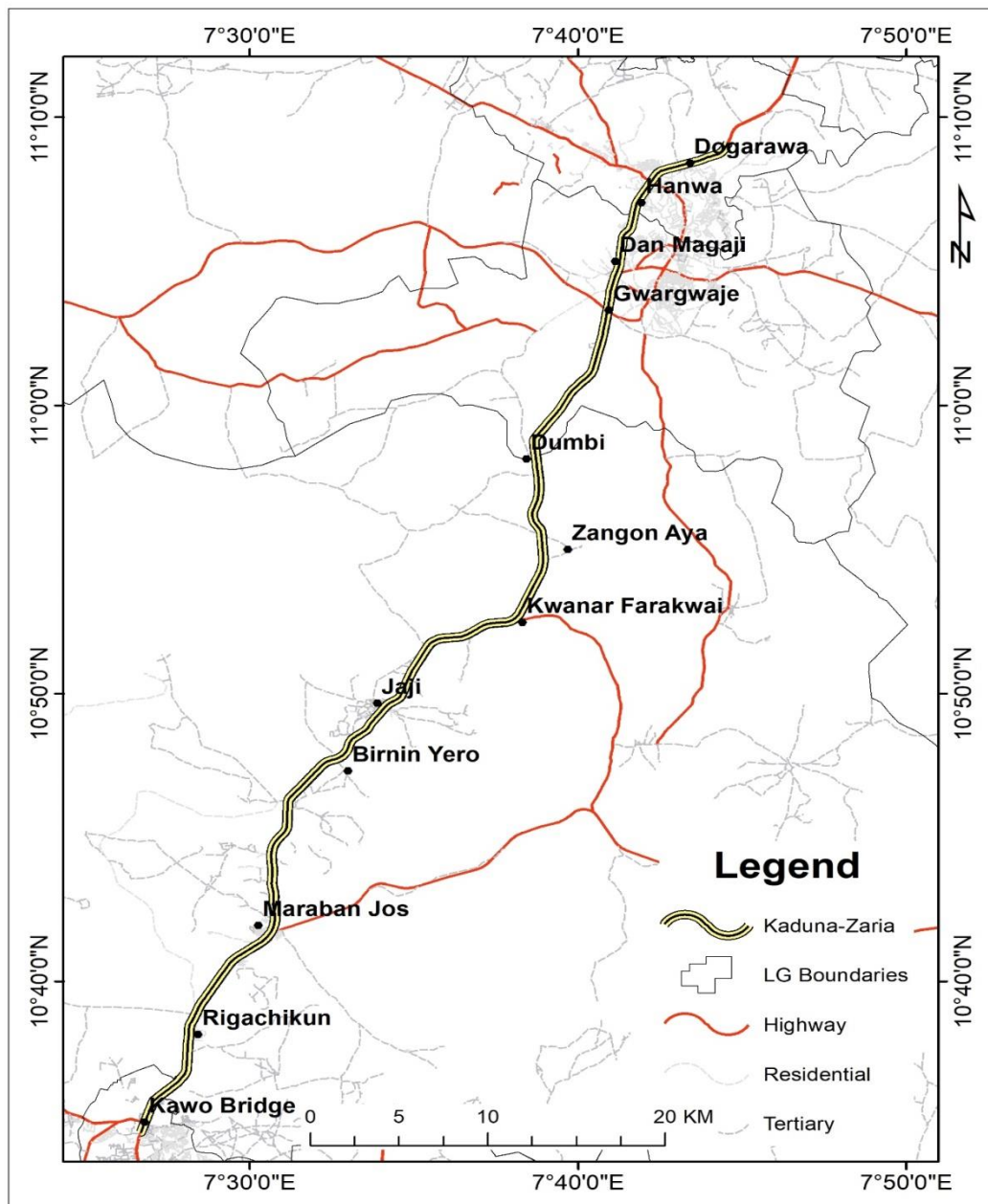


Figure 1: Zaria – Kaduna Expressway

Source: Modified from GRID Nigeria (2023)

The study area lies between Latitude $10^{\circ} 40' N - 11^{\circ} 10' N$ of the Equator and Longitude $07^{\circ} 20' E - 07^{\circ} 50' E$, of the Greenwich Meridian, that is from Queen Amina Flyover Kawo, Kaduna to Dogarawa, Zaria. The study route is about 80 kilometers long, it is a federal road located in the State. With the recent reconstruction, the Kaduna – Zaria Expressway is four lane two ways divided road that runs from Abuja – Kaduna – Zaria – Kano. The study area passes through some settlements such as: Dogarawa, Hanwa, DanMagaji, Gwargwaje, Dumbi, Kwanar-Farakwai, Zangon–Aya, Jaji, Birnin Yero, Maraban Jos, Rigachikun and Kawo (Abah, 2024). Figure 1.

Reconnaissance Survey

A reconnaissance survey was carried out for the purpose of getting the researchers' acquainted with the study area, about 80 km of road from Kaduna–Zaria was visited, FRSC offices controlling Zaria–Kaduna highway which is Kaduna, Birnin–Yero Unit and Zaria Commands were contacted to enable the researchers' access to the road.

Types of Data Required

The data that was used for this study include:

- i. Coordinate of the accident's hotspot locations.
- ii. Ten years (2014 – 2023) accidents record from FRSC

Causes of accidents

Location of accidents

Sources of Data

i. GPS which was taken to the field to collect the coordinates of the hotspots

ii. FRSC Office Kaduna and Birnin-Yero Commands

iii. Questionnaire

Questionnaire was administered to the residents and traders along the five hotspots as received from the FRSC which are: Rigachikun, Maraban Jos, Birnin-Yero, Jaji and Kwanar-Farakwai to validate the FRSC or invalidate the causes and the responses accordingly.

Sampling Size and Sampling Technique

Simple random sampling technique was used to administer the copies of questionnaire in the five hotspots established by FRSC in the study area, using Krejcie and Morgan (1970) Sampling Table (1970). A total of 357 questionnaires were administered to the five hotspots which has a total projected population of 994,035 (Kaduna Bureau of Statistics, 2023 projected).

Method of Data Analysis

The analysis of causes of road traffic accidents on Kaduna – Zaria Highway was done using the Relative Importance Index (RII), with data obtained from FRSC and questionnaire. The stored data was used to create a database, summarized and descriptively explained through a table.

$$RII = \frac{\sum W}{A * N}$$

Where:

RII: Relative Importance Index

W: Weighting given to each factor by the respondents

A: The highest weight in the research

N: Total number of respondents

Results

Table 1: Causes of Road Traffic Accidents

S/N	Causes	SA	A	D	SD	Total Respondents	Weighted total	RII
1	Speed Violation	284	63	5	5	356	1341	0.943038
2	Loss of Control	135	198	14	9	356	1179	0.731013
3	Mechanical deficient car	18	261	68	9	356	1008	0.708861
4	Reckless/Dangerous driving	234	99	23	0	356	1278	0.898734
5	Sign light violation	72	225	50	9	356	1080	0.759494
6	Wrongful overtaking	234	77	32	14	356	1255.5	0.882911
7	Overloading	221	77	27	32	356	1228.5	0.863924
8	Tyre burst	167	158	14	18	356	1201.5	0.844937
9	Brake failure	189	140	23	5	356	1228.5	0.863924
10	Bad road	117	162	14	63	356	1107	0.778481
11	Dangerous overtaking	239	86	14	18	356	1273.5	0.89557
12	Sleeping on steering	225	99	18	14	356	1260	0.886076
13	Fatigue	63	158	14	122	356	994.5	0.699367
14	Bad weather	41	212	23	81	356	1003.5	0.705696
15	Use of phone while driving	189	153	0	14	356	1242	0.873418

Source: Authors' Analysis (2024)

LEGEND SA= Strongly Agree, A= Agree, D= Disagree, SD= Strongly Disagree

Table 2: Leading Factors Causing Accidents in the Five Hotspots

S/N	Spot	Factor(s)
1	Rigachikun	Speed violation and Wrongful overtaking
2	Maraban Jos	Reckless/Dangerous driving
3	Birnin-Yero	Speed Violation

4	Jaji	Dangerous overtaking and Bad road
5	Kwanar-Farakwai	Reckless/Dangerous driving

Source: Field Survey, 2024

Discussion

In an attempt to identify the leading factors that cause road traffic accidents in the study area, data from FRSC from the year 2014 – 2023 was collected and analyzed. The variables as listed in Table 1 are: speed violation, loss of control, mechanical deficient car, dangerous driving, sign light violation, reckless driving, wrongful overtaking, overloading, tyre burst, brake failure, bad road, dangerous overtaking, sleeping on steering, fatigue, bad weather and the use of cell phone while driving were identified.

The data (results) revealed that respondents strongly agreed that speed violation with 0.943038 relative importance index is the leading cause of RTAs followed by reckless and dangerous driving at 0.898734 and then dangerous overtaking at 0.89557. At the bottom, fatigue at 0.699367 was the last factor causing accidents according to the respondents closely followed by bad weather at 0.705696 and then mechanical deficient car at 0.708861 relative importance index. These findings are supported by the findings of Afolabi and Gbadamosi, (2017) in their study of road crashes in Nigeria, where the study revealed that deficient vehicles, unserviceable car or a poor maintained automobile leads to loss of control of vehicles by the driver.

These findings are consistent with existing literature on road safety. Speeding is a well-documented risk factor for road traffic accidents. According to the World Health Organization (WHO), excessive speed is a primary contributory factor in approximately 30% of all fatal road crashes globally (WHO, 2018). Similarly, reckless and dangerous driving behaviors, such as

tailgating, weaving in and out of lanes, and ignoring traffic signals, significantly increase the risk of accidents (Elvik et al., 2009).

Dangerous overtaking is another critical factor contributing to road traffic accidents. A study published in the *Journal of Safety Research* found that overtaking maneuvers are a common precursor to accidents, particularly on highways (Clarke et al., 2002). The high RII values for these three factors suggest that they are the most critical contributors to road traffic accidents in Kaduna-Zaria Highway.

On the other hand, while fatigue, bad weather and mechanical deficient vehicles are among the important contributors of road traffic accidents in the study area, they appear to be less significant than the top three causes in your study. However, it is essential to note that fatigue, bad weather, and mechanical defects can still have a substantial impact on road safety. For example, a study published in the *Journal of Accident Analysis and Prevention* found that driver fatigue is a significant contributor to accidents, particularly on long-distance trips (Connor et al., 2002). Similarly, bad weather conditions, such as rain or fog, can reduce visibility and increase stopping distances, making it more challenging to avoid accidents (Andrey et al., 2003).

Mechanical defects, such as faulty brakes or tires, can also contribute to accidents. A study published in the *Journal of Transportation Engineering* found that vehicle defects are a common cause of accidents, particularly among older vehicles (Zhang et al., 2013).

From Table 2, the analysis of secondary data from the Federal Road Safety Corps (FRSC) Kaduna Command highlights significant differences in the causes of road traffic accidents across the selected five settlements—Rigachikun, Maraban Jos, Birnin Yero, Jaji, and Kwanar Farakwai identified as accident hotspots along the Kaduna-Zaria highway. Among the 15

recorded causes of accidents (Table 1), speed violation, wrongful or dangerous overtaking, reckless driving, and bad road conditions emerged as the most prevalent factors.

At Rigachikun, speed violation and wrongful overtaking dominate, indicating a combination of high vehicle density, impatience, and risky driver behavior associated with the area's proximity to Kaduna metropolis. In Maraban Jos, reckless and dangerous driving are the main causes, likely linked to the area's busy market activities, mixed traffic composition, and frequent pedestrian crossings. Birnin Yero records speed violation as the leading cause, which may be attributed to relatively open road stretches encouraging excessive speeding.

In Jaji, dangerous overtaking coupled with bad road conditions highlights the interaction between human error and infrastructural deficiencies. The blockage and diversion of traffic due to the Jaji bridge defect increase accident risks when drivers attempt to overtake on narrow passage or one-way passage. At Kwanar Farakwai, reckless and dangerous driving again stand out, possibly reflecting the influence of commercial activities especially on Monday weekly market at Lambar Zango, close to Kwanar Farakwai, which often result in dangerous driving by the drivers and recklessness of hawking and roadside traders.

Overall, the analysis shows that human factors especially speeding and reckless driving account for most crashes, while environmental factors such as poor road conditions exacerbate risks in certain areas. These findings align with FRSC (2020) and WHO (2018) reports indicating that over 80% of road accidents in Nigeria are caused by human error. Therefore, targeted interventions such as stricter enforcement of speed limits, improved road maintenance, and continuous driver education are crucial for reducing accidents along this corridor.

Conclusion

Accidents are results of the combination of several factors and it is usually difficult to single out one main cause of accident, road traffic accidents and death are a global phenomenon sweeping through the world globally. Highway like Kaduna-Zaria has accidents that cause bodily injuries, loss of lives and damage to properties, therefore the need to examine the causes of road traffic accident in order to determine why and how road traffic accidents happen becomes important. This finding is in line with the finding of Afolabi and Gbadamosi, (2017) in their study of road crashes in Nigeria, where the study revealed that deficient vehicles, unserviceable car or a poor maintained automobile leads to loss of control of vehicles by the driver.

Recommendations

Deploying technology like AI is one of the best ways to tackle the continued accidents in our roads. Given that the leading causes of road traffic accidents in this study are human-related, AI technologies provide an innovative pathway to reducing crashes by monitoring, predicting, and correcting unsafe behavior in real time. While traditional enforcement strategies such as speed limits, road safety campaigns, and traffic patrols have been applied in Nigeria and other developing countries, they have not been sufficient to drastically reduce the incidence of crashes. AI-enabled systems can enhance efficiency, impartiality, and coverage in traffic enforcement and driver safety monitoring. If adopted strategically in Kaduna-Zaria Highway and other parts of Nigeria, AI could be a game changer in curbing the rising trend of road traffic accidents.

Conflict of Interest

None

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