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Exploring temporal patterns and determinants of accidents involving heavy-duty vehicles in the Southwestern part of Nigeria between 2011-2021

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ABSTRACT

Increasing road traffic crashes involving heavy-duty vehicles (HDVs) have become a critical concern in many regions of the world. This study was carried out to examine patterns and determinants of HDVs crashes in selected routes in Southwestern part of Nigeria. The study employed field survey to obtain information relating to crash occurrence and factors of occurrence from 200 HDV drivers selected from 1,998 drivers across 16 parks in the study area. Optimised Hotspot Analysis (OHA), inverse distance weighting (IDW) and Nearest Neighbor Analysis were also used to identify spatial cluster of HDVs' crash data. Secondary information on HDVs' crashes and locations during the study period was obtained from the archives of the statistics of operations of Federal Road Safety Corps between 2011 and 2021. Results indicated high clustering patterns of HDVs in the study area which was especially defined by the busyness and the road characteristics of the locations. Further, the study revealed roadway characteristics, brake defects, poor road signs, drivers, behavioural characteristic and weather conditions as part of the key determinants of HDVs crashes in the study location. It is concluded that understanding specificity of route characteristics would be needed to provide strategic route specific solution to incidence of HDVs in the study area.

Keywords: Heavy duty vehicles, road traffic crashes, Nigeria, road safety, road transport

1. INTRODUCTION

Road traffic crashes (RTCs) present a global challenge that affects nations worldwide significantly in terms of socio-economic and human resource losses (World Health Organization [WHO], 2018, 2023). Increasing frequency of occurrence of RTCs has been attributed to unabated increasing numbers of

vehicles around the world (Cabrera-Arnau et al., 2020). Specifically, accidents involving heavy-duty vehicles (HDVs) have become a critical concern in many regions. HDVs are particularly useful in the distribution and redistribution of raw materials, semi-processed and processed goods, as well as employment of workforce (U.S. Department of Transportation, 2015; National Road Transport Commission [NRTC], 2003), thus becoming a very significant fulcrum for commercial and economic progress especially in developing countries like Nigeria (Larranaga et al., 2017; Paixao Casaca et al., 2017; Soliani, 2022). In Nigeria, for instance, economy relies heavily on road transportation, especially the use of HDVs, to move its production including but not limited to construction materials, petrochemicals, mined products, fast moving consumable goods among other across the extensive road networks in the country due to the collapse in rail transport system and disconnect between other forms of public transportation. This over-reliance on HDVs in Nigeria has significantly resulted into high incidences of RTCs along major road transport arteries in the country, specifically impacting public safety, economic stability, and infrastructure development.

Increasing involvement of HDVs in road crashes especially in the low and middle-income countries (LMICs) has been attributed to the strenuous nature of the job which makes the driving of HDVs one of the most fatality-prone occupations (McCall & Horwitz, 2005). With human factors relating to driver errors considered to have the greatest influence on the occurrence of crashes (Ozkan et al., 2006; Sayed et al., 1995). Also, studies have revealed that majority of road crashes by HVDs are attributed to long distance driving covering several kilometers per day by majority of drivers (Zhang et al., 2021). Such strained work conditions make majority of truck drivers to result to drugs or alcohol use, have a poor diet and sleeping pattern, and seldom exercise (Crouch et al., 1993; Krueger, 2007; Moreno et al., 2006; Olson et al., 2016). This further exposes the drivers to numerous health risks including but not limited to fatigue, mental stress, emotional stress among other health issues (Makunto et al., 2023).

Though studies in Nigeria have reported general increase in the incidence of RTCs involving HDVs detailing their spatial patterns, causes, magnitude, safety issues and socio-economic cost of road traffic accidents (Ikporukpo, 2004; Arosanyin et al., 2013; Osayomi, 2013). A close study included the understanding of the spatial patterns of tanker accidents in Nigeria (Olawole & Olapoju, 2018). In general, literature on RTCs in the country have focused on the spatial pattern, causes, magnitude, safety issues and socio-economic cost of road traffic accidents (Oyemade, 1973; Jegede, 1988; Asogwa, 1992; Osime et al., 2006; Filani and Gbadamosi, 2007; Ipingbemi, 2008; Ipingbemi, 2012; Atubi and Onokala, 2009; Arosanyin et al., 2013; Osayomi, 2013). However, all these studies have either consider incidence of RTCs state-by-state or on a general basis. No identifiable study has focused on route-specific studies of the patterns and magnitude of road crashes involving HDVs. This study focuses on the examination of

temporal patterns and determinants of road traffic crashes involving HDVs in selected routes in Southwestern Nigeria. This is expected to provide information on specificity of factors and causes of road traffic crashes in order to provide tailor-fit actionable solution to identified causes of accidents involving HDVs in the study area.

For the purpose of this study, Southwestern part of Nigeria consists of states such as Lagos, Ogun, Oyo, Osun, Ekiti, and Ondo, with their characteristic dense population, burgeoning economic activities, and extensive road networks, making it a crucial area for analyzing the patterns and determinants of HDVs crashes.

The study is divided into five sections. After this section is the literature review followed by the study methods. Section four detailed results and discussion while section five provided the conclusion of the study.

2. LITERATURE REVIEW

Road traffic crashes and incidents are very rarely caused by a single factor. Rather, they occur as a result of combination of factors such as vehicle operators, equipment and infrastructure, and the natural and environments. Studies relating to operations of HDVs and road traffic crashes involving them are well represented in the literature. For instance, causes of HDVs crashes have been found to include factors that are out of control especially due to the nature of the roads, such as curvatures, downgrade (down slope) (Abdelwahab and Morral, 1997) which result from loss of braking ability, road way defects, environment and adverse weather (Federal Motor Carrier Safety Administration (FMCSA), 2006). Away from factors relating to road nature, Khattak et al., (2003) established a link between risky driving behavior by drivers such as driving under the influence (DUI), speeding, seatbelt violation and increased injury severity in single truck crashes. Some other studies have also focused on the relationship between HDVs driver' characteristics (age of drivers, especially) and crashes (Cantor et al., 2010; Zhu and Srinivasan, 2011). In another vein, distraction, emotional stress and alcohol use were also found to be associated with drivers attributes such as age, gender, speeding rate, visibility (Chen & Zhang, 2016). Further studies have established a connection between inability of drivers to balance work hours and rest period, which is likely to minimize fatigue-related risks, to occurrence of accident (Wijngaards et al., 2019). This is implying prioritizing flexibility and timely delivery over safety (Soliani, 2022; Hesse, 2016), when occupational conditions of many drivers are worsening (Jaffee & Bensman, 2016). Drivers, on the other hand, in a bid to adjust to these strained conditions make safety compromises by indulging in drug usage, extending long hours especially when compensation is based on drivers' productivity rather than time worked (Girotto et al., 2019), overspeeding and reduced vehicle maintenance (Lemike et al., 2021; Ryley

& Belzer, 2023). In some related studies, Simontelli et al., (2018) and Friswell & Williamson, (2019) adduce longer waiting time for loading and unloading good as responsible for drivers' fatigue and eventual impact on driving efficiency.

In terms of approaches to the study of road traffic crashes involving HDVs, scholars have established spatial approaches as become increasingly dominant in recent methodological frontiers of road safety research (Mannering & Bhat, 2013; Ziakopoulos & Yannis, 2020). These approaches are established as providing basis for the understanding of the spatio-temporal dynamics of crashes which is essential for devising effective interventions and improving road traffic safety (Yoon & Lee, 2021). Other studies have also utilized advanced statistical and econometric models to address the spatial and temporal dimensions of road traffic crash data (Alnawmasi et al., 2024; Xing et al., 2023). Amidst various other approaches for the understanding the patterns of road traffic crashes, this study adopted the combination of survey and spatial analytic approaches to identify crash hotspots as well as spatial temporal clusters of crashes involving HDVs in the study area.

3. METHOD

3.1 STUDY AREA

The study was carried out in the Southwestern part of Nigeria which is one of the nation's six geopolitical zones. Southwestern Nigeria is made up of six states: Osun, Oyo, Ogun, Lagos, Ondo, and Ekiti. The area is 78,771 km^2, and its coordinates are 30 °E and 6 °E East of the Greenwich Meridian and 60 °N and 90 °N North of the Equator respectively (Fig. 1). This region poses one of the most well-developed transportation systems in the nation. Lagos, as well as portions of Ondo and Ogun states are straddled by inland waters which provide veritable means of local transportation. Through Ibadan, the train route connects Lagos and Osogbo. There are domestic airports located in Akure, Ibadan, and Lagos, while there is currently just one international airport in Lagos. However, not many individuals in the area use air travel. Road transit is thus by far the most prevalent mode of mobility in the area.

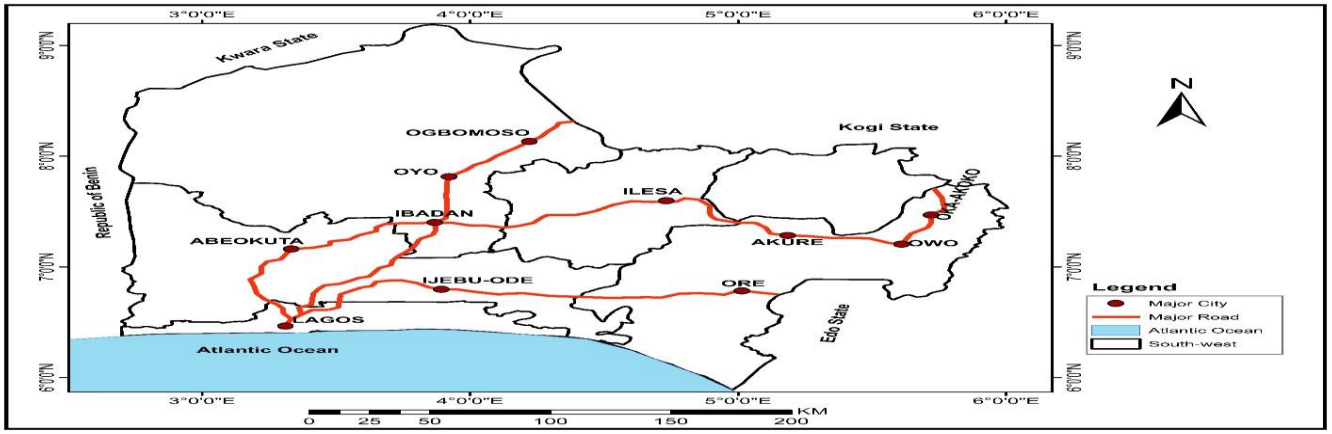


Fig 1: Study area.

3.2 DATA COLLECTION

The study utilized data from both primary and secondary sources. Primary data was gathered from field survey conducted with questionnaire administration. Primary data collection was carried out using multi-stage approach both for site and respondents' sampling. First, seven routes were identified and selected in the study area. For all these routes, a total of 16 tanker and trailer parks were identified. Second, a headcount of tankers and trailers using these parks was conducted. A total of 1,998 tankers and trailers were actively using the observed parks. The word active was used because some abandoned trailers and tankers were found near and around the parks. Third, 10 per cent of drivers of tankers and trailers in each park were purposively selected. In all an approximation of 200 drivers was selected for the survey (Table 1). The criteria for inclusion in the survey included: (a) ownership of required driving license; (b) being active driver for at least two years in any one or more of the routes identified.

Verbal consent of all sampled drivers was sought. Drivers were told of the volunteering nature of the survey and were informed of their right to withdraw from further attendance to the questionnaire should any of them feel uncomfortable with questions raised. To aid spatial representation, Global Positioning System (GPS) was used to capture and determine locations with most occurring HDVs crashes for the entire study period.

Secondary information on accident occurrence and locations during the study period was obtained from the archives of the statistics of operations of Federal Road Safety Corps between 2011 and 2021.

Descriptive statistics including graphical representation and percentage frequency distribution were used to present the data. Optimized Hotspot Analysis (OHA) and inverse distance weighting (IDW) in ArcGIS 10.8 were used to identify spatial cluster of HDVs' crash data. Nearest Neighbor Analysis was carried out using ArcGIS 10.8 to examine the distances between each location of crashes and the closest location to it. This is to ascertain spatial randomness of the occurrence of road traffic crashes involving HDVs in the study area. Relative Importance Index (RII) was used to rank factors of road accidents on perceived importance so as to prioritize critical factors of road crashes involving HDVs in the study area. Statistical Packages for Social Scientists (SPSS) was used for further statistical analysis.

Table 1: Sample selected across HDVs route

S/N	HDVS' Routes in the Study Area	Number of Identified HDVs' Parks in each Route	Estimated Number of HDVs Drivers in each	Sample Size of HDVs Drivers in each Park

			Parks	
1	Lagos-Ibadan	1	600	60
2	Lagos-Sagamu-Ore	6	450	45
3	Lagos-Otta-Abeokuta	1	200	20
4	Ibadan-Abeokuta	-	-	-
5	Ibadan-Oyo-Ogbomoso	2	200	20
6	Ibadan-Ilesa-Akure	5	450	45
7	Akure-Owo-Oka-Akoko	1	98	10
Total		**16**	**1,998**	**200**

4. Results

4.1 Frequency of crashes in the study area

Result of the magnitude of occurrence of HDVs crashes across all the selected routes and for all the study period showed the highest occurring record in 2021 with a total number of 468 while the least occurrence was in 2011. There was an evidence of downward rate of crashes from 2012 up till 2015 before a rise in incidence of crashes which was unabated till 2021 (Fig. 2).

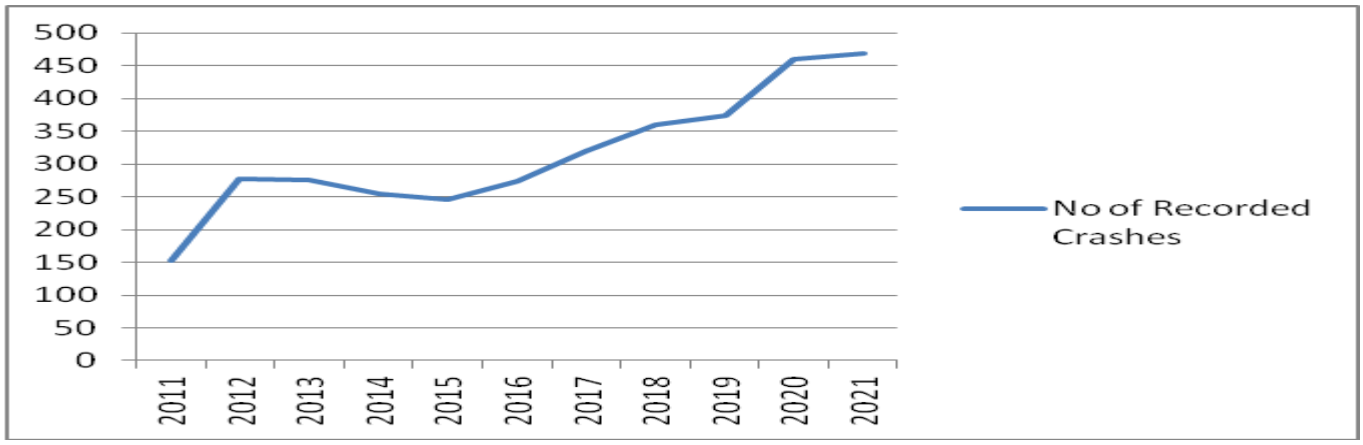


Fig. 2: Record of HDVs crashes in the study area

4.2 SPATIAL PATTERNS AND LOCATIONS OF HOTSPOTS OF HDVS CRASHES (2011-2021)

The spatial pattern of crashes involving HDVs for the entire period of study revealed clustering spots within Lagos metropolis. These spots included Apapa, Third Mainland Bridge, Long bridge, Ikorodu and Epe. Also, along Lagos-Ibadan expressway, clustering spots included Ibafo, Mowe, Remo, Ogere and Ogunmakin. Clustering spots along Abeokuta-Ibadan route, included Owode, Odeda, Omin-Adio axis. Crash spots are also clustered in Ibadan metropolis especially around Guru, Alomaja, Iwo-road, Ojoo. Along Ibadan-Oyo-Ogbomoso route, there are spots like Fiditi, Jobele, Akinmorin, Aawe, Ijawaya, Oloo,

Onigaari, Odo-oba, Ogbomoso metropolis especially at Taki roundabout and Oke-Babi, Gambari, Ilorin road. Other spots linking this route are Ido, Iseyin, Saki and Aipo. Along Ibadan-Ilesa-Akure, area of spots includes Egbeda, Osengere, Asejire bridge, Ikire, Wasinmi, Ife, Osu, Alakowe, Ilesa, Erin-Ijesa, Owena, Igbara-oke and Akure. Other spots that have link with this route are Sekona-Akoda, Osogbo-Ikirun, Iree, Oke-Ila and Ora-Igbomina, Along Akure-Owo-Oka-Akoko route area of spots are Sasa, Airport axis, Ogbese, Emure and Owo junctions, Oba-Akoko, Akungba junction (Fig. 3).

The hotspots of crashes involving HDVs along the selected routes and some strategic places in the study area for the whole years (2011-2021) included Lagos metropolis (Apapa, third Mainland bridge, Ikorodu, Long bridge and Mowe); Ibadan metropolis, Ogunmakin-Guru, Akinyele-Fiditi, Egbeda-Osengere, Asejire-Ikire, Akinmorin, Oyo township, Aawe-Ijawaya, Oloo, Odo-oba, Ogbomoso; Ife (Alakowe-Osu); Ilesa-Erin-Ijesa; Akure-Ikere, Akure-Idanre, Owo, Oba, Akungba and Oka-Akoko. Other locations were Ajebandele, Ikirun-Iree, Ileoluji, Ijebu-ode and Owena (Fig. 4). However, the pattern of HDVs crashes in the year 2011-2021 in the study area revealed an index of 0.107286 at z- value of -100.2101 and p-value of 0.000 indicating high clustered pattern in the study area (Figure 5).

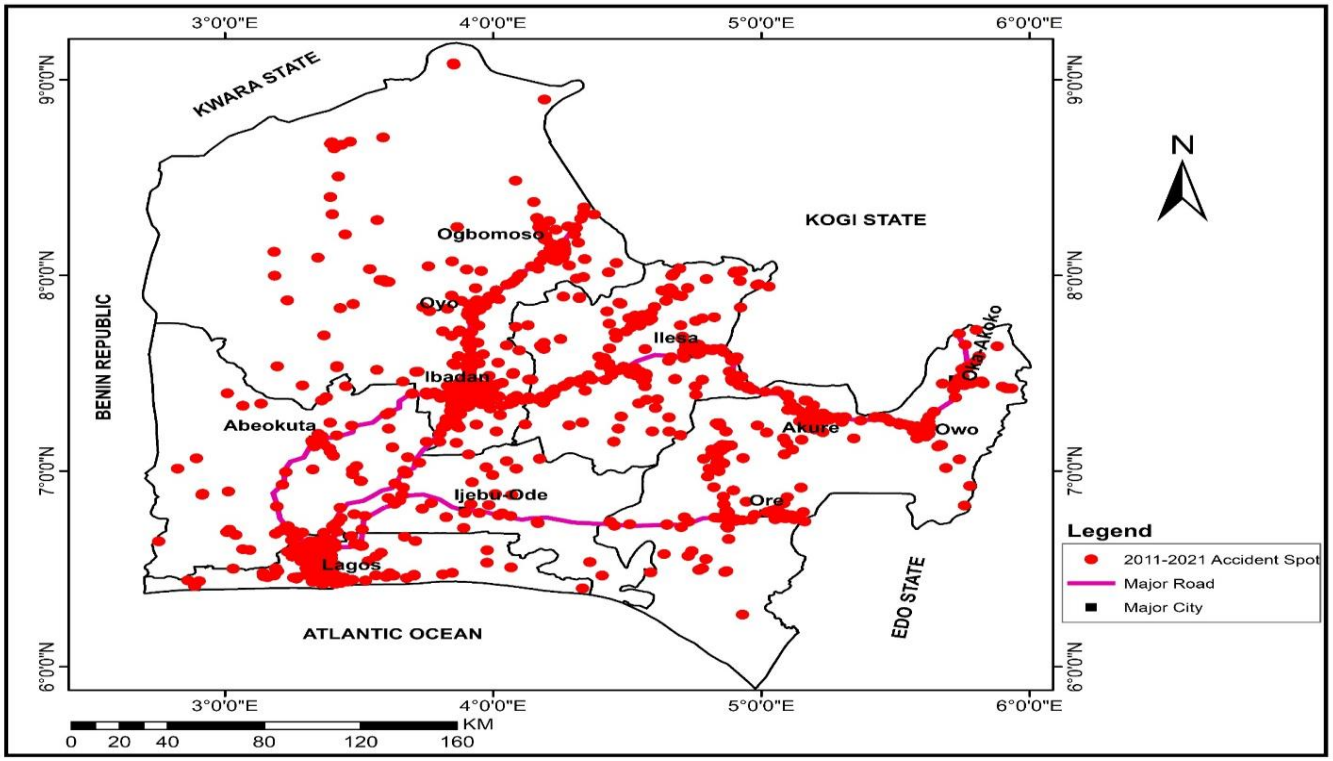


Fig. 3: Aggregated spatial patterns of HDVs crashes (2011-2021)

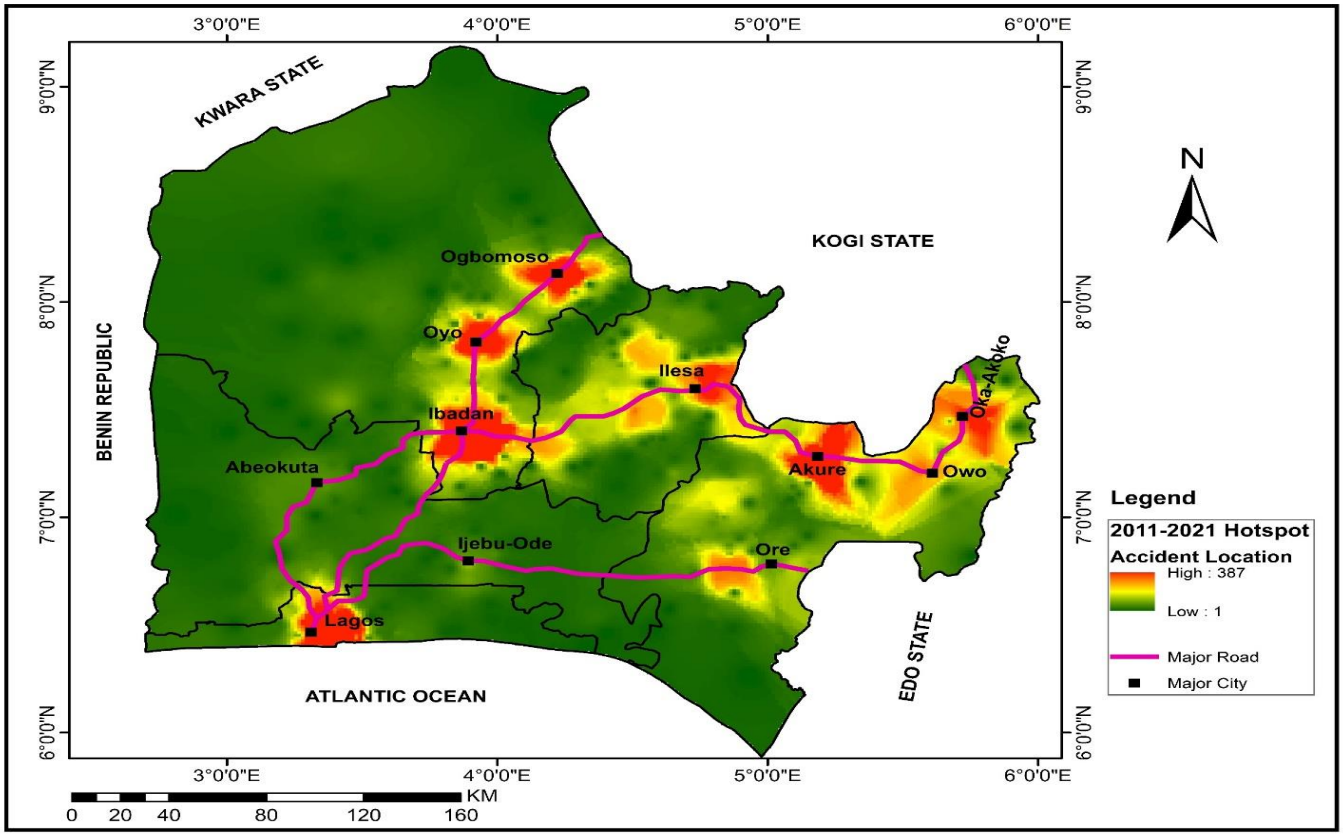
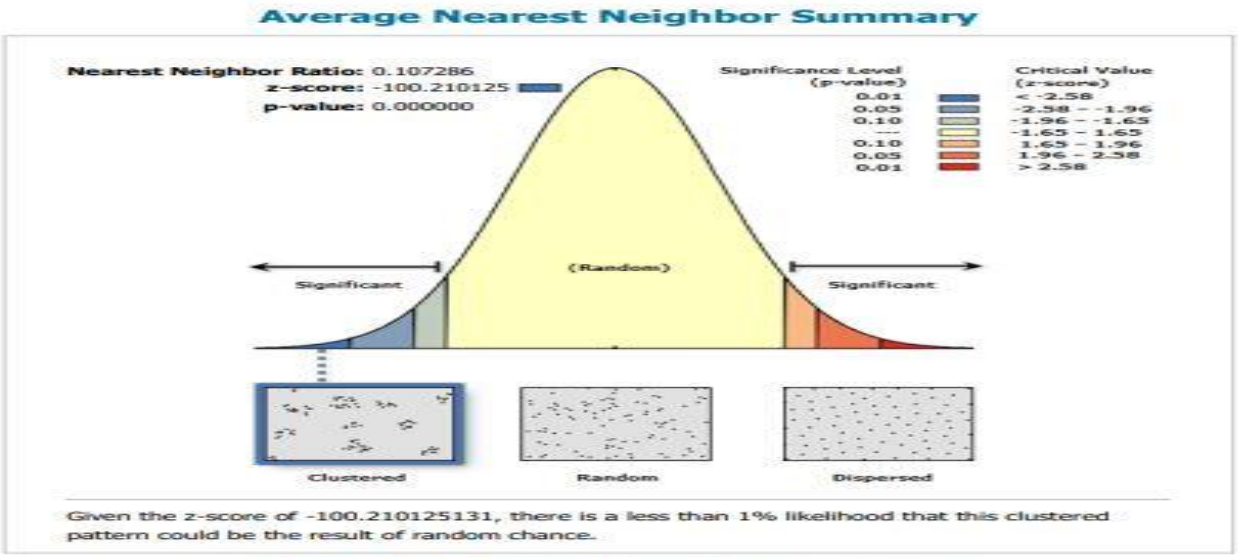


Fig. 4: Hotspots of crashes involving HDVs.



Average Nearest Neighbor Summary

Observed Mean Distance:	569.9433 Meters
Expected Mean Distance:	5312.3592 Meters
Nearest Neighbor Ratio:	0.107286
z-score:	-100.210125
p-value:	0.000000

Fig. 5: Nearest Neigbhour Index for the patterns of occurrence of HDVs crashes

4.3 CLASSIFYING GENERIC FACTORS OF HDVS CRASHES ALONG THE ROUTES

Results from this study revealed factors responsible for crashes involving HDVs in the study area to be related to traditional generic factors which are environmental related factors, human related factors, mechanical related factors and roadway related factors. These factors were either singly or jointly responsible for some of the recorded crashes in the study area. However, the study disaggregated the influences of these factors into reported causes for individual cases. Based on Relative Importance Index (RII), roadway factors exhibited highest impact, with bad roads/potholes and criminal activities both ranked 1st with an RII of 0.87. Poor road signs follow closely at 2nd (0.86), showing the influence of infrastructure on road safety. Mechanical factors which include brake failure or defect and loss of control are also ranked 2nd (0.86), while tyre burst takes 3rd place (0.85). This underscores how vehicle conditions can severely affect safety. In another vein, drunkenness (0.82) and distracted driving (0.81) are ranked relatively high as human factors influencing HDVs crashes in the study area, thus emphasizing the correlates of risky behaviors behind the wheel and road safety. However, environmental factors, such as road obstruction (0.80) and heavy rainfall (0.79), are lower but not negligible in ranking with high temperature having the lowest RII (0.53), indicating a lesser impact compared to other hazards (Table 2).

Table 2: Relative Importance Index of generic factors of HDVs crashes

CLASSIFICATION	CAUSES	SD	D	U	A	SA	RII	Rank
Environmental Factors:	Road obstruction	0	11	9	146	34	0.8	8th
	Heavy Rainfall	1	10	21	133	35	0.8	9th
	High temperature	3	116	38	34	9	0.5	13th
	Poor visibility	2	15	46	116	21	0.7	12th
	Slippery flooded road surface	2	10	35	112	41	0.8	10th
Human Factors:								
	Dangerous Driving	2	8	35	111	44	0.8	9th
	Speed limit violation	2	7	23	126	42	0.8	8th
	Wrongful overtaking	3	8	26	154	9	0.8	11th
	Overloading	2	13	21	107	57	0.8	8th
	Route violation	2	8	35	114	41	0.8	10th
	Drunkenness	1	8	25	102	64	0.8	6th

	Use of phone while driving	2	10	19	113	56	0.8	7th
	Seat belt violation	2	11	25	109	53	0.8	8th
	Distracted driving	2	7	24	111	56	0.8	7th
Mechanical Factors								
	Brake Failure	0	5	20	86	89	0.9	2nd
	Tyre burst	2	8	23	72	95	0.9	3rd
	Loss of control	1	5	20	79	95	0.9	2nd
	Mechanically deficient vehicle	0	10	17	102	71	0.8	5th
Roadway Factors								
	Bad Road/Pot-holed roads	0	2	22	80	96	0.9	1st
	Poor road signs	0	3	21	92	84	0.9	2nd
	Dangerous bends	0	6	27	104	63	0.8	6th
	Dangerous slope	0	12	17	95	76	0.8	4th
	Criminal activities	0	4	25	66	105	0.9	1st
	Animal crossing	2	9	25	122	42	0.8	9th

4.4 RANKING OF CAUSES OF HDVS CRASHES FOR ALL SELECTED ROUTE IN THE STUDY AREA

Results of the study revealed dangerous driving (DD) as ranking 1st and responsible for 564 occurrences across all routes. This is followed by speed violation, while the combination of speed violation and wrongful overtaking ranking 3rd cause of accident in all the routes. This indicates that dangerous driving, speed violation and wrongful overtaking, which are all subsets of reckless driving behaviours are the leading contributors to road safety issues in the study area. Brake failure (BF) is ranked 4th, demonstrating that vehicle maintenance plays a critical role in road safety. Loss of Control (LoC) in combination with other factors contributes significantly to the occurrence of 152 accidents across all the routes. Bad road conditions (BRD) have the lowest count (21 occurrences, ranked 18th), suggesting infrastructure issues may be less of a concern compared to behavioral and mechanical factors. However, regional records showed that Ibadan-Oyo-Ogbomoso route has high occurrences of dangerous driving (137) and speed violations (114); Akure-Owo-Oka Akoko also has a significant share of brake failures (59) and speed violations (79) while Lagos-Ibadan and Lagos-Sagamu-Ore have prominent cases of wrongful overtaking and speed-related issues, reinforcing the need for stricter enforcement (Table 3).

Table 3: Ranking of causes of HDVs crashes along the Selected Routes in the Study Area

Causes	Ibadan-Abeokuta	Akure-Owo-Oka Akoko	Ibadan-Ilesha-Akure	Ibadan-Oyo-Ogbomoso	Lagos-Ibadan	Lagos-Ota-Abeokuta	Lagos-Sagamu-Ore	All routes
BF	6	59	49	32	14	3	22	185 (4^{th})
BF, LoC	0	40	7	3	7	3	7	57 (9^{th})
BRD	0	3	6	11	0		1	21 (18^{th})
DD	17	116	126	137	100	2	66	564 (1^{st})
DO	2	13	14	65	7	0	7	108 (6^{th})
LoC	4	7	16	11	6	0	9	53 (10^{th})
MDV	2	19	14	11	17	0	4	67 (8^{th})
RV	0	1	31	15	8	0	13	68 (7^{th})
SLV	4	27	71	55	22	6	24	209 (3^{rd})
SLV, LoC	0	3	10	4	8	1	10	36 (15^{th})
SV	15	79	112	114	77	4	99	500 (2^{nd})
SV, BF	0	3	13	5	3	0	6	30 (16^{th})
SV, DD	0	9	21	12	1	0	8	51 (11^{th})

SV, DO	0	4	7	1	1	0	13	26 (17^{th})
SV, LoC	3	12	41	21	43	1	31	152 (5^{th})
SV, WO	1	7	14	10	7	0	6	45 (12^{th})
TB	1	7	7	17	6	0	2	40 (13^{th})
WO	10	20	27	117	21	2	12	209 (3^{rd})

Note: BF – Break Failure, LoC – Lose of Control, DD – Dangerous Driving, SV - Speed Violation, DO – Dangerous Overtaken, RV – Route Violation, MDV – Mechanically Deficient Vechicle, SLV – Speed Limit Violation, TB – Tyre Burst, WO – Wrongful Overtaking

5. DISCUSSION

This study was carried out with the objective of examining temporal patterns and determinants of road traffic crashes involving HDVs in selected routes in Southwestern Nigeria. Results revealed increasing incidence of HDVs crashes in virtually most of the study period. This is an evidence of the difficulty faced by developing countries in combating the menace of road traffic crashes, especially with increasing road safety awareness across the globe (Bun, 2012; Cabrera-Arnau et al., 2020). This difficulty is unconnected with little or no change in road structure and geometry which follow the antecedence of the colonial period. In terms of the locations of the hotspots of HDVs crashes, except in Lagos metropolis, where Apapa and Third Mainland fall within the city's road network density, other hotspots and locations tend towards the outskirts of cities or urban settlements. These locations are characterized by highways linking cities or states as the case may be. While hotspots noted in Apapa and Third Mainland Bridge are largely due to the prominence granted Apapa as the gateway to the nation's economy from major seaports and location where loading of dry cargoes, petroleum and liquefied products, among others, take place, with continuous truck presence on these roads. Other locations are either points where road network geometries are particularly undesirable for efficient trucking, locations where traffic management is weak or locations with collapsed or imperfect road infrastructure.

Findings revealing roadway factors as most relatively important factor of HDVs crashes in the study area is clearly an evidence of the nature of Nigerian roads which are lacking in maintenance and mostly

derelict. Drivers often attempt to swerve to avoid some defected portions of the road in most instances to avoid causing damage to their vehicles. Since HDVs require more space to navigate and maneuver, drivers end up losing control of their vehicles and face risk of colliding with other vehicles or nearby objects. This finding is in consonance with various studies which have also established positive correlation between roadway defects and traffic crashes (e.g. Federal Motor Carrier Safety Administration (FMCSA), 2006). More so, roadway defects in the study area are equally giving way to criminal activities such as kidnapping and robbery. HDVs drivers, sometimes when encountering the criminals, lose control of their vehicles, leading to eventual crash into other vehicles or nearby objects. Significantly supporting this finding are the various activities of Boko Haram and kidnapping in some routes in Nigeria. This has also been established by Wright & Ribben (2016) who emphasized that crime and criminal activities can occur anywhere on the road environment especially the bad portions of the road, which have potential of slowing down vehicles thereby creating opportunities for criminals to attack commuters or passengers.

In addition, poor road signs and loss of control were recorded as second most important factors of HDVs crashes. This is due to the fact that most Nigerian roads are devoid of road traffic signs which can provide instructive information on the nature of the road thereby helping drivers in decision making process. Besides, some of the available signs have been removed by vandals and scavengers, defaced, taken over by bushes, or faded as the case may be. The influence of this on HDVs crashes have been found to align with findings that established inadequate road infrastructure including but not limited to road traffic signals as factors inducing mental stress among drivers which in turn adversely affect driving performance (Karimi et al., 2015; Ranjbar et al., 2016; Wright & Ribben, 2016) and the significance of improved road traffic infrastructure design and installations (Kurakina et al., 2020). Such installations will not only enhance drivers' attitude to traffic information but will also improve road safety (Jima & Sipos, 2022; Konovalova et al., 2022; Cociu, 2020).

Defective brake was ranked equally with poor road signs in their relative importance as contributory factor to HDVs crashes in the study area. The identification of defective braking system as a key factor of HDVs can be attributed to the condition of the vehicles most of which are foreign-used (popularly known as Tokunbo), poor maintenance culture and gross lack of routine check for detection of any defects. As such, the finding is in line with Singh (2015) who observed in his study that faulty brakes are part of vehicle defects that can compromise vehicle's safety, reliability and performance; and when then co-exist with other crash-contributory factors; they can lead to more severe crash outcomes.

Poor drivers' behavior was also an important factor of HDVs crashes in the study area. These behaviour include dangerous driving, speed limit violation, wrongful overtaking, overloading, seatbelt violation,

drunkenness and willingness to commit other driving rule violations. All of these confirm previous research which identified various drivers' wrong attitude toward safe driving as the cause of about 90% of road traffic crashes (Mokarami et al., 2019; Han and Zhao, 2020; Abudayyeh et al., 2021). This finding however, reveals the consistent difficulty faced by road safety agency at abating drivers' disregard to road traffic safety regulations in the Nigeria on the one hand, and the outcome of little or no punitive measures at correcting such misdemeanour.

Weather condition was observed in the study as a contributory factor to HDVs crashes in the study area. Intense rainfall during rainy season, very high daily incidence of sunlight and windy situation, which are all climatic characteristics of the tropical region, could be seen as reasons for the role of weather in HDVs crashes. This finding confirms previous studies which have established the significant role of weather conditions such as rainfall, frost and strong wind on increasing road and highway crashes, as well as incidence of chain accidents on slippery roads (Jalilian et al., 2019; Hammad et al, 2019; Bergel-Hayat et al., 2013). The severity of this finding on the road traffic outcome in the study area may also still be connected to the poor road geometry and road surfaces which make driving more difficult during these weather conditions.

6. CONCLUSION

This study examined the patterns and determinants of road traffic crashes involving HDVs in selected routes in the Southwestern part of Nigeria. The study employed field survey to obtain information relating to crash occurrence and factors of occurrence from selected HDVs drivers. Optimised Hotspot Analysis (OHA), inverse distance weighting (IDW) and Nearest Neighbor Analysis were also used to identify spatial cluster of HDVs' crash data. Results showed increasing occurrence of HDVs crashes in virtually most of the study period and hotspots location relating to the level of busyness and/or route characteristics. The study revealed roadway characteristics, brake defects, poor road signs, drivers, behavioural characteristic and weather conditions as part of the key determinants of HDVs crashes in the study location.

The study provides significant information on the route peculiarities and specificity of crash determinants to individual routes in the study area. It thus provides basis for policy makers to address issues related to HDVs crashes based on the factors of occurrence in specific locations rather than generalized solution approach. However, further analysis may be needed to provide more detailed information on specific strategies put in place by various governments, where the selected routes sail through, at reducing incidence of crashes involving HDVs.

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