

Spatial Analysis of Road Safety Awareness and Traffic Accident Patterns in Urban Neighborhoods: A GIS-Based Study of Ibadan Metropolis, Nigeria

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Abstract Road accident occurrences are a universal and worldwide phenomenon. This is so because accidents happen on all categories of roads, which include street roads, express roads, tared and untarred roads, among others. The study analyses accidents in the neighborhood roads, like the streets, minor link roads, or minor roads that link major areas together, and identifies road traffic accident locations to assess the road users' safety awareness levels in the Ibadan metropolis. Data were sourced from the police traffic department. This data includes streets where accidents have occurred in the metropolis (2018-2023), and the type of vehicle involved. GPS (global positioning system) was used to take coordinates of the streets and locations. The city was divided into zones based on the magnitude of accident occurrence, and questionnaires were used to evaluate road users' road safety awareness levels for each zone. These were rated as percentages. The level of awareness of the presented road signs and the frequency of accidents in each zone were correlated to establish the relationship. ArcGIS 10.8 for spatial analysis and SPSS 17.0 for correlation analysis. Descriptive statistics data were presented using tables, charts, and maps.

The analysis reveals the magnitude of accident occurrence across the zones. The correlation analysis shows a correlation of 0.827; p-values are $< .01$. It indicates a strong correlation between accident occurrences and the level of awareness and use of road signs and symbols. The distribution of accident incidences across Ibadan city is clustered with the p-value at 0.01, which is greater than the z-score of -2.52. It was also observed that motorcycles are the most involved in accidents within the metropolis, and that accidents increase as we move away from police stations. Causes of accidents are seen to be different across the metropolis, with low traffic safety education ranking the highest.

The study therefore recommends re-educating road users on how to use the road and obey road signs and symbols as a way to reduce accident incidences within the metropolis. The presence of control agents like the police, the road safety corps, and the Oyo state traffic management personnel should be encouraged.

Keywords Cordon, Road Safety, Accident, Georeferencing, Safety consciousness

JEL R41, R42, D81, C21

1. Introduction

Road traffic safety awareness refers to methods and measures for reducing the risk of a person using the road network from being killed or seriously injured. The users of a road include pedestrians, cyclists, motorists, their passengers, and passengers of on-road public transport, mainly buses and cars. Safe road is now about providing a road environment which ensures vehicle speeds will be within the human tolerances for serious injury and death wherever conflict points exist. Kirmiziloglu (2010) posited that since the number and quantity of vehicles on roads has increased due to technological and economic, development in recent years. As a result of this increase, traffic has been one of the most important parts of our daily lives as people spend more time in traffic, thereby forcing drivers and other road users to face a higher risk of traffic accidents.

Worldwide more than 1.25 million people lose their lives annually due to traffic crashes. Everyday nearly 1,049 people under the age of 25 lose their lives in traffic accidents World Health Organization (2004). Traffic signs are the oldest and most commonly used traffic control device (TCD). These signs convey messages in words or symbols and erected to regulate, warn, or guide the road users. Traffic signs are commonly used traffic safety tools, mainly developed to provide crucial information in a short time to support safe drive; but the success depends on their comprehensibility by the drivers (Tuydes-Yaman, 2012).

The American National Standard Institute (ANSI Z535.3-2011) advises that traffic signs should meet 85%, while the Organization of International Standardization (ISO 3864) pegged its own at 67%. Traffic signs in relation with congestion and traffic accident occurrences have been a topic of considerable interest to researchers in the past few decades.

This research was undertaken to access the drivers' and other road users personal characteristics in understanding of traffic signs in Ibadan city, the capital city of Oyo state. The study of the role of road user characteristics in understanding traffic signs in Ibadan is of great importance since traffic accident still occurrences along the express way and other neighborhood road.

1.1. Statement of the Problem

In spite of the studies and researches made into road traffic crash occurrences and road safety awareness levels, it appears that the benefits are not reflected in the society as there is still the feeling of insecurity among road users no matter the category they belong, the issue is why should it be so? From the literatures accident analyses have been carried out with data analysis in the form of statistics, mathematics, tables and graphs. The effect of highways and express Road Traffic Accident Injuries on Productivity in Nigeria, and also examined the spatial variation of road traffic accident casualties in Nigeria. The trends and patterns of fatal road accidents along major highways in Nigeria. According to Makinde and Opeyemi (2019), there have been alarming cases of traffic accidents on roads, which they attributed to the recklessness and low level of literacy about the use and interpretation of road signs and symbols.

Road accident occurrences are a universal and worldwide phenomenon, this is because accidents happen on all categories of roads, which include street roads, express roads, tared and untared roads, among others. Effort has been made over the years in the literature to emphasize the need for safety awareness in the use of road transport (express/highway roads). Emphasis before and now shows that road accident analysis on the highways and express roads are high. However, much attention have not been on the analysis of accidents in the neighborhood roads like the streets, minor link roads or minor roads that links avenues, estates and districts within a city. Since traffic accident is a geographical phenomenon that occurs in relation to place, time and environment this work is conducted to analyze the neighborhood road traffic accident in Ibadan city.

1.2. Aim and Objectives of the Study

The aim of this study is to analyse the relationship between the level of road safety awareness and the rate of Accident occurrences in Ibadan city of Oyo State. The specific objectives intended to be achieved at the end of this study is to examine the types of vehicles that is involved in traffic accident in the study area and to spatially analyse the safety awareness levels of road users in the study area.

2. Literature Review

There is obviously no single category of "road user". In today's motorized society virtually every one among us at some time has to use the road whether as a child or adult, pedestrian, driver, motor cyclist and so on. The traffic system places high demands on all road users. If such demands are

not mastered, or are dealt with wrongly, a collision becomes possible. The way we cope with all the demands imposed upon us by the traffic system depends not only on the way we perform, but also on the way we behave. Naturally, road user performance and road user behaviour are inextricably intertwined.

Since motor vehicles became popular and the number of accidents started to raise, approaches to making road use safer have been based on a perception that accidents are failures of skill, and that the safety of a road user is mainly determined by the level of skill applied in response to the demands that are faced. Accordingly, the general strategy has long been to increase road-use skills and decrease the demands placed on road users by the environment.

Every transport activity is designed to meet the need of the customer and is therefore incomplete until the concept of "safe arrival" by both the passenger or goods are met, Ndikom (2008). It involves authorities to put in place necessary facilities, procedures, personnel as well as machinery that would ensure safe arrival and reduce accident. It therefore makes it mandatory and essential for all road users to be safety conscious. Some of the measure to be adopted in ensuring the safe arrival of road users may include creation of walk way, cycle path, pedestrian bridges, initiate a permit system for all motor users (car, motor cycle and bicycles) encourage the use of reflective patches, traffic light among others.

2.1. Road traffic safety

Safety concerns in transportation planning are fundamental, as evidenced by a comprehensive examination of plans across 35 metropolitan areas globally (Peng & Wang, 2011). The critical importance of ensuring safety within road networks reverberates due to its extensive influence on various dimensions of people's lives. The safety performance of road transport systems hinges on a multitude of factors, encompassing network functionality, predictability, consistency, road environment, and traffic dynamics (Hafen et al., 2005). Rising concerns about the safety associated with automobiles and motorcycles are capturing the attention of road users and safety experts worldwide, with a pronounced focus on developing nations (Tavakoli Kashani & Arefkhani, 2018). Within this context, urban planners and traffic engineers are particularly attuned to the effects of diverse road network layouts on traffic safety, presenting a key arena for impactful interventions (Zhang et al., 2014). The sphere of urbanism and spatial planning significantly shapes traffic safety strategies, pursuing a harmonious equilibrium between requirements, opportunities, and road characteristics (Tăriță Cîmpeanu & Burlacu, 2012).

An integral metric for evaluating road safety emerges through the analysis of societal costs linked to accidents and injuries (American Association of State Highway and Transportation Officials AASHTO, 2010; Hafen et al., 2005; Herbel et al., 2010; Millot, 2004). Notably, while crashes remain relatively infrequent, they represent a modest proportion of incidents in the broader transportation landscape (Oregon Department of Transportation (ODOT) Traffic-Roadway

Section, (2021) (2021)). The severity of crashes is predominantly dictated by the most severely injured participant, prompting a structured approach for officials to prioritize safety improvements on specific road segments (Elvik, 2008; Golembiewski & Chandler, 2011; Ma et al., 2021; Schneider & Savolainen, 2011). As a pivotal initial step toward advancing traffic safety, the identification of clustered risk areas for traffic accidents assumes priority (Zhang & Shi, 2019). Within this framework, hotspot methodologies emerge as consequential tools, facilitating the orchestration of cost-effective road safety strategies to mitigate traffic accidents (Xu & Tao, 2018).

2.2. Traffic accidents spatial analysis

Road Traffic Accidents (RTAs) are unfortunate incidents that occur unexpectedly and unintentionally. The analysis of road accident data is essential for safety analysis and identifying areas with high accident frequencies of severe injuries and fatalities (Lee et al., 2005). The goal of traffic accident safety analysis is to prevent further accidents by identifying the cause of an accident or series of accidents (Bhalla et al., 2014). Studies have been conducted using spatial units and road networks to identify elements that impact traffic safety. Analyzing individual road segments is crucial for identifying factors that increase the risk of accidents and despite technical challenges, the use of road networks in traffic safety studies has increased (Á. Briz-Redón et al., 2019).

The study by Ziakopoulos and Yannis (2020) suggests that analyzing road safety indicators across spatial units of analysis is essential in the field of road safety. Spatial analysis of road crashes and their locations is important because road transport is distance-based. The use of Geographic Information Systems for Transportation (GIS-T) (Goodchild, 2000; Loo & Anderson, 2015; Shaw, 2000) and GIS Safety Analysis Tools have facilitated the analysis of traffic safety, including the prediction of areas where accidents are likely to occur (Mehta et al., 2015; Pulugurtha & Pasupuleti, 2013). Many spatial statistical tools are now available in GIS software to build complex models in a simple process and its ability to detect spatial relationships in accidents that cannot be detected by traditional methods of statistical data. Such spatial tools provide a geographical component to crash data, which helps in understanding the crashes in relation to the environment and road. The use of GIS in road management for traffic safety purposes allows for a variety of spatial analyses and graphical illustrations of the results for interpretation (Mohan Rao, 2014; Polat & Durduran, 2011).

The use of GIS technology has been extensively employed in road safety research to identify areas where accidents are most likely to occur. The Kernel Density Estimation (KDE) algorithm in ArcGIS has been used to analyze spatial data to determine the distribution of accident risk, as demonstrated by Budiharto and Saido (2012). Ouni and Belloumi (2019) suggest using spatial autocorrelation, specifically Moran's I and Getis-Ord statistics, as a powerful technique for spatial clustering to identify accident spatial patterns and hotspots. Moran's I measures spatial dependence to group areas with similar spatial patterns, while the Getis-Ord statistic provides

a singular measure of spatial correlation and quantifies the extent of clustering in the spatial arrangement (Satria & Castro, 2016). Colak et al. (2018) also supports the use of GIS technology, specifically KDE, for identifying accident-prone highways.

The systems perspective, views human performance as a function of many interacting system-wide factors. In the context of human error and road traffic crash causation, for example, it is now accepted that errors are a consequence of 'systems' failure rather than merely aberrant psychological factors within individuals. In a road safety context, elements of the system beyond road users, such as vehicle design and condition, road design and condition, road policies, and so on, all shape drivers behaviour on the road.

3. Methodology Research Design

This study is designed to use survey which involves the usage of structured questionnaire. The entire city was divided into regions with a 1 kilometer cordoned. This was achieved through the operation of the ArcGIS software tools on the map of Ibadan city, as shown in Figure 1. Questionnaires were administered to respondents within the cordoned area. The choice of these areas was based on locations with the highest frequency of accident occurrences in the period under study as provided by the police traffic department of the Nigerian police force. With 95% confident level, $p=0.5$ and $q=1-0.5$, acceptable error margin is 4.5% so $d=0.045$. The questionnaires were designed in a manner that they contain both open-ended and closed-ended questions. Section one had questions for pedestrians and cyclist (bicycle or motorcycle). Simple choice questions requiring respondent to tick their choice among the options yes or no. Section two had questions for vehicle drivers and other road users they will be required to interpret some of the road signs and symbols. Not less than twenty-four questionnaires were administered to respondents in each of the twenty zones.

This sampling design is based on the concept of the geographic pattern of traffic accident analysis, which believes that traffic accidents occur in place, time, and environment. Hence the need for cordoning the place (roads and streets).

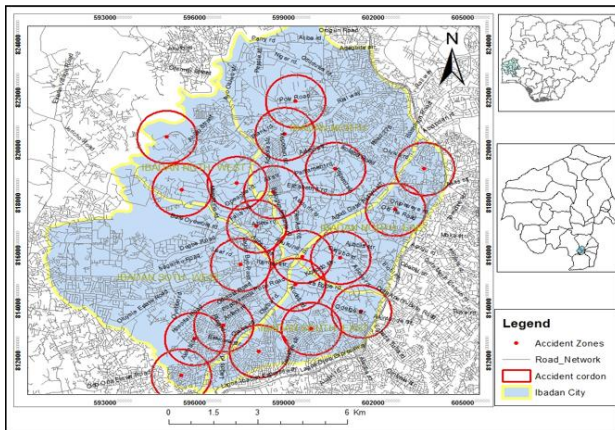


Figure 1. Map of Ibadan showing the cordoned area

3.1. Sampling Procedure

The sampling procedure that was used in this study is the stratified and simple random technique. Stratification was used to delineate the city into regions using available information from police records, applying the buffering tool in the ArcGIS 10.2. The delineated or cordoned area was visited with a questionnaire using a simple random sampling technique to pick and identify candidates for interview within the (stratified/delineated) cordoned distance of one kilometer (1km).

3.2. Sources of Data

Data for the research were sourced through primary and secondary sources.

Primary sources: the primary data used for this work were obtained from the administration of a predetermined questionnaires, direct observation and oral interviews. Forty questionnaires were administered in each zone, making a total of two hundred within Ibadan city of Oyo State. These instruments were needed to harvest information on the depth of their traffic education and understanding of the road signs and symbols.

Secondary sources: Information on traffic accidents was sourced from the police traffic records. The Nigerian transport system and the place for a vibrant traffic education system, among others, are derived from journals. Write-ups on the importance of traffic education and the need to ensure safety on roads, and the need to imbibe positive attitude and behavior among others were retrieved from the internet. The analog map of Ibadan city was also collected from the State Ministry of Lands and Survey in Ibadan, and the road map of the city was sourced from the Oyo State Ministry of Transport.

3.3. Creation of Spatial Data

The most distinguishing feature of the GIS tool is its spatial analysis capabilities; it can process data to derive new information. Accident data were collected from the archive of the Nigeria Police traffic Department State headquarters in Ibadan Oyo State. The Accident records for Ibadan city for the period of (2018-2023) were used for this study. Database (attribute data) created in a table format showing accident

type, number of occurrences, and streets/roads in the local government of occurrence. The analog map and the road map were scanned, georeferenced, and digitized in ArcGIS 10.2. A global positioning system (GPS) device shall be used to take the coordinates of the locations where accidents have occurred in Ibadan city.

3.4. Road traffic crash georeferencing

Georeferencing is the creation of a database that enables us to tie a particular event in geographical space to a location with the use of a GPS (global positioning system). As a result, streets given in the police records were divided into groups, and a table was created with spaces to record the name of the street, the point (x and y, coordinates), and the local government area using the GPS. The Spatial analysis to be carried out will include buffering analysis (cordoning), Trend Analysis, nearest neighbor analysis, and accident distance decay, as thematic maps were used to show the accident situations and their uniqueness across the local government in Ibadan city.

4. Results

On the analysis of the collected data through data acquisition from police records, questionnaires, observation, and literature review. The police traffic department records reveal streets and roads where accidents occurred in the period under review. A GPS global positioning system device was used to take the geographical coordinates of the streets. On this basis, a 1-kilometer cordoned area was established around the zones for questionnaire administration. Hypothesis testing was done using the scores from the questionnaire and the rate of traffic accident occurrence in the SPSS environment to find the correlation analysis.

The results from the questionnaire were based on 100%, and it is related to the available data on accidents from the police records and subjected to correlation analysis in the SPSS environment, which established the correlation/relationship between the level of traffic safety awareness and usage and the rate of accident occurrence in the city. Also, descriptive statistics were applied to the data collected from the traffic department of the Nigerian police, and the data is displayed using various charts and graphs in Microsoft Excel to enhance understanding.

Table 1. Survey ratings for zones (Source: field work)

Road signs understanding rating in % (x)	No of accidents (y)	Zones
95	11	Salvation Army Road
80	19	Ojo-Oba Road
79	15	Baale Akintayo Road
79	11	Elizabeth Road
78	19	Tunji Aderinlo Street
73	19	Lam Adesina Road
73	18	Amadiyya Street
72	18	Oderinlo Street
68	19	Poly Igokodo Road
65	24	Omilabu Street
65	20	Onireke Road
61	23	Agodi Gate Road
55	24	Odo-Ona Elewe Road
55	20	Akintayo Street
52	27	Plank Road
48	20	Adegun Street
45	26	Ayo Adesina Street
45	28	Poly Road
43	34	Kobomoji Street
42	24	Lanre Adepoju

Table 2. The magnitude of the accidents in the study area (Source: Police traffic department records)

LGA	Zone	Number Of Accident Cases
Ibadan North	Poly Road	28
	Plank Road	27
	Agodi Gate	23
	Elizabeth Road	11
Ibadan North East	Baale Akintayo Road	15
	Poly Igokodo Road	19
	Onireke Road	20
	Salvation Ary Road	11
Ibadan South West	Amadeyya Street	18
	Adegun Street	20
	Lanre Adepoju	24
	Odo-Ona Elewe Road	24
Ibadan South East	Omilabu Street	24
	Ojo-Oba Road	19
	Akintayo Street	20
	Lam Adasina Street	19
Ibadan North East	Tunji Adrinlo Street	19
	Ayo Adesina Street	26
	Kobomoji Street	34
	Oderinlo Street	18

Roads in Ibadan city are frequented by a great diversity of users, particularly young and old, who use different types of vehicles, as well as pedestrians, who constitute the group at highest risk of being involved in a road crash. Vehicle fleets, including trucks, minibusses, and taxis, are also growing in number. Motorcycles have become the most popular form of transport within the city. The number of motor vehicles in operation is growing rapidly, resulting in a surprising level of violence on the road. This situation is likely to worsen unless firm and coordinated measures are taken; death and injury on the roads is quite a phenomenon, an indication that the road safety awareness level is still not high enough.

4.1. The Vehicles that are involved in road traffic crashes

Table 3 shows the number of times the various types have been involved in accidents in the city in the period under review. Accidents involving motorcycles appear to be more frequent than any other type of accident in the neighborhood. In the period under review, motorcycle accidents account for 74.55% of the total accidents in the neighborhood of Ibadan city.

Table 3. Vehicles, years, and percentage of accident involvement (Source: Police traffic department)

Year	Motorcycle	Car	Lorry	Bus	Total
2003	21 (51%)	16 (39%)	NA	4 (10%)	41
2004	19 (59%)	5 (15%)	1 (3%)	7 (22%)	32
2005	60 (87%)	4 (6%)	0	5 (7%)	69
2006	25 (78%)	4 (13%)	1 (3%)	2 (6%)	32
2007	19 (59%)	5 (16%)	1 (3%)	8 (25%)	32
2008	25 (86%)	3 (10%)	0	1 (4%)	29
2009	32 (74%)	7 (16%)	NA	4 (9%)	43
2010	27 (79%)	4 (12%)	3 (9%)	1 (3%)	34
2011	19 (76%)	1 (4%)	3 (12%)	2 (8%)	25
2012	23 (88%)	1 (4%)	2(8%)	0	26
2013	20 (83%)	3 (13%)	0	1 (4%)	24
	290 (74.55%)	53 (13.60%)	11 (2.80%)	35 (9.0%)	389

The next is an accident involving cars, which accounts for 13.60%; this is followed by accidents involving buses, responsible for 9.00%, and Lorries, 2.80%. This can be attributed to the level of education of the motorcycle riders, who are mainly not well educated and lack adequate knowledge of road safety principles.

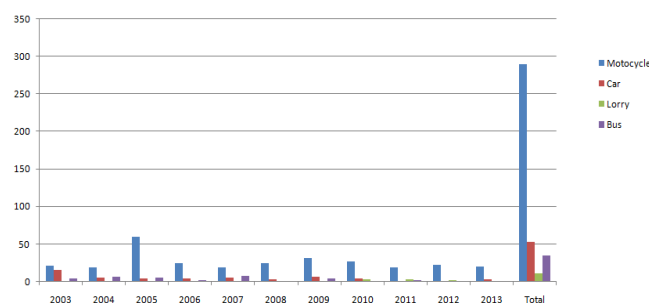


Figure 2. The years and vehicles involved in the accident

The graph in Figure 2 shows that accidents involving motorcycles were highest in the year 2005. This is because most riders are not properly trained and, as a result, do not know the traffic signs and symbols, let alone obey them. It was observed that motorcycles are the most involved in traffic accidents in the city, followed by cars, buses, and Lorries respectively. The year 2005 is seen to be the year with the highest incidence of traffic accidents, with motorcycles being the highest contributor.

4.2. Spatial Analysis of the Safety Consciousness Levels

The data in Tables 1-3 were imported into ArcGIS 10.2 for spatial analysis of accident locations in the study area. The results are presented below as diagrams and thematic maps.

Nearest neighbors analysis

This analysis helps us to find out if accident occurrences are evenly spread, distributed, or clustered in a particular region in the city. The result is shown in Figure 3.

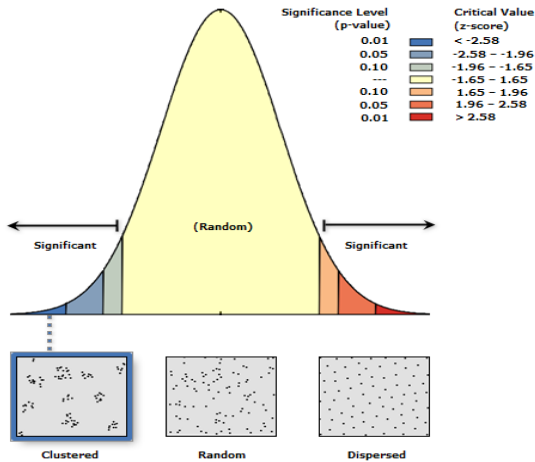


Figure 3. Spatial analysis of accident occurrence in Ibadan city.

The p-value is 0.01, which is greater than -2.52, which is the z-score. This result means that the distribution of accident incidences across Ibadan city is clustered. Implies that accident incidences are more in some areas because of the lack of presence of the enforcement agents in those areas, which has created a large distance corridor for the intending traffic offender to go unchecked and unpunished each time the rules are broken.

Distance decay analysis

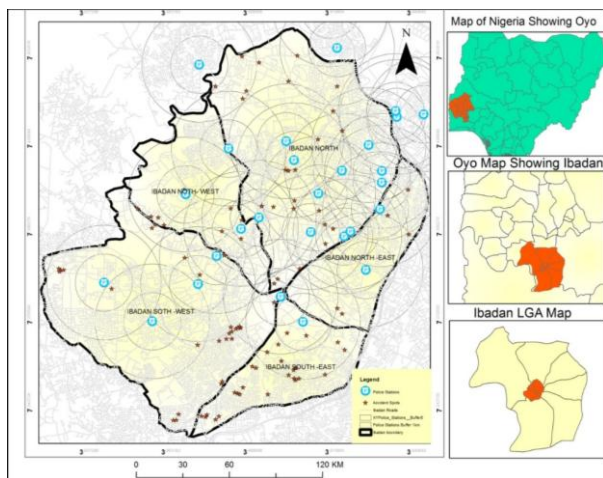


Figure 4. Map of Ibadan city showing the buffered police station.

From Table 4, of 408 accident occurrences in the police records, 52 occurred within 1 kilometer of a police station, 121 within 2 kilometers, and the rest outside 2 kilometers. And 145 happened within 3km.

Table 4. Distance decay and accident occurrence

Buffered distance	No. of Accident
1km	52
2km	121
3km	145

This means the accident rate increases as you move away from the police post or traffic regulation agents. Implies that carelessness and disobedience to traffic signs and symbols increase when enforcement agents are not in a position to sanction or arrest. Local government area in the city with fewer police stations has a higher number of accidents within the neighborhood.

Safety consciousness levels

The data at the local government level, i.e., the local governments that make up Ibadan city, are in Table 5. It was observed that some types of accidents are prevalent or peculiar to specific local government areas, based on the type of vehicles that are involved. This reveals that the knowledge levels of road users vary with the type of vehicle they are using. This explained why some types of accidents are more frequent in some locations than others, as safety awareness levels increase with an increase in knowledge of road usage education. This data was used to create thematic maps aimed to drive home the prevailing safety situation and consciousness in each of the Local government areas, using ArcGIS computer software.

Table 5. The types of Accidents in Ibadan city (Source: Police traffic department)

LGA	MC/MC	Car/MC	Car/Car	MC/Ped	Car/Ped.	Total
IBA N	26	20	16	19	14	95
IBA S\E	25	21	5	24	20	95
IBA N\W	26	20	4	19	26	95
IBA S\W	27	25	4	81	21	158
IBA N\E	32	13	5	25	20	95
Total	136	99	34	131	121	538

Motorcycle-to-Motorcycle Safety Consciousness Level

This refers to accidents that occurred between motorcycles on the street and city roads.

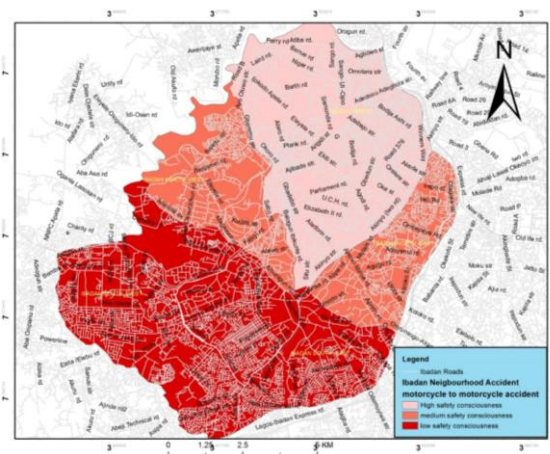


Figure 5. Map of Ibadan showing motorcycle-to-motorcycle safety consciousness levels.

The map in Figure 5 shows the level of safety consciousness among motorcycle users. It reveals that Ibadan South West and South East LGA are very low in safety consciousness level in terms of motorcycle usage. This mainly involves commercial motorcycle riders who do not go through proper training before they get on the road with the intention of making money. They are only conscious of who and where they will carry the next passenger. Another factor responsible could also be the smooth road in the locality, which promotes speed. The people mostly involved are students and workers who will not call their riders to order, either because they do not know or because they are too hasty to get to school or the workplace as soon as possible. These two local governments recorded motorcycle accidents, which means their awareness of motorcycle use is still very low, and so enlightenment and education on traffic laws and regulations will be needed to arrest the situation. Ibadan North is seen to be the most traffic safety conscious, followed by Ibadan North West and Ibadan North East.

Motorcycle-to-Pedestrians Safety Consciousness Levels

This refers to accidents that occurred between motorcycles and pedestrians on the street and city roads.

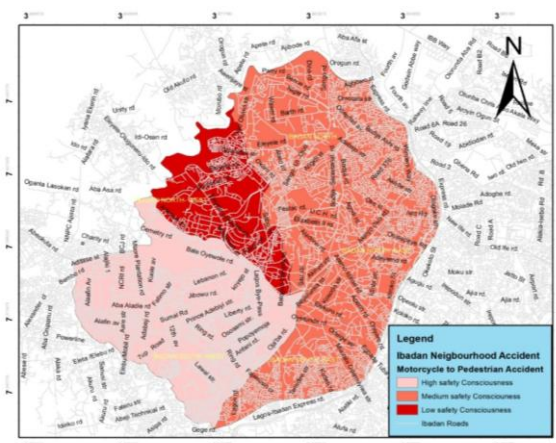


Figure 6. Map of Ibadan showing motorcycle-to-pedestrian safety consciousness levels.

The consciousness level in the use of the road between pedestrian and motorcycle users is seen to be very low in Ibadan North West LGA (see Figure 6). The streets here are relatively paved; there is more paved street in this LGA. It could be that the people here do not know how to cross the road, especially school children. Adults are also not left out, as adults are usually victims due to the carelessness and lack of respect for pedestrians on the part of motorcycle riders. Ibadan Southwest is observed to be the most safety-conscious LGA in terms of accidents involving pedestrians and motorcycles. It is also observed that the people here are educated, which may have influenced their road safety consciousness level. But the levels of consciousness in Ibadan North and Ibadan North East are medium.

Car-to-motorcycle safety consciousness levels

This refers to accidents that occurred between cars and motorcycles on the street and city roads.

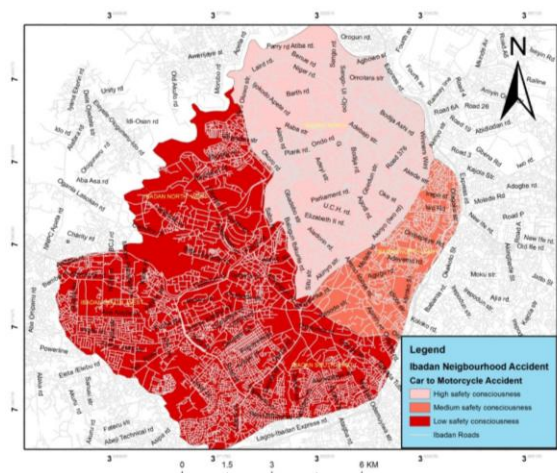


Figure 7. Map of Ibadan showing car-to-motorcycle safety consciousness levels.

Ibadan North West, Ibadan South West, and Ibadan South East local government areas are observed to have the highest reported accident cases between cars and motorcycles from the map in Figure 7. By implication, it can be said to have the lowest road safety consciousness level in terms of car-to-motorcycle accidents. This is associated with distraction on the part of car drivers due to the use of mobile phones during driving, mostly within the city, where there are no traffic officials to check them, bearing in mind the risky behavior of the average motorcycle rider. This act reduces driving performance in a number of ways, such as longer braking reaction time, reaction to traffic signals, and inability to keep in the correct lane, among others. Ibadan North has the highest consciousness level, followed by Ibadan North East.

Car-to-car safety consciousness levels

This refers to accidents that occurred between cars on the street and city roads.

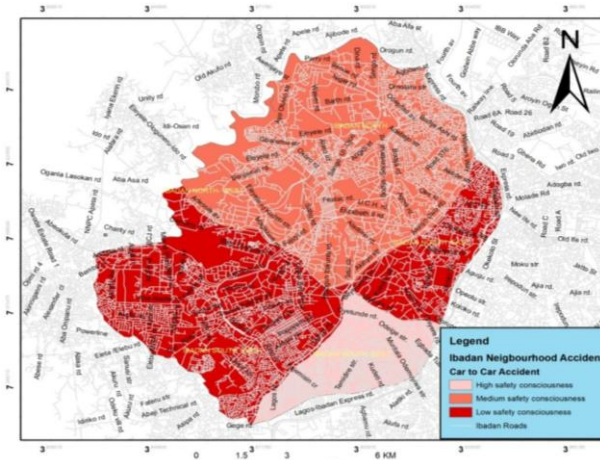


Figure 8. Map of Ibadan showing car-to-car safety consciousness levels.

The majority of drivers in Ibadan South West and Ibadan North East do not possess the right authorization from government-authorized agencies like the Federal Road Safety Commission, FRSC, and are unqualified to drive cars on the main road. This has made the safety level in the areas low.

This accounts for the high accident rate between cars; most drivers are ignorant of highway codes or traffic orders. They put their lives and those of other road users at risk of traffic accidents. As a result of their inexperience, since they were never given any tutorial or taught how to use vehicles on the road by government-accredited driving schools, their decision-making ability and reaction speed to traffic are bad. Ibadan North West and North East are moderate in their awareness levels, while Ibadan South East has the highest consciousness level (see Figure 8).

Car-to-Pedestrian Safety Consciousness Levels

This refers to accidents that occurred between cars and pedestrians on the street and city roads.

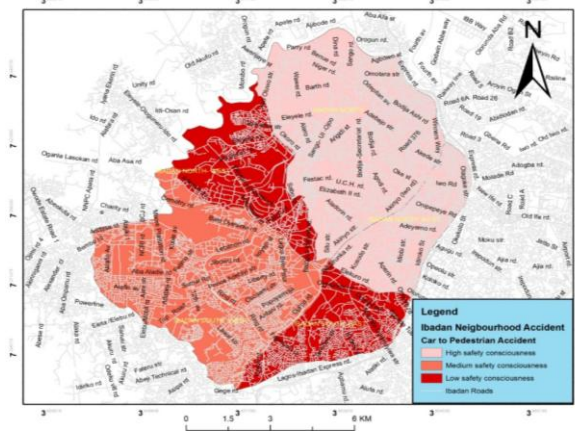


Figure 9. Map of Ibadan showing car-to-pedestrian safety consciousness levels.

Ibadan South East and North West are known for a high level of cars knocking people down. As observed, many roads in this LGA are paved, but there are no pedestrian footbridges. Where safety consciousness is high, people would have requested the construction of footbridges. But in Ibadan North and North East, footbridges or zebra crossings are made available to ensure the safety of the people, and if they use them, we can then say that the road safety consciousness level is very high, whereas in Ibadan South West, the safety consciousness level is at a medium level (see Figure 9).

Trends of accidents across the study area

Trend analysis refers to the general direction of movement to which the overall accident situation is trending across the city. The trend tool is available in the Spatial Analysis toolbox in ArcGIS. A critical look reveals that the general movement of accidents across the city is from west to east. From the map in Figure 10, areas with very low accident occurrence are shifting from the west of the city to the east, implying that as you move eastward, accident occurrence increases. It further shows that attention must be given to the two LGAs that are located in the Eastern part of Ibadan city, which are Ibadan South East and Ibadan North East, as a proactive measure to manage accident cases, which include education, enforcement, and road maintenance, to reverse this trend.

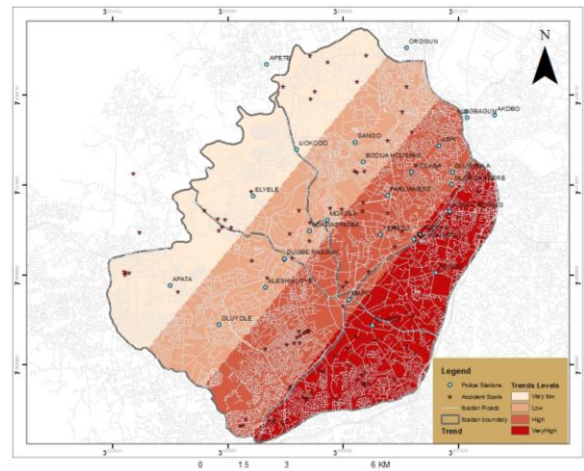


Figure 10. Ibadan city map showing the trend of accidents.

Accident incidences are observed to have a clustered distribution pattern across the city, while each LGA in the city has a dominant type of traffic accident associated with it. It was also seen that the movement direction of accidents across the city is West to East, as the number of traffic accidents increases as one moves further away from the police station or post.

The General Safety Consciousness Level

The map in Figure 11 shows the general road safety consciousness level. It is the combination of all the various types of accidents in the city, with the aim to know which of the local governments within the city has the lowest level of safety consciousness, as such a local government will have the highest accident occurrence.

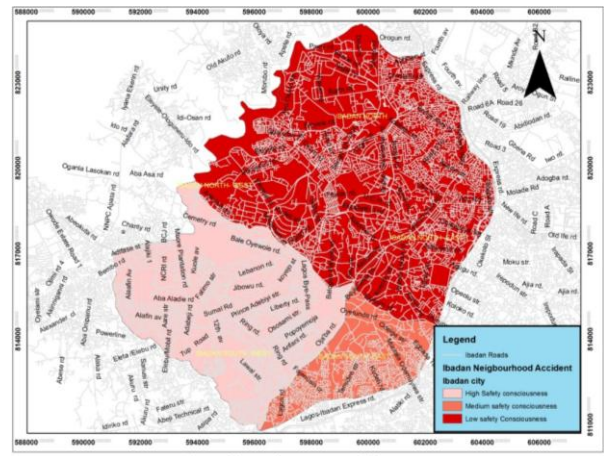


Figure 11. Map of Ibadan showing the general safety consciousness levels.

The map (Figure 11) shows the safety consciousness level of the entire Ibadan city as it concerns all the various categories of accidents. Ibadan South West is seen to have the lowest incidence of accidents when all occurrences are put together in the period under review. Ibadan South East is the next, while Ibadan North West, Ibadan North, and Ibadan North East are the worst, and by implication, the safety consciousness level in these LGAs needs to be improved upon so that the roads will be safe for use by all.

5. Factors Responsible for Road Traffic Crash Occurrences

Table 5 shows the causes of accidents in Ibadan city. As shown in Table 6, these causes are divided into three major factors. This includes driver-related factors, vehicle-related factors, and environmental factors. Each of the factors has contributed at different levels to accident occurrence in the study area.

Table 6. The factors responsible for accidents in the city. (Source: Police traffic department 2018-2023)

Factors	Magnitude of occurrence	Contribution %
Drivers related factors		
Over speeding	18	16.4%
Drink driving/drugs	11	10%
Distracted driving	10	9%
Inexperienced/unqualified drivers	20	18.2%
<i>Total</i>	<i>59</i>	<i>53.6%</i>
Vehicle-related factors		
Vehicle brake failure	15	13.6%
Vehicle tyres	12	11%
Vehicle light	10	9%
<i>Total</i>	<i>37</i>	<i>33.6%</i>
Environmental factors		
Bad roads/potholes	9	8.2%
Street trading	10	9%
Poor visibility	7	6.4%
<i>Total</i>	<i>26</i>	<i>23.6%</i>

5.1. Driver-Related Factors

The driver-related factors contributed 53.6% of the total accident occurrences within the period under review. The unsafe actions of the drivers that cause a traffic accident include:

Speed and indiscriminate use of Sirens

An increase in average speed is directly related both to the likelihood of a crash occurring and to the severity of the consequences of the crash. Traveling too fast for prevailing conditions or above the speed limit contributes to road traffic accidents. The risk of being injured increases exponentially with speed, much faster than the average speed. The severity of the accident depends on the vehicle speed change at impact and the transfer of kinetic energy. Though vehicles traveling slower than average speed are also at increased risk of road traffic accidents. From the data above, this unsafe act has happened 18 (eighteen) times, contributing 16.4% to accidents in the period under review. This action is mostly carried out by private or public office holders, such as bank vehicle drivers or government vehicle drivers.

Drink-driving and use of drugs

Drinking and driving increases both the risk of a traffic accident and the likelihood that death or serious injury will result. The risk of being involved in a traffic accident increases significantly above a blood alcohol concentration. Doctors often advise patients to abstain from driving vehicles or operating machinery while under certain drugs, as these drugs are known to cause side effects of sleepiness and fatigue. Accidents that occurred due to this action have hap-

pened 11 (eleven) times, contributing 10% to accidents in the period under review.

Distracted driving

There are many types of distractions that can lead to impaired driving, but recently, there has been a marked increase around the world in the use of mobile phones by drivers, which is becoming a growing concern for road safety. The distraction caused by mobile phones can impair driving performance in a number of ways, e.g., longer reaction times (notably braking reaction time, but also reaction to traffic signals), impaired ability to keep in the correct lane, and shorter following distances. Text messaging also results in considerably reduced driving performance, with young drivers at particular risk of the effects of distraction resulting from this use. Drivers using a mobile phone are approximately four times more likely to be involved in a traffic accident than when a driver does not use a phone. Hands-free phones are not much safer than hand-held phone sets, as they too have been recorded to result in traffic accidents when shocking news is received while driving. This unsafe act has caused accident situations 10 (ten) times, contributing 9% to accidents in the period under review.

Inexperienced and unqualified drivers

The majority of drivers do not possess the right authorization from government-authorized agencies like the Federal Road Safety Commission, FRSC, and are unqualified before driving cars or any other vehicle on road pavements. This is the major reason most drivers are ignorant of highway codes or traffic signs and symbols. They put their lives and those of other road users at risk of traffic accidents. As a result of their inexperience, since they were never given any tutorial or taught how to use their vehicles on highways by government accredited driving schools, their decision making ability and reaction speed to traffic is bad. Ibadan city has experienced accidents that result from inexperience 20 (twenty) times, or contributing 18.2% to accidents during the period under review.

5.2. Vehicle Factors

This factor has contributed 33.6% of the total accidents in the city during the period under review. The vehicle itself is a key factor when analyzing the remote causes of a traffic accident, and it is incorporated with gadgets like the horn, side mirrors, wipers, braking system, trafficators, headlights, and brake-lights (to mention just a few) so as to avoid road accidents. Malfunction of any vehicle parts, such as tires, engines, braking systems, or the lighting systems, can cause road traffic accidents. The reliability of the vehicle is in itself a function of the condition of the vehicle at every given time. Vehicle components and vehicle maintenance are the two main conditions that affect vehicle factors as they relate to the causes of road traffic accidents. Some of the unsafe conditions of vehicles include:

Vehicle Brake System

Brakes are generally applied to rotating axles or wheels. Vehicles use a combination of braking mechanisms that work

jointly with the accelerator as the main synchronizer of the speeds of vehicles. Any malfunctioning of the brake sub-system should be taken very seriously as a potential source of an unavoidable accident. Available data shows that a brake failure resulting in a traffic accident has occurred 15 (fifteen) times, contributing 13.6% to accidents in the period under review.

Vehicle Body and Tyres

The firmness of the structure of a vehicle, though less prominent, contributes to some measure to causing road traffic accidents. One of the dominant factors in determining the stability and safety of vehicles on the road is the tyres. Tyres designed and specified for cold regions are not those specified for temperate regions like Nigeria. However, this is not the case with most tyres used in Nigeria, as vehicle owners do not take the specification of tires into consideration when buying and fixing tyres onto their vehicles, and this has been known to cause tyre ruptures, thus leading to traffic accidents. Some other tyre-related causes of road accidents could be due to one or a combination of over-inflated tyres, under-inflated tyres, thread of tyres are thoroughly worn out. Accidents involving vehicles have occurred 12 (twelve) times, contributing 11% to the accident situation.

Vehicle Lights

The failure of vehicle lights is a major factor in road traffic accidents. Failure of vehicle lights has a tendency to misinform and mislead other road users, thereby providing a good opportunity for an accident to occur. Vehicle lights are very useful at all times during the day, in the dark, and in poor/bad weather. For example, a failed trafficator light of a vehicle ahead will not normally provide the usual warning to other vehicles behind that it is about to undertake a turning manoeuvre, and if for instance, the driver of the vehicle behind has not allowed for a sufficient stopping sight distance or the vehicle has a faulty brake sub-system, this could result in an accident occurring. These poor conditions of vehicles have produced 10 (ten) or contributing 9% of the reported accident cases in the city.

5.3. Environmental Factors

Environmentally related conditions, such as fog, sunrays, mist, and rain, in no small measure, contribute greatly to the rate of road traffic accidents. A poorly maintained vehicle, for example, on a rainy day, is most likely to cause a road traffic accident if the wipers are faulty and not functioning, as the driver will be unable to see ahead. Hence, environmental factors contributed 23.6% of the total accidents that occurred in the city in the period under review.

Accidents due to poor visibility occurred 7 (seven) times, contributing 6.4% to accidents. Our roads are often poorly designed, necessary important road facilities like drains are not adequately provided for, and to top it all off, they are rarely rehabilitated and are in a dilapidated state.

Poor condition of the roads, the city has experienced 9 (nine) times, contributing 8.2% to accidents due to this poor condition of the roads.

Street trading is another serious environmental condition that results in accidents in the city as vehicle drivers try to avoid people. The city has seen 10 (ten) times, or contributing 9% to accidents of this type.

6. Conclusions

In conclusion, a hypothesis test is aimed at determining whether there is a relationship between the Level of Traffic Education awareness and Road Accident Occurrences. Stated as thus:

H₀: There is no significant relationship between the level of traffic education awareness and usage and road accident occurrences.

H₁: There is a significant relationship between the level of traffic education awareness and usage and road accident occurrences.

Table 2 shows the number of accidents that have occurred in the study area within the period under review as obtained from the police traffic records, and Table 1 responds to the questionnaire, where respondents answered YES or NO to traffic and regulation as a way to test their level of safety awareness and compliance with traffic regulations. The “YES” percentages were rated against the “NO” percentages. It was entered into the SPSS (17.0) environment. The rating for each of the areas or zones was taken as X, while the number of accidents in each of the areas or zones was given by the police traffic department and was taken as Y; correlation analysis was carried out on the data. The results are presented in Table 7.

Table 7. The result of the correlation analysis

	Sign Ratings (%)	No. of Accident
Sign Ratings (%)		
Pearson Correlation	1	0.827
Sig. (2-tailed)		0.000
N	20	20
No. of Accident		
Pearson Correlation	0.827	1
Sig. (2-tailed)	0.000	
N	20	20

Table 7 presents the results of the correlation analysis. The calculated r was 0.827; p-values were < .01. This indicates a strong correlation between accident occurrences and the level of awareness of road signs and symbols. 0.827 indicates that the high safety of road users is greatly dependent on the level of awareness of road sign usage, and this, however, leads to a reduction in the occurrence of road accidents in the city. This, therefore, implies that there is a noticeable reduction in accident occurrences as road safety awareness and usage consciousness increase. We therefore accept the alternate hypothesis that states there is a significant relationship between the level of traffic education awareness and usage and road accident occurrences.

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