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## Mapping and Analysis of the Temporal Changes of Road Traffic Accident Hotspots Using GIS and Remote Sensing in Owerri, Imo State, Nigeria

**Egenamba Juliet Ngozi**

Lecturer, Department of Surveying and Geo-informatics,  
Federal Polytechnic Nekede, Owerri, Imo State, Nigeria

**Dr. Baywood Ceciliar Nkechiis**

Lecturer, Department of Surveying and Geo-informatics,  
Federal University of Technology, Owerri, Nigeria

**Yusuf, Muntairu Abdulwaheed**

Lecturer, Department of Surveying and Geo-informatics,  
Federal Polytechnic Nekede, Owerri Imo State, Nigeria

### **Abstract:**

*The accident rates per vehicle in Nigeria are alarmingly high. The traffic condition in the city of Owerri is no different. The traffic accidents are predictable and can be avoided by improving preventions. These pose a lot of concern in Owerri Municipal Council and its environs of Imo State, Nigeria because road traffic accident has done more harm than good in the city, it has led to loss of lives and properties, severe injuries and pains and above all it has deteriorated the socio-economic growth and development of the city. This paper is aimed at mapping and analysis of the temporal changes of road traffic accident hotspots using GIS and Remote Sensing in Owerri Municipal Council and its environs in Imo State, Nigeria. The methodology adopted was the GIS method of Digitization/Data conversion, Creation of relational database table of road traffic accident hotspots records and performance of GIS analysis such as spatial queries, buffering operation and spatial overlay using Arc GIS 10.3 and Infoterra satellite imagery of 0.5 resolution. Test of hypothesis using Chi-Square was also used to analyze the data obtained from social survey (questionnaires). Result showed that there was an increase in road traffic accidents (RTAs), RTDs, RTIs and Car damages in 2017 than in 2016. Depression and Careless Driving, Over-speeding, night driving and impatience and were the major Human factors that contributed to the cause of the road accidents in 2017. Vehicle with bad tyres and no speed limits contributed to road accidents. Tarred and pothole roads and Driving during Rainy Season were observed to be the highest Road factor that contributed to the cause of accidents. Hotspot cluster was along Owerri-Okigwe Road at IMSU junction. It was recommended that there should be good quality roads and the bad ones should be frequently maintained; people should be made to know the importance of Safe Landing when driving; Speed limit control/gadgets should be made compulsory, every vehicle found without speed limit gadgets should be penalized; there should be strict adherence and enforcement of road safety measures and rules on road users and drivers, defaulters should be heavily penalized and punished. The Digital map, the results obtained in both queries and SPSS were shown in digital thematic maps, tabular data and charts respectively.*

**Keywords:** Accident hotspots, road transportation, road traffic safety, road traffic accident, temporal changes, spatial query, GIS and remote sensing

### **1. Introduction**

The socio-economic growth and development of the country is highly dependent on the level and safety of its transportation system. Road Transportation systems are designed to move people, goods, and services efficiently, economically, and safely from one place to another (Adeofun and Oyedepo, 2011). Despite this, there are many accidents that are commonly encountered at a variety of spatial and temporal scale. Road Traffic Accident Hotspot refers to a place where most of the accident happens/occurs. It appears to occur regularly at some flash points such as sharp bends, potholes, and curved sections of the highway. At such points, over speeding drivers usually find it difficult to control their vehicles, which then results in fatal and other types of road traffic accidents Tessa, (2006). Road traffic safety refers to the methods or measures used to prevent road users from being killed or seriously injured (Aliyu, 2012). Typical road users include pedestrians, cyclists, motorists, vehicle passengers, horse riders and passengers, on road public transport (mainly buses). Road Traffic Accidents are one of the world's largest public health and injury problems. It is the leading causes of injuries and deaths globally (Onyikwu 2016). Road Traffic Accident occurs when a vehicle that is moving along a road way

collides with another vehicle or object. It is any injury due to crashes originating from terminating with or involving a vehicle partially or fully on a public road. It is projected that road traffic accident injuries will move up to the third position by year 2020 among other leading causes of the global disease burden. They are considerable economic losses to victims, their families, and to a country as a whole (Rouzbeh and Shahriar, 2017).

There are different causes of road traffic accidents which includes; Lack of appropriate road engineering; Poor awareness levels; Rapid urbanization motorization; Non-existent injury prevention programs. The most important factors are driver's behavior, vehicle characteristics and roadway design. The major cause of road traffic accident was careless driving. The majority of accident victims were among the most productive class in the society; age group 15-40 years. Road traffic accidents were the third leading cause of death after the diseases of the circulating system and cancer.

There is no enough data in the relationship between road characteristics and road traffic accident severity in Imo State, Owerri Municipal Council. However, according to the Federal Road Safety Commission (FRSC) report, the death rate due to car accidents are significantly increasing among pedestrians and passengers due to bad road from time to time in Owerri Municipal Council. As a result of this road traffic accident, there are likely to be accident hotspot, that is, where all these accidents occur. The high traffic volume in Owerri Municipality has become a source of concern to the people, especially its negative effects on the economic growth and development. The application of Geographic Information System (GIS) technology will reduce the pattern, rate and effects of road traffic accidents in Owerri Municipal.

### 1.1. Statement of Problem

The nature of transportation provides enhanced opportunities, but it is also a risk to travelers, drivers and pedestrians (Tesfalem, 2010). In this regard, Mekete (2000) cited in Tesfalem (2010) indicated that despite the important positive role urban transport plays in economic, social and political activities of cities and towns, it also generates major social and economic problems through traffic accident. World Health Organization (1998) ranked road accidents as the 9th leading cause of mortality in the world. It estimated that 1.17 million death occur each year worldwide due to road traffic accident. According to Atubi (2010b), a breakdown of the figure indicates however that about 70 per cent of the death occurs in developing countries like Nigeria. (Filani and Gbadamosi, 2007) attributed the high burden of traffic injury mortality in Nigeria to unsafe road environments, poor enforcement of existing traffic laws, road rage and aggressive driving as well as alcohol misuse. Institutional interventions through legislation and enforcement such as speed controls, vehicle safety inspections and driver testing systems such as a compulsory defensive driver's course for drivers of public service have been implemented (Filani and Gbadamosi, 2007).

Therefore, there is a need for optimizing Road Traffic Accidents (RTA) resources by identifying areas of priority in the Owerri Capital City of Imo State. This is aimed at providing a better understanding of the patterns and trends of road traffic fatal accidents in the study area. It is also important to find out the contributing factors associated with road traffic fatal accidents in the hotspots. In Owerri, RTA data is collected through the accident report forms, which are completed by the police. Data on RTA is then forwarded to a variety of agencies which include the Road Transportation and Traffic Law Enforcement in Nigeria and Federal Road Safety Corps for storage, analysis and Statistics (Oyeyemi, 2003).

The traditional way of RTA analysis has involved a plethora of statistical models (Oulha, 2013). However, statistical approaches to RTA neglect the spatial dimension of risks and their distribution (Oulha, 2013). Spatiotemporal mapping and analysis of RTA hotspots in GIS is considered one of the elementary steps to lessen road accident rates (Anderson, 2009). This will assist in identifying such accident hotspots and caution road users accordingly.

In Owerri, the problem of managing and control the alarming rate of road traffic accidents caused by bad roads, drivers' carelessness or fault, vehicular malfunctioning, weather condition etc. has not been solved hence, this research. The application of Geographic Information System in the mapping and analysis of road traffic accident in Owerri Capital City of Imo State Nigeria is of utmost importance as the tool will help in the control, management and reduction of the large occurrences of road traffic accident in the state which will enhance socio-economic growth and development of the state.

### 1.2. Aim and Objectives

This paper is aimed at mapping and analysis of the temporal changes of road traffic accident hotspots using Geographic Information System (GIS) and Remote Sensing approaches in Owerri Municipal Council and its environs in Imo State, Nigeria. The objectives to achieve the above research aim are as follows:

- To map the spatial distribution, analyze the pattern of distribution and time of occurrence of the road traffic accident hotspots in the Owerri Capital city.
- To determine the factors that contribute to the occurrence of road traffic accidents and accident hotspots and to analyze the social effect/impact of road accidents in Owerri Capital City.
- To analyze the alternative measures that can be implemented to improve road safety and to minimize the occurrence and costs of road accidents in Owerri Capital City.
- To determine the temporal changes in the occurrence of road traffic accidents hotspots in the study area.
- To analyze the nature of road traffic accidents hotspots in the study area.

### 1.3. Significance of the Study

Accident information is useful to different stakeholders. The results of this study provide the Road Transportation and Traffic Law Enforcement in Nigeria, Federal Road Safety Corps, Owerri Municipality City Engineers, Police, Town Planners and drivers, with the spatial distribution of risky road segments and in particular, the location of road traffic fatal accidents hotspots in Owerri Capital City. This information can be used as the basis for improving road safety by allocating

resources in high priority areas (Anderson, 2009; Mitra, 2010; Chen et al. 2011). Thus, it will provide the fundamental scientific approach in identifying, managing and preventing RTAs hotspots.

#### 1.4. How Different Factors Contribute in Road Traffic Accidents

- Drivers: over speeding, rash driving, violation of rules, failure to understand signs, fatigue, alcohol.
- Pedestrians: Carelessness, Illiteracy, crossing at wrong places, moving on carriage way, jay walkers.
- Passengers: Projecting their body outside vehicle, by talking to drivers, alighting and boarding vehicle from wrong side, travelling on footboards, catching a running bus etc.
- Vehicles: Failure of brakes or steering, tire burst, insufficient headlights, overloading, projecting loads.
- Road Conditions: Potholes, damaged road, eroded road, merging of rural roads with highways, diversion, and illegal speed breakers.
- Weather Conditions: Heavy rainfall, wind storms, heat.

These factors are grouped into 3 major factors

- Human factor
- Vehicular factor
- Road and environmental factor

## 2. Material and Methods

### 2.1. Study Area

Owerri Municipal Council and its environs consist of Owerri Municipal and some parts of Owerri North and Owerri West, all in Owerri Federal Constituency Imo State. They are the 3 local Governments in Imo State that make up Owerri Federal Constituency. Owerri lies between Latitude  $05^{\circ}25'57''$  North of the equator and Longitude  $07^{\circ}01'04''$  East of the Green-wish Meridian. Its head-quarter is in the city of Owerri. It has an area of 175,395 according to the census, with a 460 postal code. This is shown in Figure 1, Figure 2 and Figure 3.

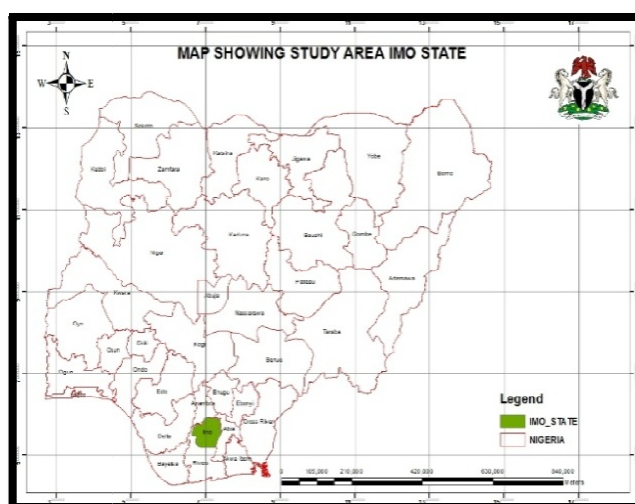


Figure 1: Administrative Map of Nigeria

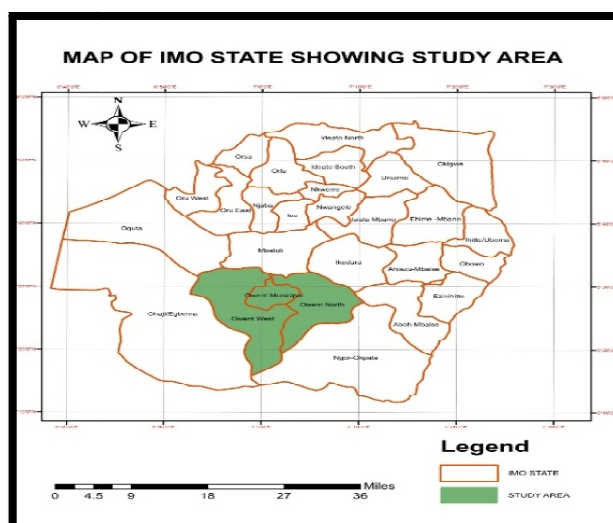


Figure 2: Map of Owerri Municipal, Owerri North and Owerri West



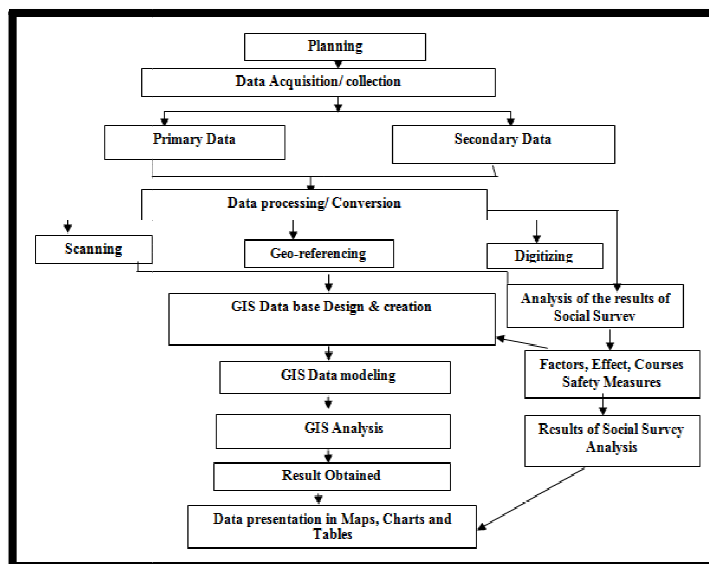


Figure 4: Flowchart of Methodology

## 2.4. Data Conversion

### 2.4.1. Scanning, Geo-referencing and Vectorization

This stage involved the conversion of the Administrative map of Owerri Municipal Council which was originally in analogue format into a computer-based format using the AO scanner. Subsequently, the scanned topographic map was exported to the Arc Map environment for geo-referencing using the Arc GIS 10.3 software. This was then followed by the creation and on-screen digitizing of CAD layers for each of the geographic features and classes on the map, this is done in order to get a vectorized map of the local Government Area. Each of the layers later became themes. The following themes were available among others: major roads, streets, locality, water body, canal, marshy areas, towns, villages, administrative boundaries, local government boundaries etc.

### 2.4.2. G.P.S Mapping of Road Traffic Accident Hotspots and Data Processing

GPS positions of various road traffic accident hotspots occurrences and other points of interest in the Local Government Area were obtained using a handheld GPS. The data was downloaded into a computer and plotted in a digital base map. Based on relational data model, road traffic accident hotspots attribute database was modeled and developed for the purpose of instructiveness. A relational database is efficient and flexible for data search, data retrieval and creation of tabular reports (Chang, 2007).

## 2.5. Analysis

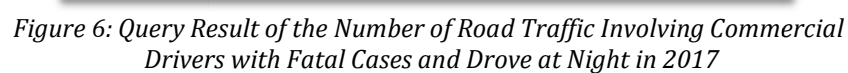
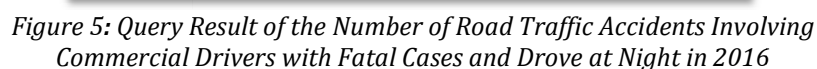
The Federal Road Safety Commission data were used to populate the database. GIS analyses performed on the database include the following; Spatial overlay and spatial queries.

The information obtained from social surveys/questionnaires such as the factors, causes and effect of road traffic accident were analyzed using SPSS software. Test of Hypothesis was performed. For this research, Chi-square were used. The results were in tables and the conclusion drawn from the inference will either be to accept the null hypothesis ( $H_0$ ) or to reject the null hypothesis ( $H_0$ ), invariably accepting the alternate hypothesis ( $H_1$ ) using the critical value obtained from the statistical table. The critical value also called the P-value which is a significant value is usually 0.05. Result of the critical value of 0.05 was gotten from the statistical table and called  $F_{\text{tabulated}}$ . Decision Rule was taking in order to make inference and conclude as 'Reject  $H_0$  if  $F_{\text{cal}}$  is greater than  $F_{\text{tab}}$ ' or Accept  $H_0$  if result proves otherwise.

## 3. Results and Discussions

### 3.1. Query Results

About 7 queries were produced to answer specific questions that will enable the aim of the paper to be achieved. This was done for both 2016 and 2017.





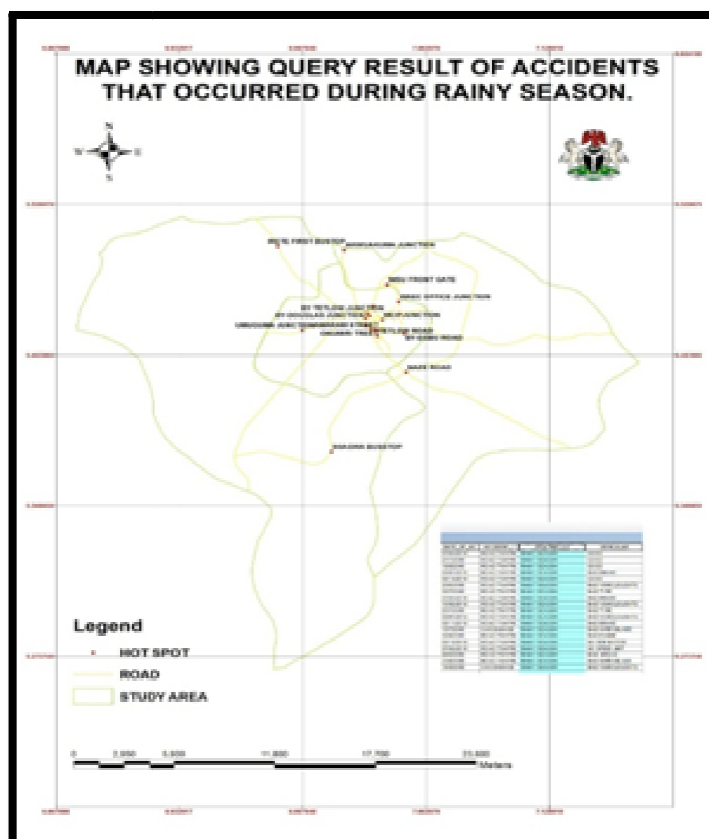


Figure 7: Query Result of the Number of Road Traffic Accidents That Occurred During Rainy Season in 2016

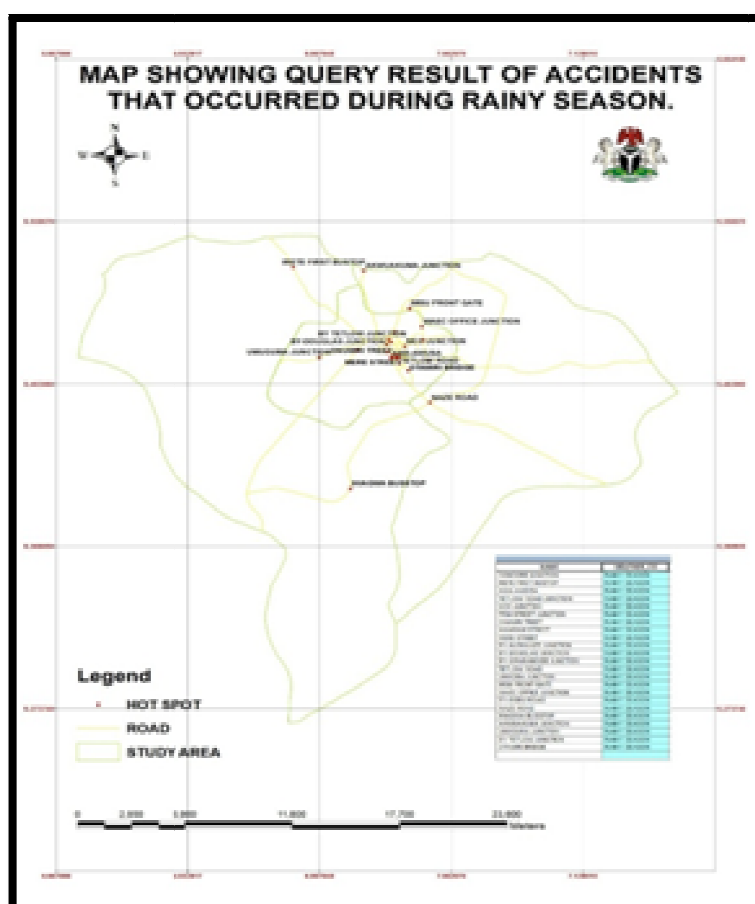
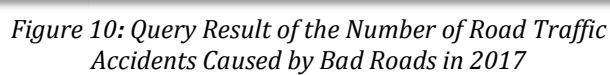


Figure 8: Query Result of the Number of Road Traffic Accidents That Occurred During Rainy Season in 2017





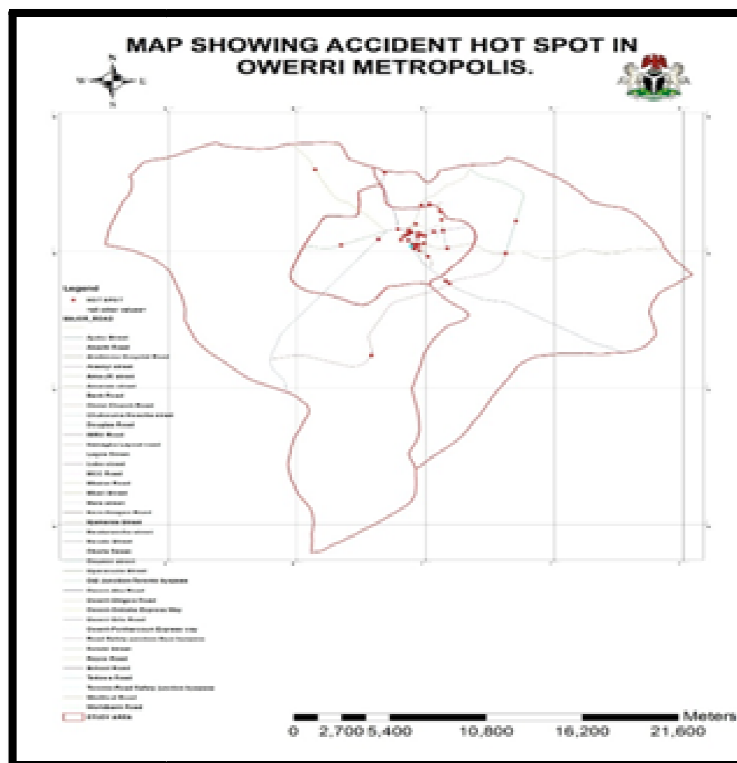


Figure 11: Query Result of Road Traffic Accidents Hotspots

The result in **Figure 5** revealed that in 2016, 3 road traffic accidents involved commercial drivers with fatal cases drove at night and the vehicles involved are bus-truck, bus-motorcycle and truck-bus at Owerri-Onitsha express way, Amaram Street, and MCC road respectively. It was also revealed that about 12 lives were lost caused by over-speeding and night driving. In order to land safely while driving at night, over speeding should be avoided.

Query result shown in **Figure 6**, recorded that in 2017, 5 road traffic accidents involved commercial drivers with fatal cases drove at night. Vehicles involved are bus-truck, bus-motorcycle, truck-bus and truck-tricycle at Owerri-Onitsha express way, Amaram Street, MCC road, Road safety junction-Nazebyepass and Owerri-Orlu road respectively. It was also revealed that about 21 lives were lost and the major causes were over-speeding, night driving, impatience and brake failure. Regular checking of the brakes, use of speed limit device and calmness in driving will save life and avoid RTA, RTD, RTI and car damage.

The Figure 7, revealed that in 2016 about 19 road traffic accidents occurred during rainy season. Which involved 11 cases of Road Traffic Deaths (RTD), 2 cases of Car Damages and 6 cases of Road Traffic Injury (3 Minor Injuries and 3 Major Injuries). Driving during rainy season requires great carefulness and concentration both on the road itself due to its slippery nature and on the vehicle. Meaning that the vehicles should be very sound with no form of mal-functioning or deformity. Major causes are brake failure, no side mirror, bad tyres, bad/no vehicle lights, bad wipers, no speed limits and over-speeding.

Figure 8 revealed that in 2017 about 23 road traffic accidents occurred during rainy season. Of which 14 cases were RTD, 1 case of Car Damage and 8 cases of RTI (2 Minor Injuries and 6 Major Injuries). Major causes are: bad brake, no side mirror, bad tyres, bad/no vehicle lights, bad wipers, no speed limits, over-speeding, over confidence and impatience.

Figure 9 demonstrated that in 2016, out of the 41 accident cases, about 3 road traffic accidents were caused by bad roads. The roads include Onumiristreet, MCC road and Road Safety junction-Naze bypass which are minor single lane, main single lane and main single lane respectively. The pothole, sloppy and un-tarred nature/condition of the roads makes it most vulnerable to road accidents and death. Attributed causes of accidents on these roads are night driving, alcoholic influence while driving, over-speeding, disobeying traffic laws and driving under the rain amongst others.

Figure 10 demonstrated that in 2017, about 13 road traffic accidents were caused by bad roads. The hotspots include Ama-awusa, Lobo street, Lagos street, Amaram street, Mere street, Okorie street, by Oparanozie junction, Oparanozie street, By West-end, Rainbow junction, Umuorii, Ihiagwabustop and Umuguma junction which are minor single lanes and main single lanes respectively. The pothole, sloppy and un-tarred nature/condition of the roads makes it most vulnerable to accidents and death. To overcome accidents and careless deaths on these roads, night driving should be avoided or apply carefulness, avoid driving after being intoxicated with alcohol, apply and use speed limit gadgets, obey road traffic laws, vehicle lights should be very bright etc.

Figure 11, is a query result that showed the road traffic accident hotspots in Owerri Municipal Council, Imo State. The result revealed that there are about 41 road accident hotspots within the study area. Each of the hotspots have their causes, number of cases, severity of accidents, and condition of road at the time of accident, time of accident and so on. The result also revealed that IMSU junction roundabout is the most dangerous hotspot.

### 3.2. Statistical Results

Test of Hypothesis using Chi-square analysis performed on the road accident records obtained from questionnaires from Federal Road Safety Commission and Police Station revealed that there are 3 major factors that contributed to the occurrence of road traffic accidents, they are the Human Factor, the vehicular factor and the road factor.

Test of Hypothesis using Chi-Square analysis was carried out on each of these Factors individually for 2016 and 2017 respectively and result obtained showed the year at which Road Traffic Accidents occurred more.

#### 3.2.1. Decision for Human Factor

Since the result of  $\chi^2_{\text{CALCULATED}} = 12.23$  is less than ( $<$ )  $\chi^2_{0.05,13} = 22.362$ , (tabulated), we fail to reject  $H_0$  and conclude that there is a significant difference in the number of Human Factors that caused Road Traffic Accidents that occurred in Owerri Capital city between the years 2016 and 2017 respectively. In other words, the number of Road Traffic Accidents that was caused by Human Factors is greater in 2017 than in 2016.

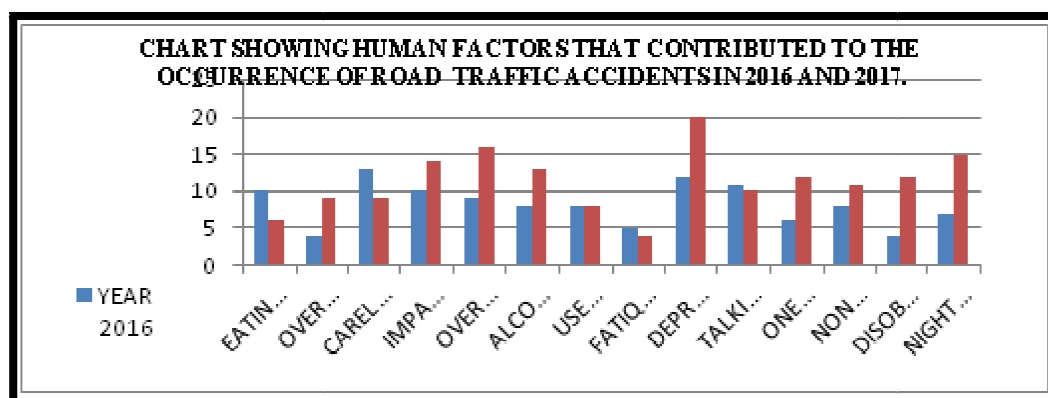


Figure 12: Human Factor That Contributed to the Occurrence of Road Traffic Accidents in 2016 and 2017

Figure 12 further revealed that 2017 did not only record higher number of accidents caused by Human Factors but also revealed the highest human factor which is Depression and Careless Driving. Then, the lowest human factor in 2017 is Fatigue.

#### 3.2.2. Decision for Vehicular Factor

Since the result of  $\chi^2_{\text{CALCULATED}} = 9.991$  is less than ( $<$ )  $\chi^2_{0.05,9} = 16.919$ , (tabulated), we therefore fail to reject  $H_0$  and conclude that there is a significant difference in the number of Road Traffic accidents that occurred in Owerri Capital city between the years 2016 and 2017 respectively as a result of Vehicular factors. In other words, the number of Road Traffic Accidents that was caused by Vehicular Factors is greater in 2017 than in 2016.

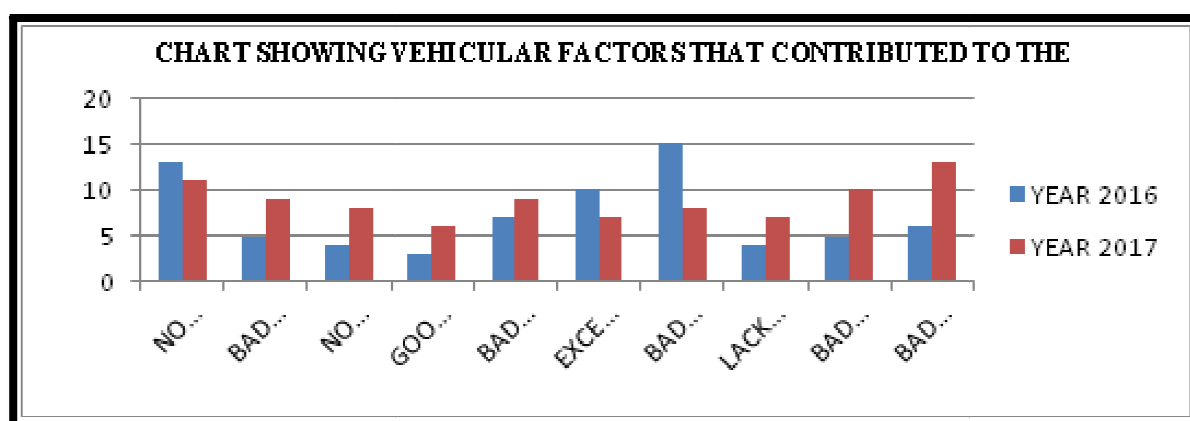


Figure 13: Vehicular Factor That Contributed to the Occurrence of Road Traffic Accidents in 2016 and 2017

Figure 13 further revealed that 2017 did not only record higher number of accidents caused by Vehicular Factors but also revealed the highest and lowest vehicular factors which are Bad Tyres and Good vehicles respectively.

#### 3.2.3. Decision for Road Factors

Since the result of  $\chi^2_{\text{CALCULATED}} = 7.1658$  is less than ( $<$ )  $\chi^2_{0.05,8} = 15.507$ , (tabulated), we therefore fail to reject  $H_0$  and conclude that there is a significant difference in the number of Road Traffic accidents that occurred in Owerri

Capital City between the years 2016 and 2017 respectively as a result of Road factors. It however means that the number of Road Traffic Accidents that was caused by Road Factors is greater in 2017 than in 2016.

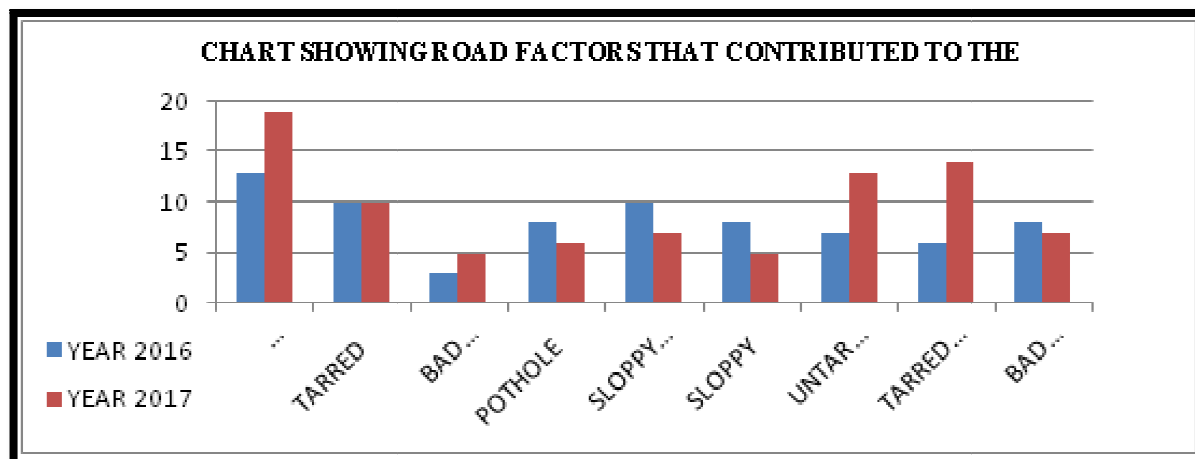


Figure 14: Road Factors That Contributed to the Occurrence of Road Traffic Accidents in 2016 and 2017

Figure 14 further revealed that 2017 did not only record higher number of accidents caused by Road Factors but also revealed the highest and lowest road factors which are Tarred and Potholes roads and then Bad roads and Sloppy roads respectively.

### 3.3. Temporal Changes in the Occurrence of Road Traffic Accidents Hot Spots in Owerri Capital City

Test of Hypothesis using Chi-Square analysis was carried out on the Temporal Changes by months of occurrences of Road Traffic Accidents in 2016 and 2017 respectively and result obtained showed the year at which Road Traffic Accidents occurred more.

Decision for Temporary Changes: Since the result of  $\chi^2_{\text{CALCULATED}} = 1.8815$  is less than  $(<) \chi^2_{0.05,11} = 19.675$ , (tabulated), we therefore fail to reject  $H_0$  and conclude that there is a significant difference in the number of Road Traffic accidents that occurred in Owerri Capital city between the years 2016 and 2017 respectively as a result of Temporal changes that occurred between the months of the year. 2017 however, showed higher occurrences of accidents than 2016.

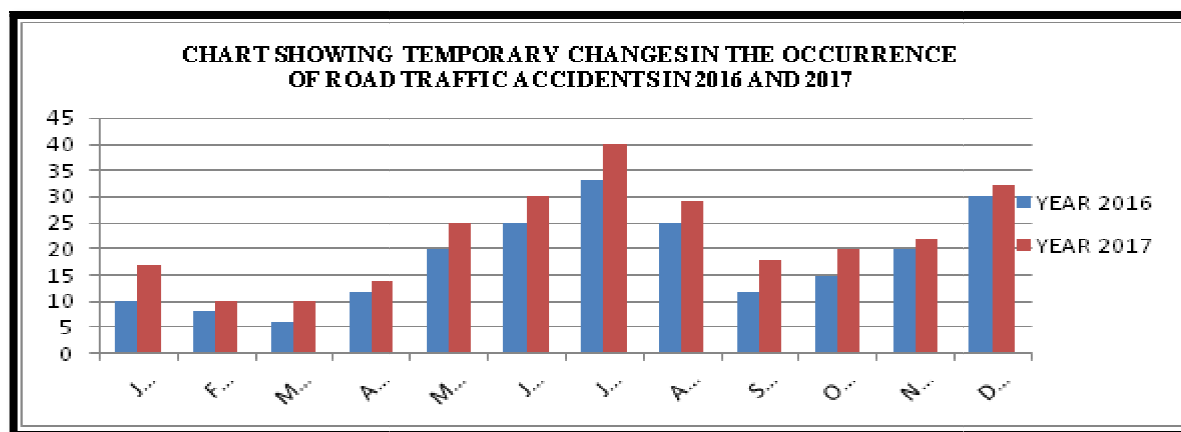


Figure 15: Temporal Changes in Months in the Occurrence of Road Traffic Accidents in 2016 and 2017

Figure 15 further revealed that 2017 did not only record higher number of accidents as a result of Temporal Changes but also revealed the highest and lowest months of occurrences which are in July and then February and March respectively. December is another time where road accident rate is usually on the high side, and this is due to the various festivals and activities that go along with it. People tend to travel from their abroad to their home towns and vice versa to spend some quality time with their loved ones and families whom they haven't seen a long time. At this time, the roads are usually very busy with lots of vehicles running to and fro the roads and high-ways. With the anxiety of travelling many times a day, many drivers go on uncontrollable speed which mostly leads to terrible accidents that ends up on death, injuries like broken arms, legs, brain damage, bruises and so on.

## 4. Findings

The findings made on this paper are as follows:

Road Traffic Accidents Occurred more in 2017 than in 2016, this was because the causes of the RTAs were higher. There was no control in the factors that caused the RTA which led to increase in RTD, RTI and Car damage.

- Human factor: In 2017, road users especially drivers exhibited more non-chalant attitude in driving than in 2016. They seem to be above the law by disobeying Road Traffic laws, they drive when they are depressed, they drive Carelessly, they Over Speed, driving at Night, not patient, driving when drunk, One-Way Driving, Non Use of Helmet, Talking and Driving, Use of Phones, Eating and Driving and Fatigue.
- Vehicular factor: There was an increase in mal-functioning of the vehicles in 2017 than in 2016. This was caused by the drivers' careless, forgetfulness and bad economy/ lack of money syndrome to change and repair bad tyres, bad engine, bad wiper blade, bad vehicle lights, side Mirrors, bad brakes, speed limit gadgets, control carrying capacity and frequent Maintenance of the car.
- Road factors: 2017 experienced an increase in road factor problems than in 2016. There were more Potholes on the tarred roads, Tarred and Sloppy roads, Untarred roads, Potholes on Sloppy roads, Potholes on Bad roads, Bad and Sloppy roads. These led to increase in RTAs, RTDs, RTI and car damages.

The spatial distribution of the road traffic accident hotspots in the Owerri Capital city was mapped and shown in Figure 11. The study revealed 41 accident hotspots.

The hazardous or most dangerous hotspot within the study area is the IMSU junction roundabout.

The study also revealed the Percentage increase in Total number of accidents, lives lost, injured and car damages in 2017 over 2016. Which was due to increase in the effects of the causes of road accidents. This is shown in Table 1.

S/N	Total	2016	2017	% Increase of 2017 Over 2016
1	Total number of accidents	162	170	4.71%
2	Total number of lives lost	217	244	11.07%
3	Total number of injured	49	67	26.87%
4	Total number of car damage	89	90	1.11%

*Table 1: Percentage Increase in Total Number of Accidents, Lives Lost, Injured and Car Damages*

- Commercial drivers are fond of driving at night without checking the risks involved, this has led to untimely death of both drivers and passengers.
- The study also reported an increase in road accidents during rainy season that led to RTAs, RTDs, Minor Injuries, Major Injuries and car damage.
- The study was also able to determine the temporal variations in the occurrence of road traffic accidents. Temporal changes and patterns in the months between 2016 and 2017 resulted in high road accidents and July, the peak of rainy season recorded the highest accident rate. This is seconded by December due to lots of festivals, ceremonies and activities.

## 5. Recommendations

- During rainy season especially at its peak in July, people should drive with more calmness, patience and focus to avoid accidents because at that time the roads will be very slippery and controlling it at a sudden interception will be very difficult.
- Always check all parts or the sensitive parts of the vehicle for proper functioning before driving to avoid malfunctioning that leads to accidents and deaths.
- Night driving should be avoided but you must, you have to be at alert, focus, avoid every kind of distraction and maintain a normal and average speed.
- The dangerous hotspots of the roads should be repaired and caution sign be made known to the people of Owerri so as to avoid it or be more careful to avoid accidents that might lead to death, severe injuries like loss of arm, legs, brain damage, blindness etc.
- Quality good roads should be made available to Owerri Municipal and the bad ones should be maintained frequently to prevent RTA, RTD, Major injuries and Minor injuries when conveying people and goods from one location to the other.
- Owerri people should be made to know the importance of Safe-Landing in road safety. It is better to be late than being late. Drivers should exhibit calmness and focus when driving which will prevent and control accident, death, injuries and psychological trauma.
- Speed limit device should be made compulsory. Every vehicle found without speed limit gadgets should be penalized.
- Efforts should be made to improve road safety measures and create awareness on the importance of proper road usage and adherence to road traffic rules. Road safety measures such as 'Do not drive while eating', 'Do not drive when tired', 'Do not drive when you are depressed', 'Do not drive while on drugs', 'Do not drive without seat belt', 'Do not talk while driving', 'make sure that the vehicle is frequently checked of functionality', 'road signs and symbols must be obeyed' and so on.
- It is important to adopt GIS technology to produce reliable and up to date information on road accident data for the benefit of road users, Government agencies, researchers and decision makers.

## 6. Conclusion

GIS is a very important tool that has the capability to map and analyze road traffic accidents and also to identify road accident hotspots which can prevent future occurrences. GIS remains a very powerful tool for mapping and analysis of the temporal changes of road traffic accident hotspots in Owerri, Imo State, Nigeria. It will also improve the spatial capabilities to analyze accident hotspot, predict future occurrence of Road Traffic Accidents and to minimize the rate of Road Traffic Accidents occurrence in the Municipal, State and Nation at large.

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