Characterization of Road Traffic Accidents and Identification of Hotspots in a Typical Administrative City of Nigeria.

Baloye¹ David O. and Palamuleni² L.G
¹Department of Geography, Obafemi Awolowo University, Ile-Ife, Nigeria.
²North West University, Mafikeng Campus, Department of Geography and Environmental Sciences, Private Bag X2046, Mmabatho, 2735, South Africa.
Email: dafidethebeloved@gmail.com, dobaloye@oauife.edu.ng, Lobina.Palamuleni@nwu.ac.za

Abstract
The objectives of this study were to characterize road traffic accidents (RTAs) and identify hotspots in a typical urban administrative centre of Osogbo, southwest Nigeria using archived data for four consecutive years (2010-2013). Relying on both descriptive and geoinformation techniques, the results show that year 2011 accounted for the highest count of RTAs (31.4%), followed by 2012, 2010 and 2013 with 28.6%, 20.3% and 19.7% RTAs respectively, with the highest occurrence taking place in the ‘ember’ months, that is, September to December. In terms of the initiating factors for the recorded RTAs, externalities, relating to pedestrian or stray animals crossing accounted for 3.2% causes, while drivers’ state of mind and psychological influence at the time of the accidents accounted for 30.4%. Also, light weight vehicles (LWV) constituted 35% of vehicle types involved in the RTAs, followed by two and three legged bicycles and motor cycles (MC) (29%). On the basis of the operators, commercial vehicles accounted for 40% of RTAs, followed by RTAs involving commercial and private vehicles (27%). Furthermore, of the 290 RTAs for the period under consideration, 870 casualties were recorded with 89.54% injured and 10.46% dead. On identifying hotspots of RTAs in Osogbo, the study revealed that the Gbogan – Osogbo highway, connecting Osogbo to Ife and Ibadan, two major cities of influence, has the highest rates of RTAs, while the segment of the highway between 667071.852E, 855062445N and 667230.603E, 855540.812N was identified as hotspot with the highest RTAs.

Key words: Road Traffic Accidents; Hotspots; Developing countries; Nigeria.

Introduction
Studies have shown that road traffic accidents (RTAs) are a major cause of human deaths and severe injury, globally, but with a disproportionate number occurring in developing countries (Ogunsanya, 2002; Manyara, 2013; WHO, 2013; Parkinson, Kent, Aldous, Oosthuizen G. and Clarke, 2014; Leijdesdorf, van Dijck, Krijnen, Vleggeert-Lankamp and Schipper, 2014). The quarterly report of the African Development Bank (ADB, 2014) indicated that RTAs caused 25% of all injury related deaths in Africa and recorded higher rate of human morbidity than diseases. In Nigeria, about 34 deaths are recorded annually in 100,000 population while a more
number of people with different degrees of injuries are often unaccounted (Ezenwa, 1986; Kolawole, 2015). The Federal Road Safety Corps in Nigeria reported at least 98,494 cases of road accidents between 2000 and 2006 (about 14,074 annually). This is typical of developing countries, such as India, Nigeria, Srilanka and Paraguay among others, where studies show that they are characterised with low standards of road and safety infrastructure and where urbanisation has not been supported with adequate infrastructure (Sumaila, 2013).

Causes of RTAs can be fairly grouped as 'general' and 'specific'. According to Ansari, Akhdar, Mandoorah, and Moutaery (2000), the general causes of RTAs include increase in number of vehicles and expansion of transport network, large national projects that require extension of existing road networks, and activities of foreigners with lesser understanding of the road systems. The specific causes include driver error, excess speed, poor cognizance of road signs and road conditions (Ansari, Akhdar, Mandoorah, and Moutaery, 2000). In general, causes of RTAs from most countries can be summarized to include driver behavior, vehicle types (motorcycles to large trucks), roadway condition (design, capacity, pavement type), traffic characteristics (flow, speed, density, occupancy), and environmental factors (weather) (Li, Zhu and Sui, 2007; Pepple and Adio, 2014).

Studies on road traffic accidents RTAs in Nigeria have shown that they have not yet received required attention judging by the increasing number of cases that are recorded (Ezenwa, 1986; Bun, 2012). Data from the Federal Road Safety Corps (FRSC), the body charged with the responsibility of maintaining safety on Nigerian roads, in 2012 also indicated that although the annual number of cases of RTAs decreased from about 8,477 in 2007 to 4,765, the number of deaths and injured people per accident has significantly increased (number of deaths per accident has increased from about 55% in 2007 to 90% in 2011 while the number of injured have increased by about 156.5%). A critical study of the data showed that while the Nigerian Road management strategies may have worked to significantly reduce the number of crashes, the number of casualties has increased per accidents.

Most RTAs occur in cities and large towns, where population is often large and means of transportation are many (Nantulya and Reich, 2002). Studies such as Nantulya and Reich (2002), Bun (2012), Sumaila (2013) among others have attributed the high frequency of RTAs and associated casualties in Nigeria to poor road maintenance and poor enforcement of regulations often linked with corruption. Other studies (Anderson 2009; Cheng and Washington, 2009) have indicated the recent research interests in identification of RTAs hotspots for monitoring with the intention of reducing them and significantly reducing the fatalities. According to Cheng and
Washington (2009), identification of hot spots (sites with promise, black spots, accident-prone locations, priority investigation locations) is an important and routine activity for improving the overall safety of roadway networks (Williams, Idowu and Olonade, 2015). The aim of the present study is therefore to provide a RTAs reduction scheme for a typical urban centre, Osogbo, the administrative capital of the State of Osun, Nigeria. Specific objectives are to characterise RTAs, and identify the RTA hotspots in the study area.

**Materials and Methods**

**Study area**

The study area is Osogbo, a typical urbanized administrative capital city in Osun State, Nigeria. Located on 7°41’01”N, 4°29’57”E; 7°52’02”N, 4°37’47”E as shown in figure 1, the study area is in the tropical wet and dry tropical rainforest climate, and it is characterised by about 25 - 28°C, mean relative humidity of about 82.6% (Eludoyin, Adelekan, Webster, and Eludoyin 2014) and monthly rainfall of 200 and 350 mm (Iloeje 1981). Population as at 2011 was estimated as 438,516 (Aguda and Adegboyega, 2013) while built up areas have increased from about 3.95 km² in 1962 to 241.79 km² in 2011 (Aguda and Adegboyega, 2013) Main road traffic modes of transport in the study area are taxis or cabs, mini-buses (locally known as ‘korope’) and motorcycles (also locally called ‘okada’) (Olawole and Aloba 2014). Both cabs and minibuses often pligt the primary roads while ‘okada’ are frequently used on the secondary routes.

![Figure 1: Osogbo Area of Osun State](image-url)
Data types and analysis

Records of road traffic accidents between 2010 and 2013 were obtained from the database of the Federal Road Safety Commission (FRSC), Osogbo command. The datasets include information on vehicle types and category, routes, causes of RTAs as well as daily casualty counts and locational information on the RTAs between 2010 and 2013. The data were first summarized into monthly aggregate and the database entries relating to causes of RTAs were also reclassified for clarity sake and analysis. RTA causes relating to state and nature of the vehicles involved in the accidents, break failure, use of mechanically deficient vehicles, tyre bursts while on motion and loss of control were grouped as Mechanical factors of RTAs while issues relating to poor road design like hidden junctions or sharp corners, and absence of road shoulders and other allied road facilities as well as general road condition were grouped as road factors of RTAs. Other classes are drivers' psychological wellbeing/state, covering issues like driving under the influence of alcohol, fatigue and dangerous driving; willful disobedience of highway codes, relating to route violation, speed limit violation, use of phone while driving, wrong towing and dangerous overtaking; and externalities, which covers illegal pedestrian crossing and animals straying into the roads. A Global Positioning System (GPS) receiver was used to track the location of the accidents and the coordinate list generated used in to map the spatial distribution of the RTA. Simple descriptive statistical analysis including frequencies and percentages were used to characterize the data into topical headings.

With respect to identifying RTA hotspots in the study area, the locations of the RTAs were first plotted on the city's road network layer using ArcGIS 10.1 software and then all the roads were divided into segments of 500 meters using the Divide Line by Length Add-in of the software. The segmentation of the major routes at regular interval was done to know the segment with the highest occurrences of RTAs. The segmented routes were later spatially joined with the layer containing RTAs on these routes. The output RTA_Major_Routes_Join layer was then classified to show routes with the highest RTAs.

Results and Discussion

Characterization of RTAs in Osogbo

The assessment of RTAs in Osogbo between 2010 and 2013 as shown in figure 2 reveals a 10% reduction in the annual RTA count within the 4 year period. This reduction is particularly noticeable from 2011 to 2013 and may have been attributed to the increased and improved road safety mechanisms put in place by the Road Safety Corps. Also, a month by month analysis of
the RTAs showed that the highest number of road crashes took place between the 'ember' periods, that is, September to December, except for 2013 which had its peak in June (figure 3). This result is similar to those obtained by Ukoji (2014), Vanguard (2012) and Mosadomi (2012) among others. Traditionally, the 'ember' months in Nigeria is marked with increased RTAs because of the increased vehicular activities and end of the year rush (Ojo, 2013). It is interesting to note that year 2011 recorded high RTAs in most of the months except in June when there was a significant reduction in the RTA count.

Similarly, as shown in figure 4, vehicle types involved in the RTAs showed that heavy duty vehicles (HDV) including trucks and trailers records the highest RTAs (45.45%) for 2010. Motorcycles (MC) popularly called 'okada' and tricycles popularly called 'keke Napep' (56.67%) in 2011 and light weight vehicles (LWV) including buses, suburban utility vehicles (SUVs) and pickups in 2012 and 2013. Aggregately between 2010 and 2013, MC accounts for 29%, light cars (LCR) 17%, LWV 35%, and HDV 18%. The remaining 2% is accounted for by unidentified vehicles.
types (UVT). The 2011 RTAs topped by motorcycles coincided with the period when this means of transportation were becoming major class of road users responsible for RTAs across the country (Ukoji, 2014; Olufowobi, 2012; Ohakwe, Iwueze, and Chikezie, 2011). The increasing number of LWV, especially buses (korope) involved in RTAs in Osogbo may be attributed to the fact that they are the major means of transportation in the city.

Figure 4: Vehicle types involved in RTAs in Osogbo between 2010-2013

In terms of vehicle ownership involved in the RTAs, commercial vehicle account for 40.86%, 41.18% and 44.00% for the period 2011-2013 while involving commercial and private vehicles account for 43.1% in 2010 (figure 5). On the other hand, RTAs between private and government owned vehicles as well as those between commercial and government owned vehicles only accounts for between 0% and 1.78% during the period under consideration.

Figure 5: Ownership Category of Vehicles involved in RTAs in Osogbo between 2010-2013.
An overall assessment of the factors responsible for RTAs in Osogbo showed that externalities, relating to stray animals or pedestrian crossing account for the least cause (3.2%), followed by road factors, relating to bad state of roads, bad road design and badly located road signs and billboards (6.10%). Mechanical factors, relating to issues surrounding the performance and state of wellbeing of the vehicles accounted for 12.1% of the RTAs. Drivers' state of mind and psychological influence accounted for 30.4% of RTAs while willful disobedience of drivers to road safety codes accounted for the highest factors of RTAs in Osogbo (Figure 6). This presupposes that the sensitization programmes for drivers and other road users, carried out by the FRSC commands in the study area, the government of the state as well as other stakeholders is still far from achieving its goals.

**Figure 6: Causes of RTAs in Osogbo between 2010 and 2013**

Although the annual RTA count suggest an insignificant reduction between 201 and 2013, a look at the casualty records involved in the RTA reveal otherwise. A total of 870 casualties was recorded from the 290 RTAs within the period under consideration. The distribution, shown in figure 7, reveals that in 2010, there were 161 injured (91%) and 16 deaths (9%). In 2011 the percentage of the dead slightly rose to 9.8% while the percentage of death also increased marginally to 90.2%. By 2012, the number of injured rose to 207 (92%) while dead victims reduced to 8%. However in 2013, the percentage of deaths increased to 17%, an all-time high value from 2010, while the percentage of people injured reduced to 83%. Although year 2013
had the lowest casualty figure of 155 out of the four years in the study, it records the highest number of deaths. This figure signifies a sharp deviation from the intent of the road safety goals of the FRSC and the government of the state. The high number of light weight vehicles like buses used for commercial purposes and factors responsible for the TRAs suggest the need for improved road safety measures directed mostly at the drivers of this means of transportation, who in most cases have been found out to be highly uneducated and have little or no regards for highway codes.

![Figure 7: Casualties involved in RTAs in Osogbo between 2010 and 2013](image)

**Identification of the RTA hotspots**

The spatial distribution of the RTAs on all the roads in the study area indicated that a very low count of 6.08% RTAs occurred on Osogbo township roads while the remaining 93.92% RTAs occurred on the seven major routes in the city (Figure 8). Table 1 shows a summary of the record of RTAs on the 7 major routes in Osogbo from 2010 to 2013, with the highest number of RTAs taking place on Gbogan - Osogbo (GBN/SGB) highway. This may be attributed to the volume of traffic associated with route. The fact it connects Osogbo to cities like Ife, Ibadan and by extension Lagos, accounts for the high volume of traffic recorded by the route when compared with other major routes linking osogbo to adjoining cities and towns. Although this route records the highest RTAs, the occurrences did not take place on all all the segments of the route. In other words, the RTAs were not equally distributed on all the segments of the route.
Figure 8: Spatial Distribution of RTAs in Osogbo between 2010 and 2013

Table 1: RTA count on Major highways in Osogbo between 2010-2013

<table>
<thead>
<tr>
<th>Route Name</th>
<th>Route Code</th>
<th>2010</th>
<th>2011</th>
<th>2012</th>
<th>2013</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iwo-Osogbo</td>
<td>IWO/SGB</td>
<td>5</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Ede-Osogbo</td>
<td>EDE/SGB</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ikirun-Osogbo</td>
<td>IKR/SGB</td>
<td>3</td>
<td>2</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>Gbogan-Osogbo</td>
<td>GBN/SGB</td>
<td>44</td>
<td>71</td>
<td>60</td>
<td>41</td>
</tr>
<tr>
<td>Ilesa-Osogbo</td>
<td>LES/SGB</td>
<td>2</td>
<td>7</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Osogbo-Township</td>
<td>SGB</td>
<td>1</td>
<td>7</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Ilobu-Osogbo</td>
<td>ILB/SGB</td>
<td>3</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Iwo-Ejigbo</td>
<td>IWO/EJG</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Ejigbo-Osogbo</td>
<td>EJG/SGB</td>
<td></td>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>Ibokun-Osogbo</td>
<td>IBK/SGB</td>
<td></td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Figure 9 shows the classification of the major routes using the occurrence of RTAs. Three classes, based on the frequency of RTAs were created. The low class were made up of routes having between one and three (1-3) occurrences of RTA per 500 meters of road segment, medium had between four to ten (4-10) RTA occurrences, while high class of RTA had 11 and above occurrences of RTAs per 500 meter of road segment. The result shows that 76% of the major road segments of Osogbo falls within low class of RTA occurrence, 16.67% falls within
medium while the remaining 7.14 were identified as having high occurrences of RTAs. These classes were identified as probable RTA hotspots. Figure 10 on the other hand shows the segment of the routes with the highest occurrence of RTA. For proper road safety measures, areas identified as RTA hotspot should be well investigated to determine factors responsible for the increased occurrence of RTA in the area. Also, identified hotspots must be visibly marked so as to call the attention of the road users to the need to drive carefully, especially when around these areas.

Figure 9: Probable Hotspots of RTAs in Osogbo between 2010 and 2013
**Conclusion**

Road accident, especially in developing countries like Nigeria is fast becoming a major killer of people, most importantly, the active population. Regardless of the deliberate measures put in place at different levels of organization, Nigeria still ranks as of the countries with the highest RTAs regionally and internationally. Aside from resulting in the death of many, those who are lucky not to have died, have had to be living with various levels of disabilities and traumas. By and large, road accidents in Nigeria have mounted severe socio-economic pressure on the people and society at large. This study showed that the temporal distribution of RTAs in Osogbo is significantly high during the last quarter of the years under consideration. The study also showed that very few RTAs occurred within the city centre while about 93.92% took place along major inter town roads. Lastly, by identifying probable and most critical RTA hotspot in the study area, this paper has contributed to research interest concerned with monitoring hotspots for RTAs, with the intention of significantly reducing fatalities on urban roads in developing countries.
REFERENCES


Olawole M.O. and Aloba O (2014): Mobility characteristics of the elderly and their associated level of satisfaction with transport services in Osogbo, Southwestern Nigeria. Transport Policy 35, 105-116


