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A Study of the Factors That Influence the Rate of Pedestrian Accidents in Lagos Ikorodu Expressway, Nigeria

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Abstract:
The most common mode of movement to all inhabitants is walking. It cuts across the rich and poor, the young and old, the able and disable or the male and female. It is one means of movement that comes by instinct, naturally, not involving any learning process. As a matter of facts, we are all pedestrians at some point in our journey. The increase in human population has shown an increase in vehicular traffic and no doubt, traffic volume has been found to be a major contributing factor to pedestrian crashes. The aim of this study is to carry out a road safety audit (RSA) as well as investigating the factors that influence pedestrian accidents in Lagos-
Ikorodu expressway in Lagos, Nigeria. Direct observation and reconnaissance survey were employed for the purpose of this paper. Pedestrian traffic count was also conducted to obtain the daily and hourly movement of pedestrian in the study area. Structured questionnaire was used to obtain the perception of respondents on the causes of pedestrian accident while Yamane sample size determination was employed to determine the sample size of 514 respondents. Five hundred and fourteen (514) copies of questionnaire were administered out of which 500 were returned and analysed using Stepwise regression. The result shows that drunkenness (x2) is the major factor that cause pedestrians accident in the study area with about 56.5% of the variation. Pedestrian carelessness (x3) contributed 6.7% to accident rates while poor enlightenment (x 4) and over speeding (x1) accounted for 6.6% and 3.6% respectively. The study recommend that highways patrol officers should be well trained on how to identify drunk drivers using blood alcohol concentration (BAC) equipment, pedestrians need to be more educated and enlightened through various awareness campaign as well as inculcating traffic education at schools, government should also ensure that there is a stipulated overall speed limit for urban centres and finally, the concept of FOOT and TOES was suggested to help minimize pedestrian accidents.

Keywords: Accident, journey, pedestrian, traffic, walking

1. Introduction

The most common mode of movement to all inhabitants is walking. It cuts across the rich and poor, the young and old, the able and disable or the male and female. It is one means of movement that comes by instinct, naturally, not involving any learning process. Every human being is a pedestrian at a particular time of the day although it is a mode common to all, yet very little resources have been allocated to it. Walking has been the dominant transport mode for many centuries in all countries. Before industrialisation took place, there were some alternatives such as riding of animals, horse drawn carriages and water transport, but walking must have been by far the most substantial transport mode. Although walking is not usually seen as a transportation mode, every human trip begins or finishes with walking. The pedestrian mode has received recognition as a vital building block at every age of urbanization. The increase in human population has shown an increase in vehicular traffic and no doubt, traffic volume has been found to be a major contributing factor to pedestrian crashes. Zegeer et al (2004) reported that traffic volume was the second most important factor in explaining pedestrian crashes. The analysis showed that, for a specific pedestrian volume level, the frequency of pedestrian accidents per intersection per year generally increased as the motor vehicle traffic volume increased

However, several approaches had been employed to reduce crashes between vehicles and pedestrians on the highways in the state. These have for the most part utilised initiatives to avoid the crashes from occurring, such as education programs, punitive measures and infrastructure improvements. These approaches have met with some successes but the problem still persists. Over the past few decades research conducted in the area of vehicle safety and safety standards have been limited to improving the protection of vehicle occupants and not pedestrians who are more vulnerable. (Oyesiku, 2002; Dewey, 2013; Getu, 2013, Solagberu, 2014). There have been so much research on pedestrian

safety in Lagos and Nigeria as a whole. Some of which includes Raji (2013), who observed that the 1992 Nigeria transport policy draft only defined pedestrian in an implicit term, types, needs of pedestrians as well as pedestrian's safety measure are missing. However, in 2012, Lagos State government came up with traffic law where pedestrians are adequately captured. Raji (2013), also noted that Nigerian cities are growing and expanding without concomitant response to road transport infrastructure provisions, the pedestrian aspect of these infrastructure has been ignored and as well used for other purposes (Raji, Oloriegbe and Adeosun, 2014).

1.1. Aim

The aim of this study is to carry out a road safety audit (RSA) as well as investigating the factors that influence pedestrian accidents in Lagos-Ikorodu expressway.

1.2. Study Area

Ikorodu road is a major expressway connecting the mainland of Lagos to Ikorodu. The road is designated as A1 highway for its entire 24.5-kilometre length (Oshodi, 2017). For most of Lagos portion, it is a four-lane expressway with two frontage roads parallel to the expressway. The expressway crosses other major expressway such as Apapa-Oworonshoki and Lagos-Ibadan expressway. The expressway also hosts many of the Lagos Metropolitan Area Transport Authority (LAMATA) Bus Rapid Transit (BRT) stops and is actually constructing more BRT stops on the route. The highway has the largest number of pedestrian bridges and some new ones are on-going with a standard and friendlier walkway and raised median.

2. Conceptual Issue

2.1. Walkability

Walking is the oldest and most basic form of transportation. Each of us does it every day as some part of every trip. Everyone walks or uses a pedestrian network to get to work, to shop, to reach the bus stop, to get exercise, or just to have fun. Understanding what walkability means and understanding what pedestrians desire is key to knowing how to approach areas to encourage walking. Walkability can be defined as a measure of how friendly an area is to walking. An ideal walkable community would include housing, office, retail and adequate access to services such as public transportation, schools, and libraries. Also, streetscapes would better serve a range of users, which include pedestrians, bicyclists, transit riders, and automobiles (Jenna, 2016). Walking has numerous benefits that not only help the health of individuals but it also has several environmental benefits. It's obvious to most people that walking is exercise, and exercise equals healthier people. The more people walk, the healthier they will be. By providing an easy and comfortable pedestrian-oriented environment, it can pay big dividends for area economic vitality and growth (Clean and Network Nepal 2014).

Walkability is a recent concept that quickly became part of the lexicon of both academics and practitioners, in part due to the recognition of the above-mentioned benefits of walking and the role that a pedestrian friendly environment has in promoting walking (Abley& Turner, 2011). The term walkability was most likely brought forward to the urban design field by Bradshaw (1993), in order to provide a way to rate how walkable the neighbourhoods of Ottawa were. It was defined as the quality of a place that was a foot-friendly man-made, physical micro-environment; a range of useful, active destinations within walking distance, such as shops; a natural environment that moderates the extremes of weather and has no excessive pollution; Walkability is an important concept in sustainable urban design. Walkability also takes into account the quality of pedestrian facilities, roadway conditions, land use patterns, community support, security and comfort for walking. It is therefore relevant to this study.

2.2. Causes of Pedestrian Crash

There are several reasons while a pedestrian might be involve in a crash. These reasons according to Highways Capacity Manual have been summerized into five major factors (HCM, 2010). These factors include: Drivers, Vehicles, Pedestrians, Roadway/Environmental and Demographic/Social factors. (See fig 1).

The first factor has to do with the drivers on the highway. It is a fact that not all the drivers are qualify to drive. Some have not gone through the special trainning otherwise known as the driving school to acquire the prersquisite skills such as mastering the road signs and highway codes. Some drivers also have bad sight which often affects their visibility. Many are also given to alcohol and drugs which largely contributes to highway crashes. Another major reason for pedestrian crashes cause by drivers is distraction. Some drivers often make use of their phones to make calls or even send text messages while driving. This can be a risky adventure as both the vehicle occupants and pedestrians are at risks of being injured or killed.

Vehicle is also a key factor in pedestrian crash. The poor condition of vehicle plays a vital role in highway accidents. Some vehicles are not road worthy with all kinds of fault that can occur at any point ranging from break failure and tyre being blown out. Also, the high vehicular volume can leads to an increase in pedestrian crashes. That is, the more we have more vehicles, the more we may likely record more crashes.

There are also the demographic and social factors which include poor enforcement of laws and ordinances meant to curb drivers/pedestrian activities on the highway. Many drivers do not obey traffic laws, likewise many pedestrians do not make use of the infrastructure built for them thereby leading to conflicts between drivers and pedestrians. In addition,

there are cases in which walkways are being taken over by parked vehicles and motor cycles and even street traders thereby obstructing the free flow of pedestrian movement.

Furthermore, pedestrians contributes to the cause of crashes due to their attitude on the highways. These includes: jaywalking, distraction, carelessness, children crossing without an adult to guide them and wilfully ignoring the use of pedestrian infrastructure. All these were observed in the study area. Also, there are some alcohol/drugs impaired pedestrians who are not fit enough to use the highway, similarly the people with disability. These set of people are more vulnerable and prone to accidents.

The last factor (according to the Federal Highway Capacity Manual 2010) which is the roadway and environmental factor has to do with the roadway design, weather related issues, signs and markings that helps both pedestrians and drivers to properly use the highway and maintenance of these infrastructure. Some pedestrians do not like using pedestrian bridges because of the unkept nature of some of the bridges and poor lightings at night. At times, it is the physically challanged individual that sweeps the staircases and gets rewarded by pedestrians. All these factors are considered in the course of this research work.
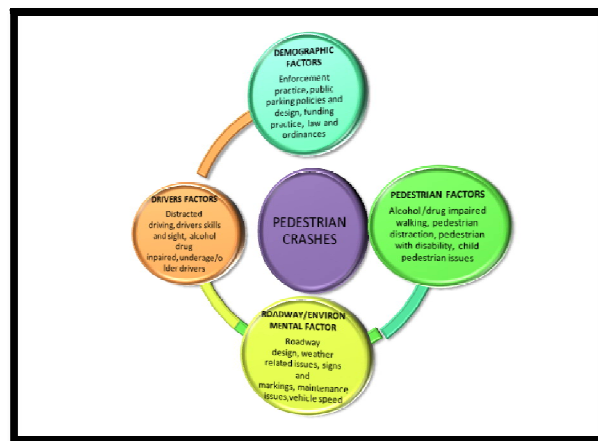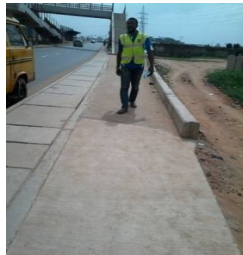

Figure 1 Major Causes of Pedestrian Crash
Source: (Highway Capacity Manual, 2010)

3. Methodology

Direct observation and reconnaissance survey were employed for the purpose of this paper. Pedestrian traffic count was conducted to obtain the daily and hourly movement of pedestrian in the study area. Structured questionnaire was used to obtain the perception of respondents on the causes of pedestrian accident in the study area. The Yamane sample size determination was employed to determine the sample size of 514 respondents as seen in table 1. Five hundred and fourteen (514) copies of questionnaire were administered out of which 500 were returned and analysed using Stepwise regression analysis.

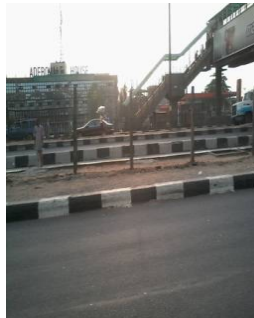| Pedestrian infrastructure	Cost	Benefit	Availability	Condition	Implementation
Signalization	Low	Increase intersection capacity, reduces crashes and improve pedestrian safety	There are insufficient pedestrian signal lights in all the study area. In facts, almost absent and Many of the available ones are not meant for pedestrians but the motorist.	Insufficient signalization in the study area. The available ones are either mal-functioned or lack electricity for its operations.	There is a need to make provision for more pedestrian signal lights in the study area. Pedestrians and drivers must also be enlightened on its functions
Walkways	Medium	Improves accessibility, increase walking as a mode of transport and reduced traffic congestion	Walkways are insufficient in all the study area. There are few walkways in the study area apart from those around the pedestrian bridges.	Some of the walkways are being taken over by petty-traders, motorcycle and hawkers. The walkways are too narrow for pedestrians considering their sizes contrary to the minimum standard of 1.5metres.	A routine maintenance is needed to ensure that footpaths are kept clean. Street traders should not be allowed to obstruct pedestrian movement

Pedestrian infrastructure	Cost	Benefit	Availability	Condition	Implementation
Zebra Crossing Signs	Low	Clearly defined crossing point where pedestrian is expected to cross. Reduced pedestrian crashes if installed at appropriate location and if pedestrian priority is ensured	Zebra crossing signs are not too pronounced in all the highways that were studied. Apart from near schools, there are insufficient zebra crossing signs in the study area.	The painting of Zebra crossing signs should be a continuous process in other to avoid fading of the signs. Its sometimes being washed away by consistent heavy down pour.	Zebra crossing signals are not suitable where traffic volume or speeds are high. Education and enforcement maybe necessary to ensure pedestrian have priority Advanced warning signs should be used if visibility is poor Awareness level on how it operates should be aggressively carried out.
Pedestrian Handrail Guide	Low	Physically prevents pedestrian access to the car carriage way Provides useful guidance for visually impaired pedestrians	There are very few pedestrian handrail guides in the study area.	The government has not made adequate provision for pedestrian handrail guide in the study area	The rail guide height placement and construction should be selected to minimize any potential sight obstruction between vehicles and pedestrians
Pedestrian Bridge	High	Traffic flow improvements. Prevent any form of physical contact with vehicles	This is ubiquitous in the study area. Pedestrians are more conversant with this infrastructure. Some of these bridges are newly constructed	There are many overhead bridges in the study area but there is still a need for more at some other busy area where they are absent.	The constructions of overhead bridges should put into consideration the over-aged, pregnant women and the physically challenged parts of the society
Median Fence	Medium	Reduces incidence of head-on crashes, prevents dangerous overtaking and discourages pedestrian from crossing	This infrastructure is available in the study area but most of it is very low. Motorist often damage this infrastructure	More attention of government is needed in this area. More law enforcement agents are needed to apprehend offenders.	This compels pedestrians to using available infrastructure.

Table 1: Road Safety Audit of the Available in the Study Area
Source: Authors Study 2018

4. Analysis and Discussion of Findings

The study was based on those factors that influence pedestrian accidents in the study area.

Seven (7) variables were examined as the probable cause (s) of pedestrian accidents. These variables are: over speeding, drunkenness, poor lighting at night, poor enlightenment, carelessness, inadequate infrastructure and pedestrian ignorance. The data were subjected to stepwise regression analysis.

The formula is given as $y = a + b_x + b_2x_2 + b_3x_3 + b_4x_4 \ldots\ldots\ldots\ldots\ldots\ldots x_n$

Where: Y= percentage of respondents that choose often and very often for the variable

x_1= over speeding

x_2= drunkenness

x_3= pedestrian carelessness

x_4= poor enlightenment

x_5= inadequate infrastructure

x_6= pedestrian ignorance

x_7= poor lighting at night

Y is the percentage of respondents who ticked very often and often on the questionnaire while X1-X7 are variables that were obtained through the works of notable scholars likeOnokomaiya (1991), Oyesiku (2008),Sulaiman (2013), Getu (2013) and Sayer etal. (2015).

4.1. Factor That Influence Pedestrian Rate of Accidents in the Study Area

In order to measure the contribution of each of the factors that could be responsible for pedestrian accidents in the study area, the data were subjected to the stepwise multiple regression analysis. The dependent variable (Y) is represented by the percentage of accident rate (according to respondents) while the independent variables are the 7 selected variables. The result of the stepwise regression analysis selected four of the seven independent variables. In all together, the four variables explained about 73.4% of the total variation in the factors that could lead to pedestrian accidents along Lagos-Ikorodu expressway at the 5% level of significance. The four variables are drunkenness, pedestrian carelessness, poor enlightenment and over speeding as seen in table 2.

Variables	Parameter Estimates	Std. Error of the Estimate	R	R²	% Change	Cumulative %
Intercept	2.201					
Drunkenness(x2)	-.260	.69876	.752	.565		56.5
Pedestrian carelessness(x3)	.263	.68005	.795	.632	6.7	63.2
Poor enlightenment (x4)	.125	.67225	.837	.698	6.6	69.8
Over speeding (x1)	-.166	.66811	.857	.734	3.6	73.4

Table 2 Stepwise Regression Output
Source: Authors computation 2018

From the regression, it was observed that drunkenness (x2) is the major factor that could cause pedestrians accident in the study area. The correlation co-efficient (r) of this variable is .752, and co-efficient of variation (r²) is .565. The coefficient of determination indicates that about 56.5% of the variation in the causes of accident is associated with drunkenness (x2). Pedestrian carelessness (x3) is also rated high in the strength of contributions to accident rates. Poor enlightenment (x_4) is another notable factor that could cause pedestrian accident in the study area. This variable, jointly with drunkenness (x2), pedestrian carelessness (x3) have a co-efficient correlation (r) of 0.837, r2 of 0.734 and a co-efficient of determination of 69.8%. This implies that about 69.8% variation in the causes of accident is jointly explained by drunkenness (x2), pedestrian carelessness (x3) and poor enlightenment (x4). Poor enlightenment (x4), added 6.6% to the total variance of the dependent variable. This further proves that they are major cause of accident in the study area. The last factor explained by the data findings is over speeding (x1). The coefficient of correlation (r) of the variable and those of the three earlier variables is 0.857, r2 of 0.734 and a co-efficient of determination of 73.4%. An additional 3.6% is however contributed by this variable. The result shows that three factors are not statistically significant in the explanation in the factors that could be responsible for pedestrian accident in the study area and thereby not captured in the explanation. The multiple regression equation generated from the analysis is represented as:

$Y = 1.000 - .260x_2 + .263x3 + .125x_4 - .166x_1$

RES= 73.4%

5. Summary and Conclusion

With the rapid increase in the number of vehicles in metropolitan Lagos and high growth rate in the population, the number of pedestrian accidents and fatalities is likely to increase if proper pedestrian infrastructure such as foot bridges, walkways, zebra crossings and more functioning pedestrian traffic light otherwise known as puffin (Pedestrian Users Friendly Intelligence) are not provided. As a matter of facts, pedestrians are been killed every day in metropolitan Lagos due to poor observation (pedestrian carelessness) and failure to give way (Reckless driving) to pedestrians. These are the two most common factors in pedestrian injury cases (Akomolafe, 2014). Our finding also shows that poor

enlightenment and over speeding are major causes of pedestrian accident in the study area. There is however the need to carry out an aggressive campaign on the importance of pedestrians on the highways and laws regulating the speed of motorist by reducing it to 40kmh at areas where there are no provisions for pedestrian bridges should be enacted in order to aid pedestrian movement.

5.1. Recommendations

Notwithstanding the nature of the problem of pedestrian/vehicle conflicts at road crossings, physical planners and traffic engineers should not stop searching for solutions that can be used to reduce pedestrian accidents on our highways. These are some of the recommendations proposed according to the findings.

- Pedestrians need to be educated and enlightened through various awareness campaign as well as inculcating traffic education at schools. This cannot be over emphasized so long as the walking environment does not meet pedestrian requirements. From the study, many of the respondents don't even know that it is an offence to cross the highway where there are provisions for pedestrian bridges. Awareness can be created through placing highways bill boards with inscriptions like: drive to remain alive, it is better to be careful a thousand times than to get killed once, use pedestrian bridge in order to avoid mortuary fridge, pedestrians are also road users, it is better to waste your time than to waste your life and kill your speed not a pedestrian etc
- Government should ensure that there is a stipulated overall speed limit for urban centres, especially build up areas and also considerations should be given to pedestrians. This can work only when accompanied with enforcement measures. The government should ensure an appropriate driver's training for all motorists. Part of driver's licence training should include adequate sensitization on the importance of pedestrians on the highways.
- Highway patrol officers should be sent on special training abroad on pedestrian safety. They should be able to identify a drunk driver through the use of blood alcohol concentration (BAC) equipment.
- Finally, proper records of pedestrian's accident should be kept in our data base. The researcher discovered that there were no records for pedestrian accident from all the agencies contacted (i.e. Federal Road Safety Corps and the Nigerian Police) though there were data on road crashes generally. These agencies however, should be well equipped with sophisticated apparatus in other to update their data base.

Following the research recommendations, the study can be better summarized in a concept of FOOT and TOES. This concept is a simple way to highlight the responsibilities of the government and the pedestrians in ensuring pedestrian safety. There are five toes in a foot which represents the government task (5Es). The foot stands for pedestrians of which their solely responsibility is to adhere to the proper usage of these infrastructure that are provided. If this is done, it will no doubt reduce the rate of pedestrian crashes if not totally eradicated. The five toes from the foot however, stands for Expansion, Engineering, Education, Enlightenment and Enforcement. These are the basic strategies that the government need to employ in order to ensure pedestrian safety on the highway. The narrow roads need to be expanded to accommodate more walkways, pedestrian refuge and raised median. According to the Institute of Transportation Engineers (I.T.E), the minimum standard for walkway is 1.5m (5ft). After which the government will embark on citing of pedestrian infrastructure (Engineering) where it is deficient. Studies had shown certain criteria for constructing foot bridges, these includes: vehicular flow, pedestrians flow, nature of land use and types of roads. Also, an aggressive campaign on educating the pupils from primary and nursery schools should be practiced. Pedestrian safety as a subject can be inculcated in their curriculum so that they can grow with the safety culture. Enlightenment however can be carried out and targeted to all other road users and various groups such as drivers, market women, students and fleet operators among others. Television and radio adverts in form of jingles can also be employed as illiteracy remains a major hindrance to the usage of any pedestrian infrastructure.

Finally, enforcement can be defined as a process by which adherence to specific rules and regulations are imposed in a society by force of punishment initiated by the laws of the land (Oxford Dictionary). Generally, road safety laws and regulations are targeted at preventing breaches or the occurrence of accidents. Such laws cover setting vehicle standards, technical standards for road design and construction, service quality and delivery standards. The agencies responsible for this task should be further strengthened and empowered to ensure that offenders face the long arm of the law. Effective enforcement requires a system of realistic penalties for all infringements, the most popular with universal application being financial penalties. But a major problem in many countries is that financial penalties are often inadequate deterrents. There should be a more severe punitive measure for offenders such as imprisonment for pedestrians and impounding of vehicles of motorist.
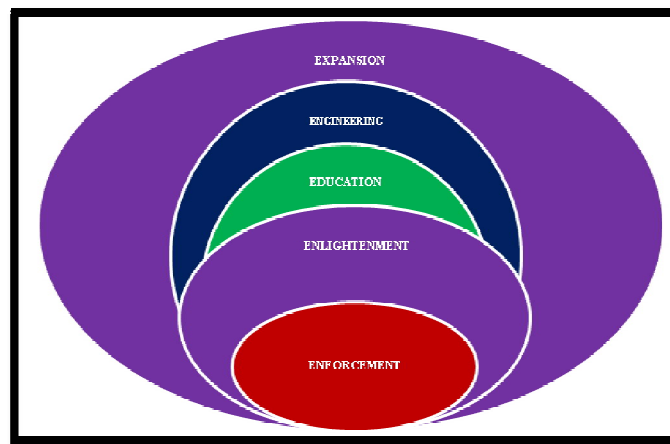
Figure 2: Foot and Toes Concept for Efficient Pedestrian Safety
Source: Author (2018)

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