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Analytical study of the causal factors of road traffic crashes in southwestern Nigeria

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The study examines the causal factors of road traffic crashes in some selected states in South western part of Nigeria. Data were obtained from a total of 352 respondents, from four out of six states that made up of southwestern Nigeria using stratified random sampling technique. Regression Analysis was adopted in analyzing the data obtained. This was done in order to establish the relationship between human characteristics, vehicular characteristics,roadway characteristics,environmental characteristics, and road traffic crashes in the study areas. Based on the findings of the study, it was concluded that human, vehicle, roadway and environment had significant contribution of about 79.4% on the road traffic crashes in the study area.

Key words: Causes, crashes, Nigeria, road, traffic

INTRODUCTION

The problem of transportation safety is of great magnitude encompassing all modes of transportation, all economic levels, and all transport purposes. In terms of fatalities, injuries and number of crashes, the dominant mode of transportation in Nigeria is the roadway. An analysis of the traffic crashes data recorded over a five-year period of 2000-2006 shows that 98,494 cases of traffic crashes were recorded out of which 28,366 were fatal and resulted into 47,092 deaths (FRSC, 2009). This revealing statistics show that Nigeria is placed among the fore front nations (especially the thirdworld nations) experiencing the highest rate of road tragedies in the world.

Crash is an event that produces injury and/or property damage, involves a motor vehicle in transport, and occur on a traffic way or while the vehicle is still in motion after running off the traffic way (Bureau of Transport Statistics, 1999). Common vernacular could define "accident" as an event occurring by chance or from unknown causes. However, in this case of transportation safety events, only a small percentage of events that are dealt with can be considered as unavoidable events or true accidents (Horodniceanu et al.,1979). Many agree that in the case of highways and roadways, crashes are not just a matter of luck or misfortune, but a combination of multiple conditions or actions. Most of these conditions and actions are predictable occurrences, and thus should not be considered "accident". In this study the term "crash" or "collision" will be used in lieu of the term "accident".

The application of safety principles to the field of transportation has been primarily directed toward crash investigation, with the express purpose of finding those conditions and combinations of factors that lead to undesirable traffic crashes. For the most part, causes of crashes are categorized within four basic groups; person, vehicle, roadway and environment. Consider the person to be defined as the vehicle operator, a vehicle passenger, a pedestrian, or a bystander; the vehicle as the transporting conveyance such as automobile, truck, van, recreational vehicle, train, motorcycle or bicycle just to name a few; the roadway as the total infrastructure of pavement, shoulder, signs, signals marking, safety devices, right-of-way and the maintenance of each in addition to the prevailing traffic conditions; and the environment as the weather and lighting conditions, which affect visibility and traction at minimum.

Research Questions

In the course of this study, the following research questions will be answered;

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a) What is the joint contribution of human, vehicle, environment, and roadway to the
road traffic crashes in some selected south western states of Nigeria?
b) What is the relative contribution of each of the above variables to the prediction of traffic
crashes in the study areas?

Causes of Traffic Crashes

The term "cause" refers to an at-fault determinant of a crash or a determinate that increases crash risk or severity. Investigating causes of traffic crashes is complicated by the fact that a given crash seldom has a single unambiguous cause. Crash causes are often a sequence of causes. For example, the initial cause of a pedestrian crash may be the pedestrian darting out in the road. If the vehicle driver subsequently is distracted, fails to see the pedestrians and safely stop the vehicle or manoeuvre around the pedestrian, both the pedestrian action and the driver lack of attention will likely be listed as causes of the crash. In addition, there may be circumstances that took place prior to the crash that may have contributed to its occurrence. For instance, the pedestrian may have been distraught, an emotional condition that could have led to lack of care and diminished observational awareness of surroundings, while the driver of the vehicle may have had defective brakes which in turn reflects on poor vehicle maintenance.

The important question is "what are the causes of these traffic crashes?" The causes of crashes and fatalities are usually complex and involve many factors. Based on studies conducted in different part of the world, it is possible to construct a list of categories that could influence the occurrence of road traffic crashes. If the factors that have contributed to the crash are identified it is then possible to modify and improve the transportation system. Crashes are caused by many factors, sometimes singly but more frequently in combination. Traffic crashes are caused due to interaction of vehicle, driver, roadway and environmental factors. These factors will be examined in depth.

Driver characteristics

The major contributing factor for many crashes is the performance of driver in both single vehicle and multi-vehicle crashes. The pre-crash driver behaviour and attitude is very important in judging the driver's actions. These include; inattention, cigarette, medical conditions, alcohol and drug abuse; inattention to the roadway and surrounding traffic, speeding and disregarding traffic law and/or traffic control devices, which could result from confusion or unfamiliarity with the roadway. Human

factors are without doubt the most complex and difficult to isolate, as they are almost all very temporary in nature. What existed at the time of the crash may not exist moments later. Consider sensory capabilities, knowledge, judgement, attitude, alertness, health, driving skill, age, customs, habits, strengths and freedom of movement. Of these, the emotional factors are the greatest variable attributes and the most difficult to identify.

According to Vankirk (2001), drivers today are faced with many problems when driving in congested and overcrowded cities, specifically by having the senses overloaded by the vast amount of information that needs to be continuously processed – a condition also knows as information overload. The types of information a typical city driver may encounter and need to react upon are numerous and include traffic signs, traffic signals, information about detour, billboard and other advertisements, horns, loud music from passing vehicles, vehicle changing lanes, pedestrians and much more.

Vehicle characteristics

A small percentage of crashes are caused by mechanical failure of a vehicle, such as some form of tyre failure, brake failure, or steering failure. The vehicle and roadway interaction like skid resistance play a major role in stopping the vehicle from encroaching the off road features like wheelbase, median and other traffic signage. Other vehicle characteristics like wheelbase and height of centre of gravity play an important role in rollover crashes. Improvements have been made in the manufacture of tyres and vehicle design; however defects can still occur or be the product of poor vehicle maintenance.

The design of a vehicle can be a contributory factor in the severity of crashes. Some of the features and recent improvements that affect the safety of a vehicle include, airbags, Antilock Braking System (ABS), back-up sensing system, crumple zone, electronic stability system, and so on.

Road way characteristics

The roadway's conditions like the quality of pavements, shoulders, traffic control devices and intersections, can be a factor in the crash. Fewer traffic control devices and complex intersections with excessive signage lead to confusion. Highways must be designed for adequate sight distances for designed speed for the driver to have enough perception-reaction time. The traffic signals should provide enough time for decision sight distance when the signal changes from green to red. The super-elevation on highways and especially ramps should be carefully laid with correct radius and appropriate transition zones for the vehicles to negotiate curves

safely. Another important factor is the frictional forces between the pavement and tyres. If the tyres lose contact with the pavement then the vehicle starts fishtailing.

Road factors include, but are not limited to view obstruction, surface character, dimensions, signs and signals, and protective devices. All factors are subject to modification by outside influences such as the road surface that becomes slick from rainfall. Some roads were not built to serve the current high-volume and/or high-speed traffic needs. The safety of these roads is limited by hazards such as sharp curves, poor signs and pavement marking, and lack of medians to separate oncoming traffic. These limitations could present an even greater threat to highway safety because of the expected growth in the nation's population.

Environmental characteristics

The climatic and environmental conditions can also be a factor in transportation crashes. The most is weather. Weather on roads can contribute to crashes; for example wet pavement reduces friction and flowing or standing water can cause the vehicle to hydroplane. Many severe crashes have occurred during conditions of smoke or fog which can greatly reduce visibility. Vehicle travelling at high rate of speed are unable to see the slowing and or stopped vehicles in front of them, which can lead into multiple-vehicle pile-up. Glare can reduce driver's visibility, especially during the hours of sunrise and sunset. During foggy conditions, glare off of streetlights and stoplights can also affect visibility, especially at night. Wing gusts can affect vehicle stability, especially of large trucks and light weight vehicles such as bicycles and motorcycles.

Literature Review

Hendricks et al (1999) performed a study on unsafe driving acts in serious traffic crashes to determine the specific driver behaviour and unsafe driving acts that lead to crashes, and the situational, driver and vehicle characteristics associated with these behaviours. They used 11-step process to evaluate the crash, determine the primary cause of each crash, and uncover contributing factors. The crash types were recorded into seven classes with operational differences that were likely to be associated with driver behaviour/performance. It was discovered from the study that crash causation factors can be categorised into vehicle condition, environment condition, driver behaviour, roadway condition and others. It was also reported that driver behaviour caused or contributed to 99% of the crashes investigated, with the six causal factors that accounted for most of the problem behaviour in decreasing order of frequency, being driver inattention, vehicle speed, alcohol

impairment, perceptual errors, decision errors and incapacitation. Bates (2004) also substantiated that certain pedestrian behaviour, such as walking along the roadway with traffic, and crossing a roadway at a point other than an intersection are significant in fatal crashes.

Injuries from road traffic accidents(RTAs) are the most significant problem, so much so that motor vehicle-related mortality has been described as a 'disease of development'(Wintemute, 1985). There have been 'Dramatic increases in the proportion and absolute numberof traffic fatalities in a number of developingcountries' (Odero et al.,1997). The number of vehicles in developing countries is increasing (Varma et al., 1992). Of all road deaths occurring globally each year, 74%are in developing countries and there has been a 5-fold increase in traffic-related deaths in Nigeria over the last 30 years (Odero et al., 1997). Moreover, there is a fatality per accident rate which can be 20 times higher than in developed countries (Jacobs and Sayer, 1983). In Nigeria, Road traffic Accidents (RTA) have been described as an 'important cause of morbidity', with the need for a 'comprehensive accident prevention programme' (Onadeko, 1983). Indeed, some developing countries have questioned improving health care, education and other services, when, 'All these and other intended programmes aimed at making life easy for the people can be rendered meaningless if the people for which the facilities are meant are regularly killed or incapacitated through unnecessary accidents' (Ogunsanya, 1991).

Today in Nigeria, death by accident far exceeds those by any communicable disease in the country'.Road crashess have been recognized as a major public health problem in Nigeria for some time (Asogwa, 1978). Trading is a central part of Nigerian culture and traders travel large distances to markets, particularly to the 'inter-kingdom periodic markets' (Mills-Tettey and Fadare, 1991).

'Fatalism', accident causation and prevention Routes linking major metropolitan centres, such as the Ibadan–Lagos Expressway, are particularly dangerous. Oladepo and Brieger (1986) showed that a third of all accidents on this road involved fatalities, with speeding causing 28.9% and 'carelessness' 24% of accidents. Whilst it is true that the statistical picture is incomplete, it could be argued that some reduction in accident rates can be achieved by applying what is already known (Jacobs, 1982; Forjuoh and Li, 1996). Asogwa (1992), has called or 'technical know-how from advanced motorized countries where road accidents are well under control using well tested countermeasures' to be applied to Nigeria. A number of developing countries have adopted countermeasures such as speed limits and controls on drink-driving, and legislation for seat belts and motorcycle helmets (Zwi, 1993). Hills and Jacobs (1981) have called for caution, however. The efficacy of countermeasures in developed countries, they argue, may not be definitive, but also what

might be effective in developed countries may not be effective in developing countries and vice versa. The transfer of technical solutions to the problem of accident prevention clearly needs to take account of the level of development and availability of resources.

Poorer countries have lower private vehicle ownership, high rates of passenger vehicle accidents, use of open-back vehicles (Nelson and Strueber, 1991), reliance on motorcycles (Falope, 1991) and 'token compliance' with, for example, motorcycle helmet wearing (Conrad *et al.*, 1996) or seat belt use. Asogwa's (1980) before-and-after study of motorcycle helmet legislation in Nigeria showed a sharp increase in injuries and fatalities after introduction of the legislation. Sayer and Downing (1981) and Jacobs and Sayer (1983) note that the 'culture' of driver behaviour must also be considered and driver training. In puzzlement at why road accident countermeasures in Nigeria have not resulted in any reduction in accidents, Asogwa (1992), wonders whether there are 'other factors yet to be unravelled. There are many gaps in knowledge that need to be filled through research.

Research Methodology

The study was carried out in Lagos, Oyo, Ogun and Osun States of Southwestern Nigeria. The selection of these states was based on their road traffic situation and geographical proximity. In Nigeria, southwestern zone has a landmass of about 58,585 square kilometres bounded in the east by Benin (Edo state Nigeria), in the west it shares a common frontier with the Republic of Benin (formerly known as Dahomey), in the north it stretches towards Kwara and Kogi states (Nigeria) and in the south by the Gulf of Guinea (Atlantic Ocean). Southwestern zone covers about one-twelfth of Nigeria and in it are over 30 million people according to 2006 Census.

The data used in this study were collected during a survey mounted by the authors between January and May 2009. By means of structured questionnaires, data were obtained from a total of 352 respondents through random sampling technique, from four out of six states that made up of southwestern Nigeria through personal interview. The respondents made up of drivers, passengers, pedestrians, traffic warden, and traffic police. The 352 respondents were selected from some notable principal transport parks and markets in the study areas through stratified sampling techniques. The areas are Oshodi (Lagos state), Iyana Ipaja (Lagos state) Ikorodu Park (Lagos state), Iwo Road Park (Oyo state), Sanngo (Oyo state), Molete (Oyo state), Oke-fia (Osun state), Old Garage (Osun state), Olaiya Park (Osun state), Lafenwa (Ogun state), Kuto (Ogun state), and Oba Lipede Park (Ogun state). Information was solicited in respect of courses of road traffic crashes, effects of road traffic crashes on socio-economic activities of the study areas as well as remedy to the problem.

Regression Analysis was adopted in analyzing the data obtained. This was done in order to establish the relationship between human characteristics, vehicular characteristics, roadway characteristics, environmental characteristics, and road traffic crashes in the study areas.

RESULTS

In an attempt to examine the factors causing road traffic crashes in the study areas in full detail, the following variables were investigated; human characteristics, vehicular characteristics, roadway characteristics, and environmental characteristics.

The model is specified as:

$$Y = a_0 + b_1 X_1 + b_2 X_2 + b_3 X_3 \ldots + bnXn + Ui \ldots\ldots Equ. (1)$$

Where

a_0 = Constant

$Xi \ldots .Xn$ = Explanatory variables

$b_i \ldots .b_n$ = Parameters to be estimated (i = 1, 2, 3, - - - -- n)

Ui = Error term or disturbance term

Y = Dependent variable (Road traffic Crashes)

X_1 = human characteristics

X_2 = vehicular characteristics

X_3 = roadway characteristics

X_4 = environmental characteristics

The summary output of multiple regression estimation technique is shown as:

$$Y = 624.8192 + 3.7661X_1 + 2.1194X_2 + 3.3201X_3 + 2.5270X_4 + U_e \ldots\ldots\ldots\ldots\ldots\ldots (II)$$

Research question 1

What is the joint contribution of human characteristics, vehicular characteristics, roadway characteristics, and environmental characteristics to the road traffic crashes in the study areas?

The data from Table 1 indicates that a combination of independent variables; human, vehicle, environment and roadway factors yielded a coefficient of multiple Regression (R^2) of 0.794 accounting for 79.4% of the variance in road traffic crashes in southwestern Nigeria. Table 2 shows that the analysis of variance for the multiple regression data produced F-ratio value of 285.811 which is significant at 0.05. While table 3 shows the variables in the equation.

Research question 2

What is the relative contribution of each of the above variables to the prediction of traffic crashes in the study areas?

Table1.   Multiple Regression analysis of contribution of independent variables

Independent variables	
Multiple R	0.891
R Square (R^2)	0.794
Adjusted R Square	0.728
Standard Error	14.8682

Table 2. Analysis of Variance

	DF	Sum of Square	Mean Square	F-ratio
Regression	4	244231.35	61057.84	285.811
Residual	347	74128.78	213.63	

Sig. $F_{(5, 346)} = 285.811$; $P<0.05$

Table. Variables in the Equation

Variables	B	SEβ	Beta	T	Sig. T
Constant	52.6142	4.918	-	10.698	0.05
X_1	3.2401	0.254	0.247	12.756	0.01
X_2	2.2380	0.249	0.236	8.988	0.01
X_3	3.1521	0.242	0.381	13.025	0.05
X_4	2.6390	0.341	0.225	7.739	0.01

Source: Data Analysis, 2009

DISCUSSION

The results obtained from the statistical analysis of the research question indicated that human characteristics, vehicle characteristics, roadway characteristics, and environmental characteristics made a joint significant contribution of about 79.4% to the road traffic crashes in southwestern part of Nigeria. The joint contribution could not have come by chance because the F-ratio value of 285.811 lends credence to the effectiveness of the four explanatory variables in causing road traffic crashes in the study areas. Consequently, it could be inferred that 79.4% of the variance in the road traffic crashes are accounted for by the combination of the four factors.

The outcome of this research question in effect corroborated similar findings of Dixey (1999), Asogwa (1992), Iyang (1991), and Ogunsaya (1991). They all agreed that human characteristics, roadway characteristics, environmental characteristics among others are the principal causes of road traffic crashes in some developing and developed countries across the world.

Findings from research question two, unlike the first delved into separate contributions of the four explanatory variables and independently made significant contribution to the road traffic crashes, though at different degree. The most potent contributor happens to be the human characteristics (β=3.2401) closely followed by roadway characteristics (β=3.1521), environmental characteristics (β = 2.6390), and vehicle characteristics (β = 2.2380). This implies that human characteristics made the highest contribution to the road traffic crashes in the study areas, when all the independent variables are put together at 0.05 significant level. Some of the human characteristics that contribute to its potency in accident causation in-clude, alcohol or drug abuse, indecision, fatigue, in-experience, physical defects, distraction, over speeding, and confusion, just to mention a few.

Accident Prevention and Reduction Measures

Road safety reduced the risk of road traffic crashes or injury on the roads, achieved through multidisciplinary approaches involving road engineering and traffic management, education and training of road users, and vehicle design. Extensive remedial measures aimed at improving road safety have been developed in the fields of engineering, education, and enforcement-the "three Es" (Gbadamosi, 1994). These address both primary safety (reduction of road traffic crashes) and secondary safety (alleviation of injury).

Engineering measures

Many countries now regularly implement low-cost measures to "black spots", (places where accidents cluster). The subsequent savings in accidents are substantial (not uncommonly up to three quarters), with economic benefits of several times more than the cost of the measures in the first year. Successful treatments have included: changes in layout at junctions to define priorities, more widespread use of road makings to delineate traffic lanes and waiting areas for turning vehicles; improvements in skidding resistance of wet roads; more uniform street lighting; and more highly visible and legible direction, information, and warning signs.

Protective Measures

The most dramatic effects have followed the use of seat belts and child restraints in cars. Use of seat belt reduces the risk of death or serious injury by about 45 per cent. (Jacobs 1995) Publicity has also played a major part in increasing wearing rates, but for full effect it needs to be backed by legislation. Legislation for compulsory wearing was first introduced in the State of Victoria, Australia in 1971. Today all the major developed and developing countries of the world including Nigeria have laws enforcing the wearing of seat belts, with reported levels of compliance of over 90 per cent in some countries, notably for front-seat passengers in the United Kingdom. Other protective measure that are gaining support are the wearing of helmets by cyclists and the use of crash protection barriers on the central reserve of high-speed motorways, and to guard rigid object on the roadside (utility poles, sign supports, bridge abutment, and ties). Many advances have been made in vehicle design to protect occupants: there is also potential for greater protection for the vulnerable pedestrian and cyclists who come into contact with motor vehicles, but promising developments have not yet been fully exploited.

Other protective measures developed include, restrain on mobile phone usage when driving, alcohol intake, enforcement of speed limit and so on.

Enforcement of Traffic Law

Law enforcement has an important part to play in improving road safety. Police activity in this respect is most effective where technological aids are available, and when the laws are acceptable to the majority of road users. The most dramatic reductions in accidents due to law enforcement lie in the area of drinking and driving. A successful law has been based on prescribing a limit to the amount of alcohol in the blood in the range from 50mg/100ml to 100ml. The application of the law, new

technology to aid enforcement, enhanced publicity, education of teenagers in schools, and the development of rehabilitation courses are very good measures in accident reduction and prevention scheme.

Education and Training

Educating the young ones about the menace of road traffic crashes is a very good step in preventing crashes. Starting from schools, road traffic education should be part of civic education or better still a subject on its own. This will entrench a good culture of traffic into the children right from their primary school days. Training and re-training of drivers, pedestrians and other people connected with road usage is also another strategy that is very important. There suppose to be an established training institute for drivers where there would be a special training for intending drivers and also provide re-training for older drivers so as to refresh their knowledge and also keeping them abreast of new development in road safety all over the world. This will go a long way in tackling the menace of road traffic crashes in the study areas and in Nigeria at large.

Conclusion

Based on the findings of this study, it was concluded that human, vehicle, environmental and roadway characteristics are the salient factors that are responsible for road traffic crashes in South western states of Nigeria. It was also established that road traffic crashes can be ameliorated by embarking on various crashes prevention and reduction strategies such as education and training, traffic enforcement, enhanced transport coordination, road capacity expansion, and drivers' enlightment.

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