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"VEHICLE CHARACTERISTICS AND ACCIDENT RATES ON NIGERIAN ROADS: LAGOS STATE AS A CASE STUDY"

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Abstract

The main purpose of this paper is to investigate vehicle characteristics and the variables with the appropriate accident rates and to establish whether these characteristics and variables have a significant effect on accident rates on Nigerian roads, and Lagos state in particular. An appreciable high percentage of single vehicle accidents involved in skidding are more likely to occur on wet roads than on any other roads. Reports have shown that the risk of injury in different types of accidents is a function of the type and size of vehicle. Car occupants suffer higher risks in multiple accidents than those in bigger vehicles. Fatal accidents are common to light vehicles as a result of head – on collisions or loss of control caused by poor judgment. The accident ratio is a good idea for determining the level of driving ability and knowledge of good road usage. The frequency of occurrence of accidents and its relationship with vehicle characteristics are the main variables of interest of this paper. Three kinds of accidents can be identified - fatal, serious and minor. It may also be described in-terms of the number of persons involved and classified also into three, as those killed serious injury or slight injury. The loss in properties is estimated, at about eight million Naira in 2010 and rose to eleven million Naira in 2011. The purpose of this paper therefore is to set out an approach to establish the relationship between vehicle characteristic and accident rates; to develop some kind model that will help, hopefully, in analyzing the situation and to suggest possible improvements and operational strategies.

Key Words: Vehicular Characteristics, Road accidents, Questionnaire, Regression analysis, Operational characteristics

1. Introduction

Road traffic accident may be defined as anything which happens by chance, anything occurring unexpectedly and un-designed (Odugbemi, 2010). Accidents occur when a vehicle collides with another vehicle, pedestrian, animal, road debris or stationary obstructions, such as a tree or utility pole. With a total network of about 193,000 kilometers, Nigeria road sector carries more than ninety percent (90%) of domestic passengers and freight and thereby turn out to be the dominant mode (BPE 2004).

Road transport plays very important roles in the social and economic life of Nigeria. It is in the centre of connectivity of all other modes of transport. The annual reports on accidents fatalities and serious injuries have been a source a concern to all and sundry. The

administration of road transportation in Nigeria shows that the Federal Government is responsible for 34,120km (17.6%) of the road network. State governments 30,500km (15.7%) and local government 129,580km (66.7%) (FMOT 2007). Consideration is given to government reforms and its effectiveness in addressing the issues and policy thrust and strategies to mitigate the problems.

The deterioration of roads across the state often begins with cracks or pot-holes on the road pavements either at the edges or along the drive way, which are noticeable by their shapes, configuration and rate of deformations (Agbonkhese, et al., 2013). In determining the cause of an accident, it is often easier to identify the immediate cause rather than the root cause. Accident reconstruction relies on knowledge of the five phases of motor accidents.

For so long in Nigeria, there has not been a comprehensive study of vehicle characteristics that directly or indirectly affect the rate of accidents on Nigerian roads, Lagos state in particular. In some parts of the world concerted efforts are being made to establish standard that vehicles have to meet to be able to ply the country's highways. It is necessary therefore, to look into the vehicu1ar characteristics, if any, of accident causation on Nigerian roads. This is what this paper seeks to achieve.

2. Methodology

2.1 Data Collection

With the aid of questionnaires, information was obtained from Car users, Lorry drivers, Tankers and Trailer drivers and vehicle Operators generally. The questionnaires were of three parts viz; one for motor vehicle operators, another for motor vehicle dealers and the third for manufacturers/assembly plant. The motor dealers and the Assembly plants located in various places in the country were contacted. Careful study of past works was considered and Consulting firms were contacted for very useful information. Efforts were made in some instances to make immediate visits to some accident locations. The Road Traffic Accidents Statistics Department of The Motor Vehicle Transport Department at Ojodu-Berger in Lagos, and the Statistics Section of the Police Department were contacted. The data base compiled by the Police department was of tremendous assistance.

2.2 Vehicular Characteristics

Vehicle characteristics may be grouped into two: Vehicle design Parameters and Operational characteristics (Adolf, 2008).

2.2.1 Design Parameters

Vehicle design parameters do not necessarily describe directly how a vehicle is handled but may well affect its behaviour. For a brief study of the relation between handling accident and sign parameters, some design parameters mentioned below need to be defined. The design parameters considered are: weight, weight distribution, front to rear axles, power-to-weight ratio of load carried to total weight wheel base, track, height of centre of gravity above the ground, suspension system, braking system, size height, track, turning radius, wheel base, light, tyre and steering geometry and characteristics. Some of these characteristics and variables are enumerated below to show they affect accident rates.

2.2.2 Vehicle Variables

Vehicle variables which influence spot speeds include vehicle type, weight and size, driver eye height, vehicle lighting, maximum speed, power, acceleration and deceleration characteristics as shown in Table 1-4.

2.2.3 Operational Characteristics

These are the factors having to do with the handling and interaction with the operation of vehicles. Many of these affect vehicle design parameters and vehicle variables and could lead to damaging of the structures or resulting in dents. Some of the operational characteristics include: Human factors, speed, age of vehicle, make and model, acceleration and deceleration, fuel economy and operating cost, maintenance, road condition and handling

2.3 Data Analysis

Data from the police was summarized and analyzed to determine accident characteristics from month to month and from year to year. It was also possible to determine accident causalities, vehicular characteristics of accident causation, total number of accidents with emphasis on fatalities serious accidents and minor ones. Assuming that the level of discipline of the drivers on Nigerian roads is measured by the ratio of minor accidents to that of the total accidents for a particular period; it should have been possible for us to estimate this level over a period of five years. This study lends itself to regression analysis. In all, there are one hundred and twenty three variables; and two hundred respondents were treated

Table 1: Ratio of accidents of light to heavy cars on accidents analysis

	0		1		2		3		4		5		K		Total
Car weight	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N
Light	55	13.3	218	52.9	56	13.6	37	9	5	1.2	7	1.7	34	8.4	412
Heavy	37	11.0	162	48.1	66	19.6	38	11.3	6	1.8	3	0.9	25	7.4	337
Total	92	12.3	380	50.71	122	16.3	75	10	11	1.5	10	1.3	59	7.9	749

Key:
0 = No injury
1 = Minor
2 = Moderate
3 = Severe
4 = Serious (Life threatened)
5 = Critical (Survival uncertain)
K = Died within 24 hours.

Table 2: Comparison of risk of Light-weight, and Heavy weight

Accident involving two or more vehicles	Severity of accidents	Light vehicles	Heavy vehicles	All vehicles
Number people	Seriously injured	79	26	105
	Lightly injured	123	43	166
Total		202	69	271

Summary of accident records along Ikorodu-Ogijo road (2014)

Wheelbase rather than weight was used as the indication of automobile size because size is more directly related to protection of vehicle occupants while weight is aggressive to occupants of smaller vehicles and increases in vehicle size are protective of vehicle occupants, suggesting that larger but relatively lighter weight vehicles are desirable. In crashes between vehicles of the same size, severe injuries increase with vehicle size. The smaller the vehicle the greater the involvement rate in fatal crashes of vehicle in which their occupants (including the drivers) died. The relative inability of small vehicles to protect their occupants in collisions with larger vehicles is reflected in the Table 3. The small box in each cell gives the number of studied fatal crashes between vehicles of the size indicated on the left and at the bottom of the table.

Generally, the greater the relative difference in size of the vehicles involved, the greater was the ratio of incidence of death in smaller, to larger vehicles. In fatal crashes between trucks and large cars, death occurred many times as often in the cars as in the trucks. Fatal collisions

between Truck/Trailers and cars of unknown Size (i.e. an unknown mixture of small and large cars). In heavy traffic flow especially when there larger vehicles and long trucks, buses and articulated vehicles, the small car driver take quick overtaking advantage many of which result in head-on collision with the on -coming vehicle. In about 200 cases considered about 55 percent of small vehicles involved in head-on collision accidents and most of which are due to wrong overtaking, and loss of control when overtaking long and larger vehicles or when negotiating a corner. As shown in Table 4, Single vehicle accident and two vehicle accidents together constituted 76% of the 197 road accident cases considered in the investigations. Cars and Taxis are largely involved in road accidents when compared with types of vehicles as can be seen in Figure 1.

Table 3: Ratio of number of vehicles in which death occurred in smaller vehicles to larger vehicles

		2009		**2010**		**2011**		**2012**		**2013**
		No	Growth	No	Growth	No	Growth	No	Growth	No
No of accident cases	Minor	13,391	8	14,390	21	17,555	11	19,061	-	-
	Serious	7,041	3	7,212	6	7,652	18	9,001	-	-
	Fatal	2,855	14	3,242	14	3,686	12	4,153	-	-
	All	23,287	7	24,844	16	28,893	13	32,651	-	51,000
Casualties	Injured	16,161	12	18,154	3	18,660	6	20,097	-	26,500
	Killed	3,921	16	4,537	9	4,922	11	5,486	-	8,000
	All	20,082	13	22,691	4	23,582	8.5	25,583	-	34,500

	2009	**2010**	**2011**	**2012**	**2013**
No of cars	101,000	136,000	170,000	200,000	370,000
No of Trucks	63,800	84,800	110,000	130,000	230,000
Vehicle km.	69.20	92.70	118.20	139.40	251.80
Accidents	339	256	244	234	203
Casualties	290	245	199.5	183	137
Fatalities	57	49	41.6	39	32

Table 4: Single vehicle accident and two vehicle accidents

Type of accident	No of cases	Proportion of total %
Single vehicle	47	23.86
Vehicle to vehicle		
(a) Head on collision	72	36.55
(b) Intersection	31	15.74
Rear end	36	18.27
Vehicle/Motor cycle/Pedestrian	11	5.58
Total	197	100

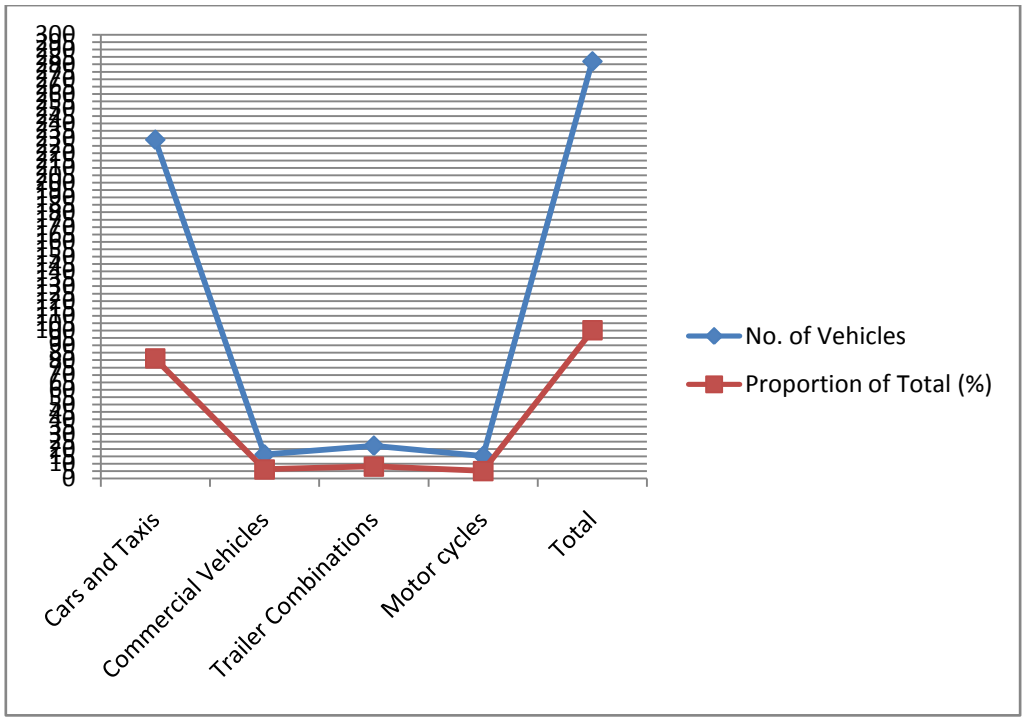

Fig 1: Distribution of class of vehicles involved in road accidents

3. Results and Discussion

3.1 Effects Of Design Variables On Road Accident

3.1.1 Size of Vehicle

Size of vehicle may be classified as small, medium and large. An obvious difference between small cars and large cars is that the load carried by a small car is a much larger proportion of the total weight than it is for a large car. This variation in the weight distribution for different models of car could indicate differences in the frequency of loss of control between cars with different drive configurations. Oar investigation on road accident scenes at various locations revealed that in most accidents involving two vehicles severity of injuries occurs to occupants of relatively light-weight vehicles as compared to those of relatively heavy vehicles.

3.1.2 Length

Over-all length of passenger cars, in conjunction with overhang and turning radius, affects driving conditions. In conjunction with turning radius, vehicle length affects widths of dead end streets, and in conjunction with track and overhang affects driveway curb radii and corner radii at intersections. Most of the vehicles which are reasonably long e.g. Trucks, buses, and articulated vehicles that cannot turn successfully with the radius of the corner may

result to overturning or side-fall. Due to the length, turning radius and track as affected by cornering forces of some vehicles, some loose the rear end into the pits or mount on kerbs. Loss of control is not uncommon in lengthy vehicles at narrow roads and corners. In parking stalls, inadequate space between the vehicle results to rear hitting where the vehicle turning have long length and relative turning radius. In some of the situations discussed above, the traffic is dependent on vehicle length in a not-too-direct manner. It is doubtful that density in queue is a linear function of vehicle length. Certainly, corner radii cannot be determined uniquely from knowledge of this length. Both of these characteristics, the first operational and the second geometric, be determined from observations of the behaviour of real traffic. However, traffic density and congestion is a function of the rate of minor accidents such as front and rear hitting, and side brush or scratch.

3.1.3 Width

This dimension affects parking-stall length and width on streets and highways and, to a lesser degree, aisle widths in parking lots. In conjunction with vehicle tracking characteristics and down vision over the nose, it affects lane widths to achieve a given lane volume on both straight and turning roadways. In conjunction with turning radius and wheelbase, it affects the clearance required of curb side objects at corners. Where the necessary clearance required is not adequate or in a narrow road, side scratch or side to side vehicle brush may occur resulting to minor accidents and serious damages.

3.1.4 Height

The height of a vehicle is another characteristic that directly affects road accidents. Excessive loading of the vehicle increases the height and vehicle in this condition is likely to overturn in descending gradients, and weight transference to the rear when ascending steep gradients may result to serious accidents. Also, overhead structures of any sort will be affected by vehicle height. This includes bridges, detectors, wires, traffic signals, signs, lighting fixtures, and tunnel openings.

3.1.5 Weight

Investigation has shown greater incidence and severity of injuries to occupants of relatively tight-weight vehicles as compared to those of heavy vehicles in single vehicle and vehicle-vehicle crashes. Further analysis of the research showed that differences in mass between

colliding vehicles contribute more to injuries to occupants of the lighter vehicles. Increases in vehicle weight are considered more aggressive to occupants of other vehicles than light ones.

3.1.6 Weight Distribution

For different makes of cars, the weight distribution varies .s they are not design on the same specifications. For example, considering front-wheel-drive cars the ratio of eight, front-to-rear is higher than for conventional cars and 'that the ratios for rear¬-engine cars may be lower. It is quite possible that this variation in the weight distribution for different makes of car could .indicate differences in the frequency of loss of control between cars with different drive configurations.

3.1.7 Ratio Of Load Carried To Total Weight

An obvious difference between small cars and large cars is that the load carried by a small car is a larger proportion of the total weight than it is for a large car. This could quite possibly affect the frequency of loss of control talk less of vehicle or car overloading which is common on Nigeria roads. Overloading of vehicles increases the centre of gravity and affects the vehicle stability most of which results to loss of control, overturning, and skidding rear - end collision of hitting on highways.

3.1.8 Braking System As A Function Of Vehicle Safety

Propelling the vehicle is important but it is even more critical to be able to stop safely without effective braking system. The ability to operate at close headways depends almost entirely upon reliable braking systems and adequate traction. The forces that must be overcome by motor vehicles if they are to proceed are rolling resistance, air resistance, grade, curve and inertia resistance forces. Grade act as a retarding force only when vehicles are ascending gradients and inertia only when speed increases are involved. When vehicles are to be stopped or slowed, all these resistance help braking action except down grade and inertia. A vehicle moving in a non-stationary air stream is subjected to lateral force, rolling and yawning moments developed as a consequence of the fact that the air flow is not parallel with the direction of forward motion of the vehicle and therefore also having braking and swaying effect. Accidents due to braking effects carry a reasonable proportion of accident caused by mechanical defects especially on motor Lorries. It is quite evident that most of the accident

involving Trailers and articulated vehicles are as a result of braking defects resulting to loss of control especially when descending gradients, and the vehicle at the front may be affected.

3.1.9 The Effect Of Locked Wheels

Investigations on roads and accidents sites revealed that 30% of Trucks Trailers and articulated vehicles that have accidents on Nigeria roads are due to effect of locked wheels while negotiating bends, sharp corners and descending gradients. As already discussed, this dangerous condition can be brought about by a variety of causes, and it is now necessary to examine the effects on the behaviour of the vehicle due to the mode of locking.

3.1.10 Front Wheels Locking

The vehicle goes on in a straight line, regardless of the position of the steering wheel. Directional control may be regained by easing off the brakes until the front wheels start to revolve.

3.2 Vehicle Variables As It Affects Spot Speeds

Excessive speed of-vehicle contributes to the relative percentage of accidents occurring in Nigeria (Police report 2009). It will be necessary to examine some of the vehicle variables which influence spot speeds. These variables include vehicle type, age, weight, driver eye height level, lighting, maximum possible speed of vehicle, horse power rating and acceleration characteristics. From the observations and Road Survey, it could be concluded that age of vehicle, as having significant effects on spot speeds in urban and rural areas. In the rural areas selected, 70 per cent of the commercial vehicles plying the roads are between 5 and 10 years old, and in the urban areas selected about 60 per cent of the vehicles between 4 to 10 years old. The maximum speed of most of them especially in rural area is an average of 70 to 80 km/hour and their deteriorating condition contributes to accident rates.

The maximum speeds of vehicles have repeatedly been reported having effect on spot speeds. It is a well known fact that maximum design speeds of normal motor vehicles are 70 km/hr. The type of vehicle is a major vehicle variable which influences speed variation. With similar road vehicle speed carried out, it was observed that the average speed of cars as being between 100 to 110 km/h; light commercial vehicles as being 110-120 km/h, medium commercial vehicles 'up to 100km/hour; while heavy commercial vehicles including Trailers and Articulated, cruise at an average speed of 80km/hr. The Police report for the 2008-2009

shows how these speeds also reflect accident rates on roads as can be seen in Table 5 (Akorodare, 2009). Investigation on 200 accident eases also revealed that 53% of the vehicles involved are commercial vehicles. It is quite evident that improvement on vehicles models and types yield a proportional gain in speed as they also reflect on accident rates on the roads.

3.3 Theory Of Regression Analysis

Regression analysis is the analysis of the relationship between dependent and independent variables; in .this case accidents rates and the factors responsible for them. The analysis goes further however, to examine the causalities of accidents owing to each of the factors responsible. Several factors contribute towards accidents. These include among others; excessive speed, drunkenness, wrong overtaking, poor visibility, obstruction etc. These factors can be represented by independent variables; X_1, X_2, X_3,……,Xn respectively. Out of the nineteen variables considered for both the stepwise and multiple regression analysis, only eight of them came up with acceptable coefficients, that is, the significant terms at $p<0.05$ as shown in Table 6.

Table 5: Changes in spot speeds on tangent level roads (2008-2009)

Type of vehicles	Sites	provided	with dual	carriage ways	all	sites
	Mean speed	Km/hr	Increase in speed km/hr/yr	% increase over 2008	Increase in speed km/hr/yr	% increase over 2009
Car	68.16	78.8	1.0	16	1.2	20
Light commercial	57.92	70.4	1.1	22	1.2	23
Medium commercial	52.64	62.4	1.0	21	1.0	22
Heavy commercial	46.56	59.68	1.2	28	1.2	29

Table 6: Variables Considered in order of severity of accident

Factors (X)	Variable Name	Coefficient Estimate
X1	Wrong Overtaking	-0.25722
X2	Drunkenness	-0.23430
X3	Inadequate Enforcement	-0.19533
X4	Visibility	-0.17996
X5	Cruising Speed	-0.15701
X6	Broken Spring	-0.15688
X7	Tiredness	-0.13399
X8	Type of Vehicle	-0.10932

This shows that all the regression hypothesis of the variables is acceptable: Given the regression equation as shown;

$$Y = B_o + B_1X_1 + B_2X_2 + B_3X_3 + B_4X_4 + B_5X_5 \ldots B_nX_n \quad 1$$

Substituting the coefficients estimated obtained into all the Betas result in;

$$Y = 2.12609 - 0.25722X_1 - 0.23430X_2 - 0.1953X_3 - 0.17996X_4 - 0.15701X_5 - 0.15688X_6 - 0.13399X_7 - 0.10932X_8 \quad 2$$

Where B_O (Constant) = 2.12609, and the minus signs show the significance of the variables. With the computer output it was realized that the variables considered as shown above have significant effects on accident rates. For example: considering visibility, the greater the visibility, the less likelihood of accidents. This can be further verified from graph of accident rates and visibility which gives a negative slope. In the case of speed, the greater the speed, the more the chances and severity of accidents.

Within the scope of this research, it is not possible to collect the values of all parameters contributing to occurrence of accidents. The questionnaire was deficient of some relevant and revealing questions which one would expect in work like this. This deficiency was known when there were more insights into the research; such additional questions expected are on: tyre pressure, make and model of vehicles, age of vehicles, acceleration, deceleration characteristics, accident spots and number of injuries etc. It is very important to carry out many road tests, road surveys, counts and studies, and visit as many accident spots as possible. These are very necessary to get enough information. It would be good if many different models of car performance parameters are obtained for the exercise. Since these performance parameters and tests are specifically carried out to avoid accidents this would indicate accident prone or not. It is also necessary to obtain vehicle measurements, specifications and design parameters; examine relationship between handling and stability and measure of stability related to proportion of overturning.

4. Conclusion

The study of accident rates has been of interest for some time. Although very little work has been done to establish the effect of vehicle characteristics on accident frequency. A direct comparison of former work with the present work may be difficult but will reveal some new

ideas. The result of the present work reveals that human factors contributed much to the frequency of road accidents. In investigating the relative importance of the vehicle variables and parameters, the results show that size has significant effect in accident fatality. It is also noted that handling and operational characteristics have great effect on accident rates. In the analysis of accidents for each year it is observed that the minority ratio (minor cases/total cases) for accidents from 2008 to 2010 is increasing at a higher rate in proportion to serious and fatality ratios, thereby indicating the growth of development and civilization in Nigeria. Vehicle operators should refrain from servicing their vehicles themselves, especially when they are not technically oriented. In addition vehicles designed for goods should not be used for carrying passengers. There is a serious need for an appraisal and a re-assessment of the automobile technology and behaviour.

References

- *Adolf D. (2008). Vehicle Operating Characteristics, Transportation and Traffic. "Engineering Handbook"*
- *Agbonkhese, O., Yisa, G.L., Dauda (2013). Bad Drainage and its Effects on Road Pavement Conditions in Nigeria.*
- *Arokodare (2009). Road Accidents Data in Nigeria 2008-2009 Analysis and Interpretation.*
- *Bureau of Public Enterprises (2004)*
- *Odugbemi, O.O. (2010). Road Transportation and Tourism in Nigeria.*
- *Draper and Smith, "Applied Regression Analysis John Wiley Publishing Company"*
- *Federal ministry of Transportation (2007)*
- *Ian J. "The Effect of Vehicle Characteristics on Road Accidents"*
- *Oyefesobi, "Measures to Improve Traffic Flow and Reduce Road Accidents in Nigeria"*