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Multivariable Traffic Accident Model among Commercial Buses.

Arowolo Matthew Oluwole and Akintaro Adekunle Omoniyi

***Abstract*— This paper present a study of commercial bus accident with the intention of gaining insight into the possible factors responsible for commercial bus accident and the attended causalities with the knowledge that many people involving in commercial accident due to high number of passengers it carries at any given time of its trips. Through the literature survey, accident report analysis and accident database many factors were responsible for the causation of bus accident but after much analysis of quantitative and qualitative accident report using Nvivo 10 and spss 16 three major outstanding factors as road, driver and vehicle were used in this report to build a traffic accident model and questionnaire survey to predict the contribution of this three factors to bus accident. The regression analysis in SPSS16 of this factors following a questionnaire survey report conducted among 150 highway and country road drivers in a transport company in Malaysia shows a linear regression contributory equation of bus accident as -273.13 + 0.034 X (Vehicle Factor) + 0.246 X (Road Factor) + 0.345 X (Driver Factor) with the Pearson correlation between the actual value of bus accident and the predictive values of driver, road and vehicle factors as it affects road accident of value 0.660 which shows that the three variables actually measure bus accident which agree with the null hypotheses H0 : $\mu_1 = \mu_2$. Understanding these factors can help to bring forth realistic strategies to improve the safety of commercial buses.**

***Index Terms*-- Regression, Driver, Road, vehicle, Fatality**

I. INTRODUCTION

In recent time with the great increase in vehicular movement road accidents involving all vehicle types are the most common cause of death among all race [1, 2]. A statistical projection of traffic fatalities round the world for the first half of 2013 shows that an estimated 15,470 people died in motor vehicle traffic crashes as reported by World health organisation [27] Also reported by the Mail online (www.mailonline.com) each year an average of 1.24 million people die in road related accident and that the world's roads are getting more deadly as well, it was projected that by 2030 the number of fatalities is expected to triple to 3.6 million. But reference [6&7] said that recent statistics confirmed that the number of crashes and fatalities occurring on our nation's roadways involving large trucks (≥10,000 pounds) are decreasing which are due to reduction in new safety technologies. The aim of this paper is to highlight the scale of the problem of commercial buses through three most essential accident causation factors and to evaluate some possible ways to reduce them. The paper will cover the extent of the problem, the causes of accidents and a demographical view of the driver despondence through questionnaire survey. [19] Performed an international comparative study across different regions in terms of motorisation, personal risk and traffic risk. [13] on their own developed a road safety performance indicator, SPIs for various areas within road safety such as speed, car occupant protection, alcohol and drugs, vehicle safety, etc with these SPIs they indicated the road safety and compare the performance between countries and over time. In a similar manner [25] developed a calibrated microsimulation model to analyze vehicle trajectories, and hence vehicle interactions, in some different scenarios and verify traffic safety levels, while [8] used mathematical model to construct road safety equation.

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Arowolo Matthew Oluwole, (PhD Research Student) Department of Industrial Engineering & Manufacturing, Universiti Teknologi Malaysia, 81310,Skudai, Johor Bahru. (+601116185023)

Akintaro Adekunle Omoniyi, Department of Mechanical Engineering, Osun State College of Technology, Esa – Oke, Nigeria. (+2348033846273)

II. BUS ACCIDENT CAUSEs ANALYSIS

Many accident causes has been suggested one of them as reported by Hakkert and Gitelman (2007) [16] based upon the potential of different road safety areas for increasing road safety as well as on the experiences and data available, seven problem areas were designated as central to road accident activities in Europe. They are: (1) alcohol and drug-use; (2) speeds; (3) protective systems; (4) daytime running lights; (5) vehicles (passive safety); (6) roads and (7) trauma management.

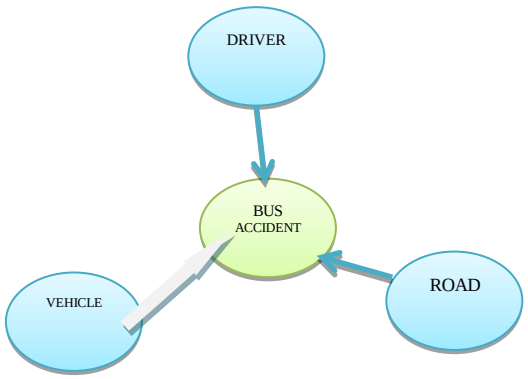

Figure 1. Three Key Causes of Bus Accident.

III. ROAD SITUATION

Road situations especially road design attributes, namely

road alignment, grade and curvature, section type, traffic-way type, the number of lanes, and speed limit are significantly associated with accident occurrence. Two-way traffic and multi-lane roads increase the probability of higher accident severity. Relatively to one-way roads, two-ways roads are 54.5%-82.7% more likely to result in severe non-incapacitating injuries and 21.4%-22.6% more likely to result in incapacitating injuries. According to [11&13] accidents that occur in multi-lane roads are more likely to be significantly associated with severe non-incapacitating injuries (7.3%), incapacitating injuries (4.5%), and fatalities (0.9%). Road curvature is positively associated with increased accident severity. The occurrence of bus accidents on straight sections greatly reduces the probability of light injuries (−15.1%), severe non incapacitating injuries (−60.4%), incapacitating injuries (−31.0%), and deaths (−5.1%). Road sections at level grade are positively associated with increased accident severity level, while slopes are related to less severe accidents. In fact, accidents that occur at level grade are more likely to result in light injury (19.8%), severe non-incapacitating injury (16.8%), incapacitating injury (20.4%), and death (3.7%).

IV. VEHICLE

In most of the commercial bus design there is no standardization or uniformity in these designs most of the design of cabin and driving seats are not done scientifically or ergonomically. The result of this is driver's fatigue which can cause distractions and can affect the driver psychologically by affecting his/her mood of driving and behavioural attitude which can again cause distraction and impaired decision making while driving [28] stated that in some private transport companies they overload their bus as much as twice their legitimate capacity which also can create accidents by overturning and rolling back the vehicle on slopes that can consequently result into accident. The following items in a vehicle were identified to assist bus driver in accident mitigation 1. Better vehicle interior design to reduce fatigue and distractions. 2. Vehicle connected with the speed regulator will assist the driver against over speeding. 3. Vehicle connected with forward collision warning will prevent accident. 4. Old and aged vehicle on the highway is risk since it can break down and cause accident thereby. 5. Installation of curve speed warning may be essential to prevent vehicle somersaulting.

V. DRIVER

The driver at all times in the period of driving uses a set of control tasks, this task can be intuitive or responses to certain traffic conditions, to drive safely the driver should be able to understand his/her surrounding and react accordingly. To do this his/her physical as well as psychological senses and action systems should be always alert and well-coordinated since in most times distraction and fatigue disrupts the driver's coordination and lead to errors in judging driving and environment which can be considered to be a serious reason fo road traffic accidents. According to [6,9] different types of distraction can lead to different driving errors or performance degradation like longitudinal, lateral controls, situation awareness and unfavorable response to certain risky road traffic conditions. Some of the items on side of drivers considered to promote road safety include 1.Given attention to road advertisement signs while driving can caused distraction, 2. As a driver wearing of seat belt provide safety, 3. Receiving call while driving can create distraction and cause accident, 4. Habitual speeding can cause accident, 5. Driving with the influence of alcohol/drug is bad and

dangerous, 6. Drowsiness and fatigue of the driver can cause accident, 7. Acute psychological stress of the driver can cause accident; 8.Habitual disregard of traffic regulations can cause accident.

VI. MODEL METHODOLOGY

For proper monitoring of the efficiency of road safety measures and road safety improvement of bus traffic general, the most common indicators are the numbers of accidents, fatalities and injuries. All these data and numbers, however, are often not sufficient to illustrate the level of road accident, as they express or portray the "bad cases" of unsafe operational conditions of the road traffic system. Most often, counts of accidents and casualties sometimes do not reveal the processes that produce them. Therefore, additional predictive model are required for assessing the safety conditions of commercial bus traffic system and also for progress monitoring [28].

VII. DATA COLLECTION

A questionnaire was designed to obtain information on about three major factors regarded as to influence road safety. The questionnaire for this study was translated into Malay languages to account for the local language and norms so as to capture the target respondent of bus driver in Malaysia highways. The questionnaire survey consisted of six factors forming the identifiable factors influencing road safety, these questionnaire was design to consist of three parts. The first part involved an eligibility of the respondents which were mainly road safety expertise that involve in driving and the enforcement of road safety measure. The second part of the questionnaire collected information on the demographics of the respondents. The last part of the questionnaire gathered the respondent's views and opinions regarding the identifiable three factors influencing commercial road accident.

VIII. MODEL FORMULATION

The model developed is capable of measuring both road safety situations and traffic accident trends of any nation. A multiple linear regression model can also be used to measure individual effect of identified factors in the model. The resulting model allowed identification of the safety factors in the independed variables that predicted the traffic accident

and also established the road safety index.

$D = \beta 0 + \beta 1 X1 + \beta 2X2 + \beta 3X3 + \beta 4X4 + \beta 5X5$

……. Equation 1

Table 2 Descriptive Statistics

	N	Range	Minimum	Maximum	Mean		Std. Deviation	Variance	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Gen	35	1.00	1.00	2.00	1.1429	.06001	.35504	.126	2.134	.398	2.705	.778
Age	35	3.00	1.00	4.00	2.1429	.14862	.87927	.773	.534	.398	-.165	.778
Mar	35	3.00	1.00	4.00	2.0857	.17572	1.03955	1.081	-.013	.398	-1.856	.778
Tyv	35	.00	1.00	1.00	1.0000	.00000	.00000	.000	.	.	.	.
Valid N	35											

Table 3. Multiple Correlation Coefficients

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.660[a]	.435	.321	.92975	.435	3.820	25	124	.000

a. Predictors: (Constant), Accidtrate, Rcall, DrivPwk, Stress, VehAge, DrivExp, RoadInfr, OldVeh, Intrsectn, InteriorDesg, TrafficRegul, JournyPref, CurveSpeed, Seatbelt, DegreeCuv, RoundAbt, AlcholDriv, DriverAsst, TrafficLight, BillBoard, Fatigue, RoadAdvt, ForwardColl, Hbspeed, SpeedRegu

Table 4. Regression Coefficients and Constant Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
	B	Std. Error	Beta			Zero-order	Partial	Part
(Constant)	-273.13	.074		.000	1.000			
REGR factor score 1 for analysis 1 (Vehicle Factors)	.034	.104	.034	.323	.747	.074	.027	.024
REGR factor score 1 1 for analysis 2 (Road Factors)	.246	.092	.246	2.687	.008	.353	.218	.199
REGR factor score 1 for analysis 3 (Driver Factors)	.345	.103	.345	3.336	.001	.395	.268	.247

a. Dependent Variable: REGR factor score 1 for analysis 7

Equation (1) above can be expressed in the form: $\text{Log } D = \beta 1 \log X1 + \beta 2 \log X2 + \beta 3 \log X3 + \beta 4 \log X4 +$

$\beta 5 \log X5$ ……. Equation 2

Hamed et al(1998) model time until accident occurrence situation and come up with the formular:

$G_T(t) = P_r[T \leq t]$ …….. Equation 3

Where GT(t) is cumulative distribution function of the time between accident and Pr is probability of having an accident before sometimes t and let T be a random variable representing the time to a commercial bus accident as depended variable.

IX. RESULTS AND DISCUSSION

Demographics Respondent

The summary of respondent's demographic characteristics is presented in table 4 but in table 3 most respondents were aged 25 – 35 years (48.6%), 18 – 24 years (22.9%), 36 – 44 years (20.0%) and 45 – 54 years (8.6%). Under gender out of 35 respondent 30 were male with 85.7% while only 5 female responded forming 14.3% three of them never speed as they travel 8.6%, those that seldom speed and those that were not so sure as they drive were 7 forming 20% each, 14 reportedly speed frequently as they travel which is about 40% while 4 of the respondent speed very frequently each time they drive as explained in table 5. Also in table 6, 5.7% never wear seat belt as they drive,14.3% seldom wear seat belt, 2.9% is not so sure if they wear seat belt while driving, 22.9% frequently wear seat belt while a total of 54.3% will always wear seat belt as they drive.

Table 1 Age Processing Summary.

Age	Population	Marginal Percentage
18 – 24 years	8	22.9%
25 – 35 years	17	48.6%
36 – 44 years	7	20.0%
45 – 54 years	3	8.6%

The efficacy of regression for the prediction of bus accident as in table 3 is the Pearson correlation between the actual value of bus accident and the predictive values of driver, road and vehicle factors as it affects road accident, this value of 0.660 shows that the three variables actually measure bus accident as predicted.

Table 4 of the values of the regression coefficients from column B we see that the multiple regression equation of commercial bus accident is

Bus Accident = -273.13 + 0.034 X Vehicle Factor + 0.246 X Road Factor + 0.345 X Driver Factor

The equation shows respective contribution of each factor to commercial bus accident from this study vehicle factors contribute less 0.034 followed by road factor of 0.246 and driver factor of 0.345 values.

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Arowolo Matthew Oluwole, (PhD Research Student) Department of Industrial Engineering & Manufacturing, Universiti Teknologi Malaysia, 81310,Skudai, Johor Bahru. (+601116185023)

Akintaro Adekunle Omoniyi, Department of Mechanical Engineering, Osun State College of Technology, Esa – Oke, Nigeria. (+2348033846273)