Identification of Factors that Cause Severity of Road Accidents in Ghana: a Case Study of the Northern Region

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Abstract

The incidence of deaths and injury as a result of road accidents is now a global phenomenon. As a result authorities in virtually all countries of the world are now concerned about the growth in the number of people killed and injured on their roads including Ghana. The study objective was to identify the variables that mainly contribute to accident severity in the Northern Region and to describe the impact of these variables. This study applied binary logistic regression to accident-related data collected from motor transport and traffic unit (MTTU) Northern Region traffic-police records in order to examine the contributing factors to accident severity. A total of 398 accident data from 2007-2009 was used. Among the variables obtained from police-accident reports, two independent variables were found most significantly associated with accident severity; namely, Over loading and Obstruction.

Keywords: accident severity, logistic regression, fatal accident, non-fatal accident

Introduction

It is well known that traffic accidents are of high importance to the public health spectrum in the world. Moreover, in developing countries such as Ghana, the mortality rates from road traffic accidents are rather high compared to other countries in this region. Media reports reveal that Ghana's road accident's is very high, compared to other developing countries. In 2001, Ghana was rated as the second highest road traffic accident-prone nation among six West African countries, with 73 deaths per 1000 accidents. (Sarpong, 2011). Road accidents have great effect on any country's economy especially, a developing country, like Ghana. Statistics from the National Road Safety Commission shows that, Ghana loses about 1.7 per cent of its Gross Domestic Product which is over 230 million dollars every year beside the loss of lives to road accidents. (Ghana news agency, 2010). Many people continue to be negligent and ignore the dangers involved in driving and few precautions are observed by motorists. The most talked about and serious cause of accidents nowadays in Ghana is the use of cell phone while driving.

Another cause of road accidents is over speeding. Motorists who go beyond or below the prescribed speed limits on road could hit other vehicles and they could be hit as well. Statistics show that about 30% of accidents on the roads are caused because of speeding. (Akongbota, 2011). Also, driving while intoxicated can cause fatal road accidents. Alcohol and drugs can affect ones driving skills. It causes general impairment of the brain and the function of nervous system. Drivers who drive tired or exhausted are mostly sleepy, agitated and aggressive on the roads. Fatigue can affect their clear thinking if they encounter a glitch on the roads and this can lead to accident. Some drivers disregard road rules since they are more concerned of getting to their destination than of how they would get there especially in the festive seasons as there are always many passengers and they want to travel as many times as they can to take advantage of the increasing number of passengers. Such drivers would violate road rules and laws just to get to where they are going. All these, would definitely cause serious road accidents. As much as accidents are caused by various factors, there are always preventive measures or steps that can be taken to prevent them. This study aims at examining factors, that have a higher potential for serious injury or death, such as accident location, type, and time; collision type; age and, nationality of driver at fault, and his licensing status; and vehicle type.

The Logistic regression and SPSS version 19 is used in this study to estimate the effect of the statistically significant factors on severity. Logistic regression and other related-categorical-data regression have been widely used in accident related studies. However, it has also been used to assess risk factors for various diseases.

Literature Review

The topic of crash severity has been of interest to traffic safety community because of the direct impact on occupants involved. The way forward could be to identify factors contributing to either a more or less severe crash. The approaches used to model injury severities vary from one to another, depending on the purpose of the study and data availability. The literature reviewed focuses primarily on road safety situations in Ghana and the factors that relates to severity of road accidents. The number of motor vehicles in Ghana is increasing rapidly and, coupled with population growth, is contributing to a rise in the number of road traffic injuries and fatalities. Road safety has become a major national issue receiving front-page coverage in the press and National TV news on a regular basis. Fortunately, the government and donor community have reacted quickly and increased funding to the National Road Safety Commission (NRSC), enabling the NRSC to expand and implement new targeted road safety initiatives. The Danish International Development Assistance, Danida, has been a primary supporter of government road safety activities in Ghana. Road crashes kill an average of four persons daily in Ghana. In 2005, the latest year for which statistics are available, the number of road crashes increased by 16% relative to 2004. (National Road Safety Commission, 2011) The regions Ashanti, Eastern, Gt. Accra, Central and Brong Ahafo Regions account for more than 70% of the total number of crash fatalities.

Some 70% of crashes occur on flat and straight roads. Speeding is a major cause of crashes, accounting for over 50% of reported crashes. Buses and mini-buses cause 35% of fatal crashes while cars are responsible for 32%. Road users between 16-45 years are the most vulnerable group and account for 58% of total road crash fatalities from 2002-2006.

Although fatality numbers are growing, crash risk has remained stable over the past six years. The statistics should be viewed with caution as the quality of the national data is affected by under-reporting (including both non-reporting, because not all crashes are reported, and under-recording arising from incomplete retrieval of reported crashes from police files).

James and Kim (1991) developed a logistics regression model for describing the use of child safety seats for children involved in crashes in Hawaii from 1986 through 1991. The model reveals that children riding in automobiles are less likely to be restrained; drivers that use seat belts are far more likely to restrain their children; and one-and-two-year olds are less likely to be restrained.

The study of Yannis et al. (2005) and Al-Ghamdi (2002) conducted in Greece and Saudi Arabia, respectively, considered the combined effects of factors including age on different response variables. The former tackles on combined effects of driver and motorcycle dependent factors on two response variables namely accident severity and at-fault risk. It has been found that there is a significant combined effect of age and engine size with respect to accidents. Soyoung et al (2009), assessed the effects of rainfall on the severity of single-vehicle crashes on Wisconsin interstate highways utilizing polychotomous response models. Weather-related factors considered in this study include estimated rainfall intensity for 15 min prior to a crash occurrence, water film depth, temperature, wind speed/direction, stopping sight distance and deficiency of car-following distance at the crash moment. For locations with unknown weather information, data were interpolated using the inverse squared distance method. Non-weather factors such as road geometrics, traffic conditions, collision types, vehicle types, and driver and temporal attributes were also considered. Two types of polychotomous response models were compared: ordinal logistic and sequential logistic regressions. The sequential logistic regression was tested with forward and backward formats. Comparative models were also developed for single vehicle crash severity during clear weather. In conclusion, the backward sequential logistic regression model produced the best results for predicting crash severities in rainy weather where rainfall intensity, wind speed, roadway terrain, driver's gender, and safety belt were found to be statistically significant. Their study also found that the seasonal factor was significant in clear weather. The seasonal factor is a predictor suggesting that inclement weather may affect crash severity. These findings can be used to determine the probabilities of single vehicle crash severity in rainy weather and provide quantitative support on improving road weather safety via weather warning systems, highway facility improvements, and speed limit management.

Compared with previous studies, this study applied logistic regression to accident records from MTTU's Northern Regional Office taken at crash moment to predict crash severity outcomes. Research findings from this study will provide guidance on counter measures to prevent severe crashes and improve overall safety.

Data Source

The data for this paper were solely secondary data which was taken from Motor Traffic and Transport Unit (MTTU) of the Ghana Police Service, Northern regional office, Tamale. Three years of data, containing information on accident - involved drivers for the period of 2007 to 2009, was used in this study. The data contained those accidents that had occurred in the region within the period under consideration.

Description and coding of variables in the Analysis: The following variables are considered in this study.

Dependent Variable

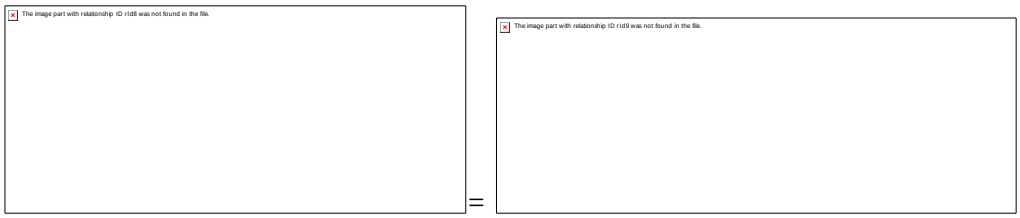
Severity of accident is a variable in the MTTU's datasets recorded as 'consequences of accident' and is assigned to all people involved in a traffic crash and it describes the injury severity level each person sustained when a traffic crash occurred. This variable was recorded as a binary variable as follows: 0 if the accident results in at least one injury but no fatality, and 1 when there is at least one fatality resulting from the accident.

Independent Variables

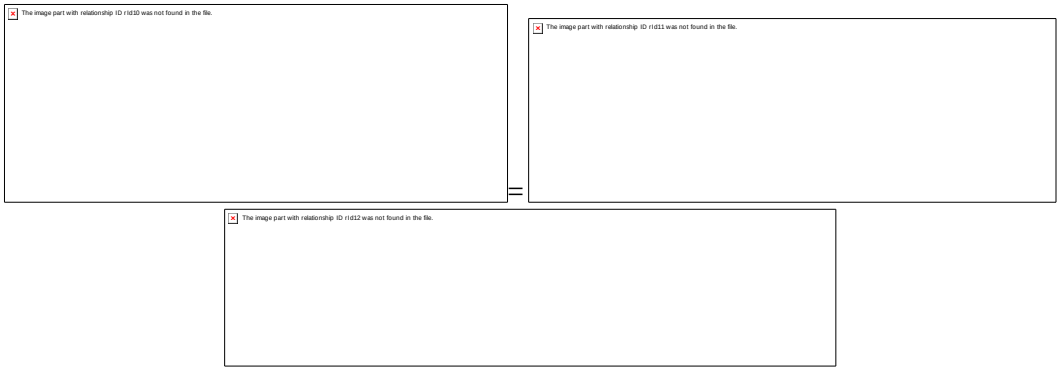
Variable list	Codes
1. Gender	0 = Male, 1 = Female
2. Age	Age of driver
3. Date of accident	Date of accident
4. Alcohol	0 = No, 1 = Yes
5. Safety belt	0 = No, 1 = Yes
6. Vehicle ownership	0 = Other, 1 = Owner
7. Type of vehicle	0 = Commercial,1 = Private
8. Age of vehicle	This is the number of years since the vehicle was manufactured
9. Weight of vehicle	0 = Heavy duty, 1 = Light weight
10. Vehicles tyres condition	0 = Old, 1 = New
11. Estimated Speed at the time of accident	0 = Above 50km/h, 1 = 50km/h and below
12. Posted speed limit at the site of accident	0 = Others, 1 = 50km/h
13. Road surface condition when accident occurred	0 = Dry Surface, 1 = Wet Surface
14. Weather condition when accident occurred	0 = Other: it includes cloudy, rain, snow, etc. 1 = Good Weather and
15. Traffic lighting condition at the time of accident	1 was assign to the option which was applicable and 0 otherwise
16. Driver's familiarity of route	1 = Pass scene of accident at least once a month and 0 = More seldom pass than once in a month
17. Type of driving license	1 was assign to the option which was applicable and 0 otherwise
18. Age of driving license	Number of years since the driver received a driving license
19. Scene of accident	0 = other, 1 = Junction
20. Cause of accident	1 was assigned to a variable which contributed in causing the accident and 0 otherwise

Model Description

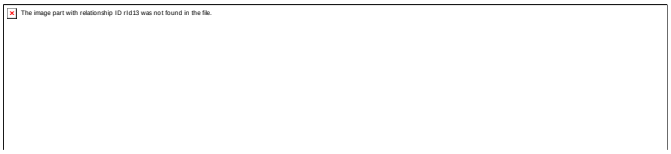
The dependent variable in this research is Accident and of dichotomous type and stands for accident severity. Each accident in the sampled data was categorized as either non-fatal or fatal. The binary logistic model used was as follows:



And thus



Where *g(x)* stands for the function of the independent variables as:



Binary Logistic regression determines the coefficients that make the observed outcome (Non-fatal or Fatal Accident) most likely using the maximum-likelihood technique. The independent variables could be continuous or dichotomous. For the latter, there should be special coding with the use of dummy variables. These dummy variables should be defined in a manner consistent to the Statistical Product and Service Solutions software used in this study (SPSS 19). The Wald tests, together with the Deviance, will be used as criteria to include or remove independent variables in the model.

Results and Discussions

A review of the accidents data revealed that among the 398 records, 3.1% involved minor injuries. The rest were considered as accidents with fatal injuries (i.e 98.7%). The wide gap between the percentages is due to the fact that most accidents are not officially reported to the police especially those without fatalities

Table 1. Classification Table

		Predicted		
		Coonsequences of accident		Percentage
Observed		No fatality	Fatality	Correct
Coonsequences of accident	No fatality	0	5	.0
	Fatality	0	393	100.0
Overall Percentage				98.7

Variable Selection

The analysis was started by testing the significance of the association each explanatory variable could have with the dependent variable.

Table 2. Variables in the Equation

	B	S.E.	Wald	df	Sig.	Exp(B)
Gender	18.736	5787.218	.000	1	.997	1.371E8
Age	-.014	.052	.073	1	.787	.986
EsiveSpeed	-2.395	2.110	1.289	1	.256	.091
Inattentn	13.839	9640.361	.000	1	.999	1023837.090
CarelessJ	14.117	7159.984	.000	1	.998	1351482.719
WOvertaking	-2.911	1.929	2.278	1	.131	.054
Inexperience	-3.633	1.903	3.643	1	.056	.026
Intoxication	14.474	4116.495	.000	1	.997	1931722.343
ORecklness	14.226	4631.994	.000	1	.998	1507534.975
OverLoading	**-6.407**	**2.413**	**7.049**	**1**	**.008**	**.002**
MechDefects	-3.608	2.021	3.186	1	.074	.027
LightsDefects	17.592	40192.969	.000	1	1.000	4.365E7
RSurfDefects	-4.696	28997.819	.000	1	1.000	.009
ORDefects	13.694	19037.554	.000	1	.999	885773.331
Obstructn	**-4.851**	**2.390**	**4.121**	**1**	**.042**	**.008**
Children	14.160	28373.733	.000	1	1.000	1410780.912
AdultsCRC	13.140	11290.749	.000	1	.999	508803.884
OPedestrian	14.054	40192.970	.000	1	1.000	1268914.865
PassengerF	-18.806	57135.291	.000	1	1.000	.000
PeddleCyclist	13.467	21569.898	.000	1	1.000	706022.050
Constant	**7.567**	**2.350**	**10.370**	**1**	**.001**	**1934.147**

Bold figures are significant at level 95%.

Codes	**Variables**
Gender	Gender of driver at fault
Age	Age of driver at fault
EsiveSpeed	Excessive speeding
Inattentn	Inattention
CarelessJ,	Drivers careless at road junction and cutting corners
WOvertaking	Improperly overtaking or cutting-in
Inexperience	Inexperience of driver
Intoxication	Intoxication
ORecklness	Other recklessness or negligence by drivers
OverLoading	Over loading
MechDefects	Mechanical defects
LightsDefects	Defective lights
RSurfDefects	Skid and road surface defects
ORDefects,	Other road defects
Obstructn	Obstructions
Children	Children
AdultsCRC	Adults crossing road carelessly
OPedestrian	Other pedestrian faults
PassengerF	Passengers faults
PeddleCyclist	Recklessness or negligence caused by peddle cyclist

For this purpose the entering selection process of logistic regression was followed. Table 2 presents the results from fitting all the explanatory variables simultaneously. From table 2 above, it appears that the variables WOvertaking, MechDefects, OverLoading and Obstructn show some significant effect whiles the rest of the variables are not significant. Therefore, further analyses were made only on those variables which showed some significant association with the dependent variable.

Finally, analyses were made on the two variables that showed significant effects on the dependent variable and they still remain significant as shown in Table 4 below.

Table 4. Variables in the Equation

							95% C.I.for EXP(B)	
	B	S.E.	Wald	df	Sig.	Exp(B)	Lower	Upper
OverLoading	-4.148	1.355	9.373	1	.002	.016	.001	.225
Obstructn	-2.444	1.195	4.185	1	.041	.087	.008	.903
Constant	4.842	.580	69.771	1	.000	126.667		

It is worth mentioning that these variables over loading and obstruction, deviate from the national expectation which is over speeding. However, the significance of these variables to accident severity in the northern region can be attributed to the bad nature of the roads in northern region as such vehicles cannot speed let alone over speed. Again, due to the bad nature of the roads, villages and communities do not have many vehicles plying their roads so drivers are forced to over load both passengers and goods. Obstruction can be attributed to the fact that the northern region has one of the highest illiteracy levels in the country and the people has no regards to road safety regulations.

Table 5. Hosmer and Lemeshow Test

Step	Chi-square	df	Sig.
1	.722	8	.999

A Hosmer and Lemeshow Test was computed comparing the observed frequencies with those expected under the linear model. A nonsignificant chi-square indicates that the data fit the model well.

The Logit Model

The model results as shown in Table 4 indicates that at 95% confidence level, obstruction and overloading were negatively related to accident severity. Accordingly, the logit model with the significant variables is:

Hence the binary logistic regression model developed in this study is:

And thus

Conclusion

This study examined the factors relating to severity of accidents in the Northern Region during the period of 2007-2009. Since the response variable is of binary nature (i.e., has two categories: fatal or non-fatal), logistic regression technique was used to develop the model. Using the concept of Deviance together with Wald Statistic, the study variables were subjected to statistical testing. Only two variables were included in the model, namely, Over Loading and Obstruction. The observed level of significance for regression coefficients for the two variables were less than 5% suggesting that these two variables were indeed good explanatory variables. The results also showed that the model provided a reasonable statistical fit. Analysis of odds in this study also showed that accidents due to Obstruction are more likely to be fatal.

The results of this study could be used to develop strategies to prevent and reduce fatal accidents in the northern region in particular. The strategies include conducting awareness programs to educate both road users and drivers and strict enforcement of the road safety regulations since the variables overloading and obstruction are all violations of the road safety regulations.

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