European Transport \ Trasporti Europei (2019) Issue 74, Paper n° 1, ISSN 1825-3997

Role of young drivers in road crashes: A case study in India

Malaya Mohanty[1]*, Satya Ranjan Samal [2]

[1] *Assistant Professor, School of Civil Engineering, KIIT University*
[2] *Assistant Professor, School of Civil Engineering, KIIT University*

Abstract

Road crashes has been the prime cause of deaths in young age people (15-25 years). Though statistics and facts suggest that the age group of 15-25 years are the most vulnerable to road crashes but a microscopic study in the desired age group was missing. The age group was divided into 4 different categories i.e. 15-18, 18-21, 21-24, and >24 years. A questionnaire was prepared containing questions related to various causes of road crashes including age, category of victim and type of injury suffered. Data was collected from an emerging smart city of India i.e. Bhubaneswar. The analysis was done by logistic regression modeling. The results revealed that in the age range of 15-25 years, it is 18-21 years age group which have the highest probability of facing a severe road crash. The probability decreases as age increases. On an average, a driver of 18-21 years age group has 100 times more chance of facing a severe road crash. Along with victims' age, time of day and type of lighting, traffic movement, character of road, type of junction, speed of vehicle, kind of vehicles involved, land use on both sides of road, drivers' license and helmet use were also found to be significantly affecting the road crashes. A questionnaire was prepared to collect the data related to causes of road crashes including age of driver and type of injury sustained. The obtained data were first analysed for statistical significance and then modelling was done using logistic regression. Speed of vehicle above 80 kmph is considered a catastrophe for riders. Similarly not using helmet increases the chances of an accident being severe by around 400 times. The modelled equations predict the severity of road crashes accurately by taking into account all the independent variables, including age groups, speed of the vehicle, helmet use, etc.

Keywords: Road crash, Safety, Logistic regression, Adolescents, Statistics, Smart city

1. Introduction

Traffic safety management is a field of transportation engineering that has been repeatedly researched across the world to study road crashes and provide various methodologies and steps to prevent it. From the studies and reports of various researchers, it can be observed that traffic safety is a very vital part of transportation engineering. It can also be well observed that the teenagers comprise a big chunk of total road crash victims around the world. From the annual global road crash statistics, it can be stated that nearly 1.3 million people die in road crashes each year, on average 3,287 deaths a day[1]. The study also states that road crashes are the 9th leading cause of deaths and may become number 5 by 2030 if not controlled and monitored. But in

* Corresponding author: Malaya Mohanty (malaya.mohantyfce@kiit.ac.in)

case of youth i.e. 15-29 years it is the leading cause of accidents. This proves the importance of traffic safety management and its research. Coming to India, where the present study is conducted, according to Ministry of Road Transport and Highways (MORTH)[2], in 2010, number of road accidents in India was around 0.5 million and number of deaths due to those accidents was 0.13 million. Number of injuries due to those accidents was 0.52 million. The conclusion that we get from the data is, 1 accidental death every 4 minutes and 1 road accident every minute. If the age group and the accident data are compared, it is seen that 55% of road accident victims fall in the age group of 25-65 years while out of rest 45%, 40% of road accident victims come from the age group of 16-24 years. These all statistics urges a researcher to study the causes and provide some mitigation measures to curb these road crashes. Hence, the paper imparts an insight to the road crash modelling by investigating one of the emerging smart city i.e. Bhubaneswar in India considering mainly the personal and environmental factors. Bhubaneswar is the capital city of Odisha, a state that lies in the eastern part of India. It is one of the few cities that is completely planned and designed. In addition, American Planning Association awarded Bhubaneswar as the smartest city in India in the year 2017. However, according to a data by MORTH and the pioneer [15], a daily newspaper the fatality rate in case of road accidents in the state of Odisha is higher than the average fatality rate of road crashes in India. In Odisha, out of every 100 road accidents, 46 lead to death which sounds very alarming. Therefore, Bhubaneswar, the capital city of Odisha and one of the smartest city in India was taken up for the present study. The main motivation behind the research was to find the gap and causes leading to the high rate of road fatalities in the city despite the fact that, the city is completely planned and has one of the best road networks in India. It was observed that Bhubaneswar has many schools and colleges of national and international repute. AIIMS, IIT Bhubaneswar, NISER, IIMT, KIIT, SOA etc. to name a few. It has been felt that due to innumerable reputed universities and local colleges, the number of adolescents in the age group of 15-25 years are very high in the city. Moreover, Bhubaneswar is also an emerging IT hub. This age group is also found nationally to be the reason behind majority of road accidents. Therefore, after doing a detailed literature review and survey in the city, a questionnaire survey was prepared and answers were collected from the adolescents who are living and commuting in the city. These answers were than deeply analysed and a detailed study has been presented in this manuscript. The manuscript does a detailed study to find out the major causes leading to road crashes among adolescents. Further, a detailed comparison using statistics has been conducted to predict the qualitative effect of the road crash due to each of the factors affecting it. The manuscript also compares the factors leading to road crashes in terms of the degree of injury that would be caused by them to the road user.

2. Literature review

According to study by La Scala et al., 2000 [3] pedestrian injury rates are related to gender, age, population, density, composition of the local population, unemployment, traffic flow, education, etc. In a similar study by Mungnimitin 2001 [4] and Bener in 2005 [5] on the pattern of road traffic accidents and their causes in developing countries of Thailand and Qatar, they concluded that the major cause of traffic accidents was careless driving (71%). The majority of accident victims (53%) was in the most productive class in the society; i.e., age group of 10-40 years. Yau in 2004 [6] investigated five groups of variables in Hongkong that influence fatality of motor cycle

accidents, namely; region, traffic condition, human, vehicle, and environment. In a related study, Williamsin 2006 [7]studied that good lighting condition at night was associated to severe vehicle crashes, which was unexpected. But a study by Pai and Saleh in 2008 [8]had contrasting findings in UK where unlit street lights showed increased chance of accident severity. Wedagama et al. in 2006 [9] concluded that separate models should be done for weekends as travel patterns changes on weekends on the basis of land use.
Wedagama and Dissanayake in 2010 [12] studied the influence of accident related factors on road fatalities considering Bali province in Indonesia as a case study. Logistic regression models were separately developed for fatal accidents considering motorcycles and all vehicles including motorcycles with data from Bali in Indonesia. Seven predictor variables were employed in the developed models. The study found the probabilities of female motorcyclists and motorists were about 79% and 72% respectively contributing more on motorcycle and motor vehicle fatal accident than males. In addition, age was also significant to influence all vehicle fatalities. Age was accounted for about 50% to influence all vehicle fatalities. TRIP in 2009 [10] came with a conclusion that roads with poor geometry, with insufficient clear distances, without turn lanes, with inadequate shoulders for the posted speed limits or with poorly laid out intersections or interchanges, pose greater risks to motorists, pedestrians and bicyclists. Seva et al. in 2012 [11] studied the motorcycle accidents in the Philippines considering personal and environmental factors. The variables considered by them for study were age, lighting conditions, traffic movement, road character, junction type, day, surface conditions, and driving behaviour. Logistic regression was used to predict the likelihood of an accident from the variables considered and a logit model was thus developed. According to their study, three variables were found to be significant predictors of motorcycle accidents. They were age, driving behaviour, and junction type. Hosmer-Lemeshow test were used by them as logistic regression for goodness of fit. The main conclusion from their study was that the younger drivers are more likely to be involved in accidents. Mohanty and Gupta in two separate studies [13, 14] after performing an extensive review reported that Road crashes account for nearly one-half of all teenage deaths. In case of accidents in urban roads, many variables like age of drivers, gender, running speed, road conditions, lighting conditions, etc. are found to be the causative agents of accidents. These all studies helped to consider more personal and environmental factors for the present study for a better and more accurate modelling.

3. Research Methodology

3.1 Variables and Factors

In this study, the dependent variable is taken as occurrence of accident and independent variables considered are various personal and environmental factors. The factors considered for survey were age of victim, time of day and lighting conditions, type of traffic, type of junction, pavement condition, average speed of vehicle during the accident, kind of vehicles involved in the accident, land use pattern on both side of road, driving license holder and use of helmet. The study aims at adolescent accident study which is the age group between 15-25 years. Hence, teenagers and newly working individuals were the participants of survey.

3.2 Procedure

After the completion of data collection, the data was checked for its correctness in all aspects. The answers given by respondents for different questions was recorded and standard deviation was calculated. The factors for which answers had standard deviation less than 10 were discarded as insignificant for analysis. After the selection of factors that are affecting the accidents more, correlations between factors were calculated using Pearson's correlation matrix. The significant factors were considered for the logistic regression modelling.

4. Results and Analysis

After the completion of survey, the questionnaires with proper answers and correct in all aspect are considered for analysis. The first analysis performed is the calculation of standard deviation (SD) of the variables and discarding those variables which have standard deviation less than 10. Table 1 shows the standard deviation of all the variables used in survey. The data are also graphically presented in Figure 1. All the considered variables were correlated with respect to types of accidents occurred. Pearson's correlation values can be known from Table 2 which shows the correlation matrix of important variables with type of accidents and also among each other. Type of Accidents (TOA) being the dependent variable, the Pearson's correlation values with respect to TOA has been presented n Figure 2. It is evident from Figure 2 that 4 independent variables namely; victim's age, speed of vehicles, kind of vehicles involved in road crash, and helmet use have Pearson value greater than 0.5 (positive and negative). Therefore these four variables have been used for logistic regression modelling.

Table 1: Standard Deviation of Variables

Variables	Standard Deviation
Victim's age	23.87
Time of day and type of lighting	19.80
Traffic movement	27.15
Type of junction	12.10
Pavement condition	2.43
Speed of Vehicle	18.15
Kind of vehicles involved	15.34
Land use on both sides of road	16.38
Driver's license possession	21.63
Helmet worn	44.49

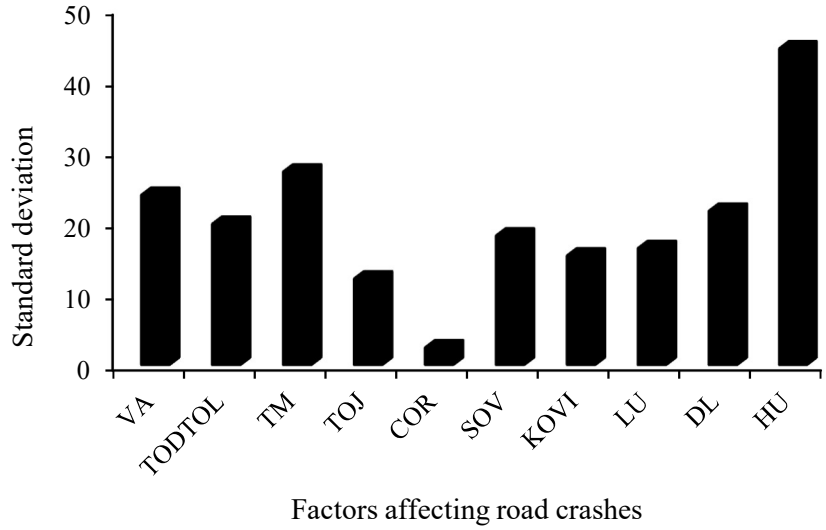

Figure 1: Standard Deviation of Variables

Where, TOA: Types of accidents; VA: Victims' age
TODTOL: Time of day and type of lighting; TM: Traffic movement
COR: Character of road; TOJ: Type of junction
SOV: Speed of vehicle; HU: Helmet use
KOVI: Kind of vehicles involved; DL: Drivers' license
LU: Land use on both sides of road

Table 2: Pearson's Correlation Matrix

	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**
TOA (1)	1										
VA (2)	-.62**	1									
TODTOL (3)	-.03	.06	1								
TM (4)	-.04	.04	.02	1							
COR (5)	.43**	-.27**	.10*	-.06	1						
TOJ (6)	.02	.014	-.08	.01	.01	1					
SOV (7)	.68**	-.41**	-.03	-.04	.32**	.10*	1				
KOVI (8)	.65**	-.08	-.05	-.01	-.05	-.01	.03	1			
LU (9)	-.01	.03	-.03	.01	-.04	.02	-.04	-.05	1		
DL (10)	.02	-.06	.02	-.03	.04	-.02	-.03	.02	.05	1	
HU (11)	.83**	-.52**	-.04	-.03	.56**	-.01	.53**	.76**	.01	-.01	1

** indicates correlation is significant at 0.01 (1%) level.
* indicates correlation is significant at 0.05 (5%) level.

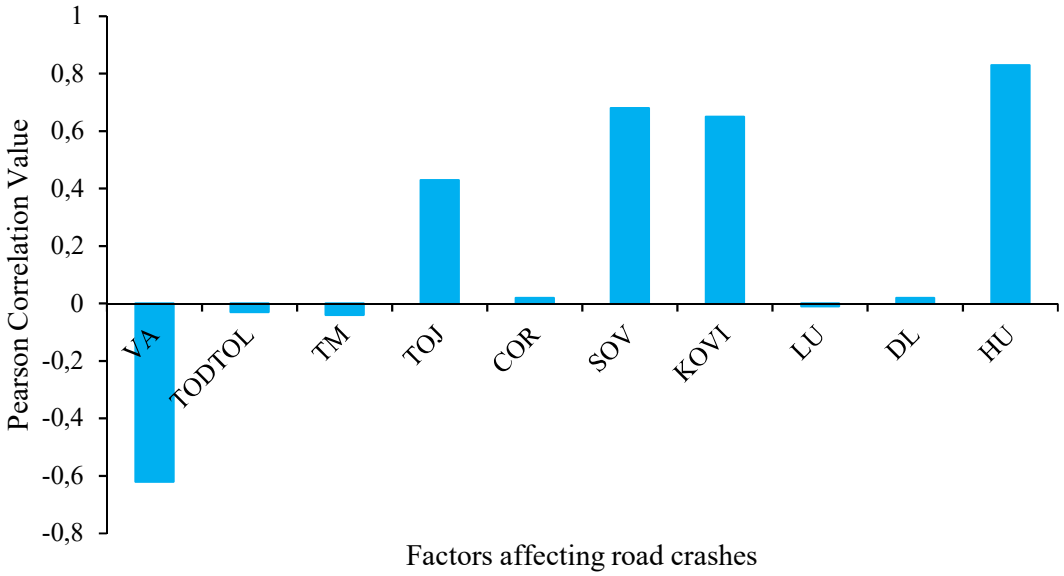

Figure 2: Pearson's Correlation value with respect to type of accidents

These four significant variables were correlated among themselves to find whether the variables are correlated among each other. It can be observed from the data in Table 2 that every factor is correlated to every other factor except "kind of vehicles involved" which was found to have no correlation with any other factors. Hence all the equations modeled can have kind of vehicles involved as one of its independent variables along with another one significant variable. The logistic regression equations modeled are given in Table 3.

Table 3: Road Crash Models

Equations	R^2 Value	%Pre.
$AC = -1.610 + 23.06A1 + 5.36A2 + 2.16A3 - 0.18K1 + 19.15K2 - 0.42K3$	0.726	83.2
$AC = 21.311 - 0.05K1 + 18.77K2 - 0.18K3 - 42.41V1 - 42.43V2 - 19.43V3 - 16.95V4$	0.755	93.5
$AC = -9.288 + 5.968H$	0.708	94.0

*: Sig.: Significance; % Pre.: Percentage Predicted

Where,
AC = Chances of severity of accidents;
A1 = 15-18 years, A2 = 18-21 years, A3 = 21-24 years, (Victims' age);
V1 = <20 kmph, V2 = 20-40 kmph, V3 = 40-60 kmph, V4 = 60-80 kmph, (Speed of vehicles);
H = Not using Helmet;
K1 = Two wheeler-two wheeler, K2 = Two wheeler-three wheeler, K3 = Two wheeler–four wheeler, K4 = Two wheeler- truck/bus (Kind of vehicles involved)

The developed equations say about the probability of occurrence of a fatal road crash as compared to a near miss/no crash with the variables as independent variables. From the equations, some startling points can be noted as follows:

- All variables and equations can be given equal importance for predicting the severity of accidents in these cities.
- Percentage of sample predicted by every equation is greater than 70% which can be considered very well.
- The actual effect of each of the choices of a variable affecting the road crash can be known from the odds ratio table which gives the actual factor or ratio as how each of the choices of a variable affects the road crash. Table 4 shows the odds ratio table.

Table 4: Odds Ratio

Eq. no. as per Table 3	Significant Factors	Reference Choice	Choices Used for Analysis	Odds Ratio
1	Victims' age	>24 years	15-18 years	Very high*
			18-21 years	212.26
			21-24 years	8.7
	Kind of vehicles involved	2 wheeler-bus/truck	2-2 wheeler	0.84
			2-3 wheeler	Very high*
			2-4 wheeler	0.66
2	Kind of vehicles involved	2 wheeler-bus/truck	2-2 wheeler	0.95
			2-3 wheeler	Very high*
			2-4 wheeler	0.84
	Seed of vehicle	>80 kmph	<20 kmph	0.00
			20-40 kmph	0.00
			40-60 kmph	0.02
			60-80 kmph	0.06
3	Helmet use	Used helmet	No helmet	390.65

*: It can be discarded as their percentage is very less and usually all have faced serious injuries

The odds ratio table gives a lot of information about each of the categories present in a variable. It can be observed from the table that if 15-18 years of age group is discarded as mentioned in the table, then 18-21 years age group is the most vulnerable group for facing a severe accident as compared to other age groups. Speed of vehicle above 80 kmph is considered a catastrophe for riders. Similarly not using helmet increases the chances of an accident being severe by around 400 times. Though kind of vehicles emerged to be a significant variable but severity is almost same for all kind of crashes. Two wheeler – bus/truck crash is considered more severe as considered to others.

5. Conclusions and Recommendations

Following conclusions can be drawn from the study and analysis of the road crashes data by young age group that were collected from one of the smart city (Bhubaneswar) of India and recommendations are also provided for the prevention of the road crashes in the studied area. A single factor alone can't be considered to be affecting the occurrence and severity of road crashes. Even in modeling the equations, more than one variable have been considered for predicting the accidents. Kind of vehicles involved has been found to be a major significant variable affecting the road crashes. Persons below 18 years of age as bounded by law should not be allowed to ride vehicles. Helmet use should be made mandatory as riding without helmet increases the chances of facing a severe road crash by 400 times. Speed limit warning signs should be provided on all hotspots where more accidents have occurred in the past or more accidents may occur. Driving above 80 kmph is considered fatal for road accidents.

References

1. http://www.asirt.org/KnowBeforeYouGo/RoadSafetyFacts/RoadCrashStatistics/tabid/213/Default.aspx Date of access: 5 October 2013, Association for Safe International Road Travel.
2. MORT&H, (2010), "Road Accidents Data", Government of India.
3. La Scala, E., Gerber, D., and Gruenewald, P. J., (2000), "Demographic and Environmental Correlates of Pedestrian Injury Collisions: A Spatial Analysis", Accident Analysis and Prevention, 32, 651-658.
4. Mungnimit, S., (2001), "Road Traffic Accident Losses", Transport and Communications Policy and Planning Bureau, Ministry of Transport and Communications, Thailand.
5. Bener, A., (2005). "The Neglected Epidemic: Road Traffic Accidents in a Developing Country, State of Qatar", International Journal of Injury Control and Safety Promotion, 12(1), 45-47.
6. Yau, K. K. W., (2004), "Risk Factors Affecting the Severity of Single Vehicle Traffic Accidents in Hong Kong", Accident Analysis and Prevention, 36(3), 333-340.
7. Williams, A. F., (2006), "Young Driver Risk Factors: Successful and Unsuccessful Approaches for Dealing with Them and an Agenda for the Future", Injury Prevention, 12 (Supp), 14-18.
8. Pai, C. W., Saleh, W., (2008), "Modelling motorcyclist injury severity by various crash types at T-junctions in the UK", Safety Science, 46(8), 1234-1247.
9. Wedagama, D. M. P., (2006), "The Relationship between Urban Land Use and Non Motorised Transport Accidents and Casualties", PhD Thesis, University of Newcastle.
10. TRIP, (2009), "Future Mobility in West Virginia: Meeting the State's Need for Safe and Efficient Mobility", U.S. Department of Transportation, Washington, D.C., www.tripnet.org.
11. Seva, R. R., Flores, G. M. T., and Gotohio, M. P. T., (2012), "Logit Model of Motorcycle Accidents in the Phillipines Considering Personal and Environmental Factors", International Journal for Traffic and Transport Engineering, Vol. 3(2), 173-184.

12. Wedagama, D. M. P., and Dissanayake, D., (2010), "The influence of accident related factors on road fatalities considering Bali province in Indonesia as a case study", Journal of Eastern Asia Society for Transportation studies, Vol. 8, pp. 1905-1917.
13. Mohanty, M., and Gupta, A., (2015), "Factors affecting road crash modeling", Journal of transport literature, Vol. 9(2), 15-19.
14. Mohanty, M., and Gupta, A., (2014), "Review of Recent Trends in Road Accident Modeling", Indian Highways, 42(12), 3-7.
15. "4,790 killed in road mishaps in Odisha in '17", Newspaper article, The Pioneer, 9 April, 2018.