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A study of factors influencing the severity of road crashes involving drunk drivers and non drunk drivers

S. Velmurugan [a,*], S. Padma [b], E. Madhu [b], S. Anuradha [b], S. Gangopadhyay [b]

[a] TES Division, Central Road Research Institute, CRRI(P.O), Mathura Road, New Delhi 110025, India
[b] TPE Division, Central Road Research Institute, CRRI(P.O), Mathura Road, New Delhi 110025, India

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ABSTRACT

In this study, an attempt has been made to develop Multinomial Logit (MNL) model by analysing the drunken and non drunken drivers involved in road crashes on Indian highways. Multinomial Logit model has been deployed to assess the influence of various parameters like vehicular, environment and geometric factors on the set of drivers who were found to be drunk at the time of getting involved in the road crash and those who were not under the influence of alcohol at the time of meeting with the road crash. The total economic cost of road crashes in the case of non-drunk driver road crash is Rs. 1046.27 million whereas in the case of drunk driver road crashes it is estimated to be Rs. 204.50 million. Further, it can be observed that economic cost of drunk driver road crashes is varying from 13 to 19 % across different types of road crashes.

1. Introduction

Drunken driving is a menace throughout the world and the Indian scenario is not an exception. India has seen a steady increase in the drunken driving cases being involved in road crashes. The fast growing economy empowering individuals at a very young age with higher spending capacities and with increasing avenues for entertainment there is no sight of these drunken driving crashes coming down in numbers. It is often argued that under the same circumstances the probability of a drunken driver encountering a serious injury is more than that of a non drunk driver. The paper makes an attempt to study the road crashes involving drunk drivers and non drunk drivers in order to assess the impact of other variables on the severity of injury and thereby understand the intricacies of influential variables on severity of injury. For this purpose, the road crash data available with the Road Safety Cell of National Highway Authority of India (NHAI) has been employed. Multinomial Logit model has been used for the formulation of the relationship.

2. Literature review

Numerous studies have been carried out in different parts of the world linking the severity of road crashes with the various influencing factors. Eluru and Bhat (2007) studied the influence of seat belt usage on the crash related injury severity and highlighted the usage of a joint correlated random coefficients binary-ordered response to underline the importance of moderating effects of unobserved individual crash related factors for the determination of injury severity and also the impact of seat belt use endogeneity. Similarly, Krull, Khattak, and Council (2000) deployed a logistic model to study how physical condition of the driver, vehicle type, roadway geometrics, Average Annual Daily Traffic, speed limit and rollover involvement affect the probability of fatal and incapacitating injuries. They found that parameters responsible for increase in road crashes contributing to fatal and severe injury are rollover involvement, failure to use a seat belt, alcohol consumption, rural roads (as opposed to urban) and higher speed limits. Similarly, O'Donnell and Connor, (1996) assessed the probabilities of four levels of injury severity as a function of driver attributes. In this study, a comparison of the Ordered Logit (OL) and Ordered Probit (OP) specifications was made which demonstrated that the injury severity rose corresponding with increase in speed, vehicle age, occupant age, alcohol levels in the blood over .08 percent, non-use of a seat belt, manner of collision (e.g., head-on crashes) and travel in a light-duty truck. Further, according to their comparison of effects, seating position of crash victims was of utmost significance (e.g., the left-rear seat of the vehicle was found to be most dangerous) and gender least relevant. Kockelman and Kweon (2002) used An OP model used to investigate the risk of different injury levels sustained under all crash types. They used the U.S. General Estimates System (GES) data set in which severity was

* Corresponding author.
E-mail addresses: vms_04@yahoo.co.in (S. Velmurugan), padmaseetharaman5@gmail.com (S. Padma), errampallim711@yahoo.com (E. Madhu), anuradha.crri@gmail.com (S. Anuradha), director.crri@nic.in (S. Gangopadhyay).

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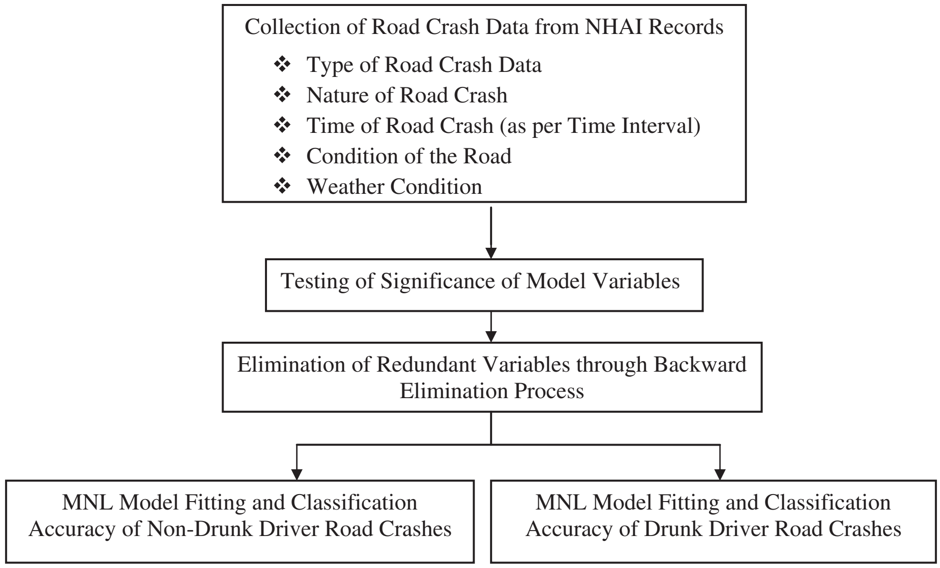

Fig. 1. Methodology adopted for development of MNL model for drunk and non-drunk driver road crashes.

described in terms of four categories consisting of no injury, not severe injury, severe injury and death by emphasizing the effects of vehicle type, while controlling for a host of other factors (such as crash type, weather, speed, and occupant characteristics). Thereafter, Ordered Probit modelling approach was deployed to investigate impact of factors like vehicle, roadway, driver, crash and environmental characteristics. The analysis further illustrated that the older drivers who consumed alcohol were more likely to be seriously injured as compared with other types of drivers. Similarly in other studies Multinomial Logit models (MNL) was deployed to assess the influence of various factors towards injury severity. A study by Wedagama and Dissanayake (2009) utilized MNL to investigate the influence of road crash related factors on motor cycle injuries. Similarly a study by Al-Ghamdi Ali (2002) utilized logistic regression and this study concluded that the road crash location and the cause of road crash are significantly associated with fatal injuries in Saudi Arabia. Apart from the studies done elsewhere, few studies carried out in India have deployed the MNL to assess the influence of road crash factors on injury severity. Having reviewed the approaches deployed for assessing the crash severity, the impact of various parameters has been evaluated using the MNL approach and the same is explained in detail in the succeeding paragraph.

Multinomial Logit Models (MNL) are the widely used models for modelling accident severity as these models are generally used to model relationship between a polytomous response variable and a set of regressor variables. These polytomous response models can be classified into two distinct types, depending on whether the response variable has an ordered or unordered structure (So and Kuhfeld, 1995) Jonsson, Ivan, and Zhang (2007).

The model assumes the following form

$$\pi_{ik} = \frac{e^{Z_{ik}}}{e^{Z_{i1}} + e^{Z_{i2}} + \ldots + e^{Z_{ik}}} \quad (1)$$

where

π_{ik} – is the probability the ith case falls in category k
Z_{ik} – is the value of kth unobserved continuous variable for the ith case.

Table 1
Variable description.

Number	Description	Codes/values	Abbreviations
1	Road crash	0 = No injury	Accident(0)
		1 = Minor injury	Accident(1)
		2 = Serious injury	Accident(2)
		3 = Fatal injury	Accident(3)
2	Nature of road crash	1 = Unknown (others), 2 = otherwise	NatAcc0
		1 = Head on collision, 2 = otherwise	NatAcc1
		1 = Rear end collision, 2 = otherwise	NatAcc2
		1 = Collision due to sides swipe/right turn/left turn, 2 = otherwise	NatAcc3
		1 = Overturning/skidding, 2 otherwise	NatAcc4
3 4	Time	1 = 1:00 A.M to 4:00 A.M, 2 = otherwise	Time1
		1 = 4:00 A.M to 7:00 A.M, 2 = otherwise	Time2
		1 = 7:00 A.M to 10:00 A.M, 2 = otherwise	Time3
		1 = 10:00 A.M to 1:00 P.M, 2 = otherwise	Time4
		1 = 1:00 P.M to 4:00 P.M, 2 = otherwise	Time5
		1 = 4:00 P.M to 7:00 P.M, 2 = otherwise	Time6
		1 = 7:00 P.M to 10:00 P.M, 2 = otherwise	Time7
		1 = 10:00 P.M to 1:00 A.M, 2 = otherwise	Time8
	Condition of the road	1 = Unknown, 2 = otherwise	RoCon0
		1 = Straight road/flat road, 2 = otherwise	RoCon1
		1 = Slight/sharp curve, 2 = otherwise	RoCon2
		1 = Gentle/steep incline/hump/dip, 2 = otherwise	RoCon3
5	Weather condition	1 = Unknown (other extraordinary), 2 = otherwise	WeaCon0
		1 = Sunny day/fine, 2 = otherwise	WeaCon1
		1 = Cloudy/mist/fog, 2 = otherwise	WeaCon2
		1 = Light/heavy rain/hail/sleet/snow, 2 = otherwise	WeaCon3
		1 = Windy day/dust storm, 2 = otherwise	WeaCon4
		1 = Very cold/V. hot, 2 = otherwise	WeaCon5