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DRIVING EXPERIENCE OF TRUCK DRIVER IN BEHAVIORAL MODELING

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Abstract

Drivers' behavior is one of the most imperative factors in determining traffic safety. Knowledge of this subject and its effective factors can be helpful to reduce the influences of human factors on traffic accidents. The objective of this study is to apply Manchester driver behavior questionnaire (DBQ) with site specific and local conditions to a group of drivers on 2 lane undivided carriageway of National Highway No: 44 near Medchal, Hyderabad, Telangana, India and to analyze their driving habit based on their driving experience. DBQ is divided into 4 fragments like errors, lapses, ordinary violations, and aggressive violations. Data collection is achieved by using field method of roadside interview technique. Data analysis has been done by applying the concept of factor analysis and ANalysis Of Variance (ANOVA) using XLSTAT. The results showed that growing in driving experience gave rise to a decrease in violations. The results demonstrated a relationship between driving experience and the score of violations. Analysis of drivers' behaviour in terms of their driving experience showed that with the increase in experience, the violation commitment is reduced, whereas the error commitment is more for experience group 2 to 5 years.

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Keywords: Driver Behavior Questionnaire, Factor analysis, ANalysis Of Variance, Road Side Interview (RSI) technique

1. Introduction

Transport in India is an important part of the Nation's economy. Development of infrastructure within the country is progressing in a rapid manner. Currently, in tune with economic growth of the country, the numbers of commercial vehicles are increasing every year. At the same time, the number of non-expert truck drivers is also increasing exponentially. Road safety is an issue of National concern, considering its magnitude and gravity and the consequent negative impacts on the economy, public health and the general welfare of the people (MORTH, 2010). Since most novice drivers are inexperienced, unskilled, uneducated, unfamiliar with the vehicle conditions and no awareness of traffic rules and regulations, Drivers' personal factors have become the main reasons of traffic accidents. The human factor is one of the major causes in half of the truck accidents (Lawton et al., 1997). Understanding, analyzing and modeling human driver behavior in a realistic way is extremely important in enhancing the safety of the commercial

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vehicles. Truck accidents are common on National highways in India.

A report on road accidents in India 2016, published by Transport Research wing under Ministry of Road Transport & Highways, Government of India, has revealed that more people died on roads accidents in India last year, as compared to the number of deaths in 2015. The country recorded 4,80,652 road accidents in 2016 leading to 1,50,785 deaths. The number suggests that at least 413 people died every day in 1,317 road accidents. Further breaking down the statistics, the data reveals that at least 17 deaths occurred in road accidents in 55 accidents every hour in the given time period. In these reported accidents, 26% are committed by truck drivers. National Highways accounted for 30% in total road accidents and 36% in total number of persons killed in 2010. State Highways accounted for 24.5% of total accidents and a share of 27.3% in the total number of persons killed in road accidents in 2010. Highways permit greater speed resulting in relatively greater number of road accidents and fatalities. In a study supported by National Highway Traffic Safety Administration (NHTSA), it was found that driver error was the major contributor in more than 90% of the crashes examined.

Drivers' fault has been revealed as the single most responsible factor for road accidents in India, killings and injuries on all roads in the country over a long period of time. Drivers' fault accounted for 77.1% of total road accidents during 2015 as against 78.8% during 2014. Within the category of drivers' fault, road accidents caused and persons killed due to exceeding lawful speed/over speeding by drivers accounted for a share of 62.2% and 61.0% respectively. Taking into account the total road accidents and total road accident killings, the share of over speeding comes to 47.9 % and 44.2% respectively. Accidents and deaths caused due to "Intake of alcohol/drugs" within the category of drivers' fault accounted for 4.2% and 6.4% respectively (MORTH, 2015). The truck driver behaviour analysis models based on their driving experience gives details about the users driving styles and patterns and driver behaviour prediction models will give details about the driver's driving information; whether it is safe or not.

In the above context an attempt is made to study the driving experience of truck driver in behavioral modeling. The objective of this current study is to adopt Road Side Interview (RSI) technique with the support of Manchester Driver Behaviour Questionnaire (DBQ) by means of site specific and local conditions to a group of truck drivers on a two lane undivided carriageway and to analyze their driving behavioral pattern considering their driving experience as a factor.

2. Driver behavior questionnaire (DBQ)

It has long been documented that safe driving is not only accomplished by being able to drive in a relatively error-free manner. Intentional violations and risk taking are important determinants of road safety as well. Manchester Driver Behavior Questionnaire (DBQ) consists of 50 items describing a variety of errors and violations during driving (Reason et al., 1990). The Driver Behavior Questionnaire (DBQ) has mainly been used as predictor of self-reported road traffic accidents. Since the publication of Reason's research results in 1990 so far, many studies have been conducted on the behaviors of drivers in different countries (Ali et al., 2016). The associations between crashes and the violation and error factors of the DBQ however, may be spuriously high due to reporting bias (Wahlberg, et al., 2008). A study on truck driver's behavior in New Zealand found out that the DBQ structure and the relation of its sub scales with accidents are different from those in the studies on regular car drivers (Sullmann et al., 2002). It is to be noted that the English and Spanish versions of 28 item DBQ questionnaire have been used in several studies (Capman et al., 2001; Meskan et al., 2002; Sullman et al., 2002). The original questionnaire is modified based on the site and local conditions of study area and is divided in to parts like errors, lapses and violations to validate against experience of the driver. Also, violations are divided into aggressive violations (obvious aggressive actions) and ordinary violations (including the ignorance of the rules without any aggressive incentive) (Lawton et al., 1997) as shown in Table 1. Violations represent the style in which the driver chooses to drive and habits established after years of driving. Respondents had to indicate how often each deviation occurred to them during their driving on a scale between 1 (very rarely to never) to 5 (nearly all the time).

Table. 1. Driver Behaviour Questionnaire (DBQ)

Type	S. No.	Description
Errors	E1	Misjudge the speed of oncoming vehicle when passing through adjacent vehicle.
	E2	Attempt to pass a vehicle that you hadn't noticed was signaling its intention to turn left/right.
	E3	Drive especially close or flash the car in front as a signal for that driver to go faster or get out of your way.
	E4	Misjudge the road surface and when braking find the distance to stop to be longer than you expected
	E5	Without checking the vehicle condition like brakes, accelerator and other vehicle technical tools.
Lapses	L1	Try to overtake without first checking your mirror, and then get hooted at by the car behind which has already begun overtaking maneuvers.
	L2	Deliberately disregard the speed limits late at night or very early in the morning
	L3	Exceed the speed limit to catch up or avoid being late
Ordinary Violations	OV1	Become impatient with a slow driver and try to overtake
	OV2	Overtake a slow-moving vehicle on the inside lane or hard shoulder of a motorway.
	OV3	Forget to dip the lights when driving during dark hours and is reminded by other drivers flashing their lights.
	OV4	Long journey driving without intermediate brakes.
	OV5	Using the cellular phone/Electric devices while driving.
Aggressive Violations	AV1	Stuck behind a slow-moving vehicle on a two-lane highway, you are driven by frustration to try to overtake in risky circumstances.
	AV2	Drive back from a party, restaurant, or pub, even though you realize that you may be over the legal blood-alcohol limit.
	AV3	Get involved in unofficial 'races' with other drivers.
	AV4	Deliberately disregard the speed limits late at night or very early in the morning.

3. Study stretch and data collection methodology

Road Side Interview (RSI) technique is adopted as the field method for the collection of data. The study stretch under consideration is a two lane undivided carriageway with paved shoulders of National Highway Number: 44 near Medchal, Hyderabad in the state of Telangana, India. The location map of the road with survey location is shown in Fig 1. Appropriate location is selected so as to conduct interviews without affecting movement of other vehicles with the help of traffic police.

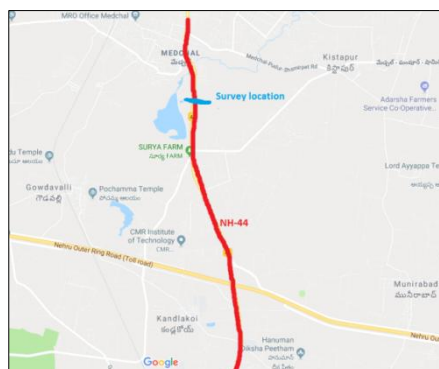


Fig. 1. Location map

Survey was conducted on normal working days in 2 shifts. A sample of well above 60% of truck drivers was targeted to obtain a fair representative data. Designated trained enumerators have interviewed the traffic and entered the data in the questionnaire format. A volume count survey was carried out simultaneously in order to assess the sample size. This survey is limited to Trucks (2 Axle / 3 Axle / Multi Axle) in freight vehicle category as these are long distance travelling vehicles. These drivers work in different cargo companies and they travel long hours on highways to transport cargo. Drivers are asked, if they would be interested in participating in this research. The majority of drivers agreed to participate in study without force application in order to make the responses reliable. Photographs illustrating the survey in progress are presented in Fig 2. Total numbers of samples are 450 have been collected during the survey and is distributed based on the driving experience of the truck driver as shown in Table 2. The mean age of the drivers is 38.6 years and the mean experience is 7.42 years.



Fig. 2. Questionnaire survey in progress

Table. 2. Sample characteristics

Variable	Group	Description (Experience)	Number	Percentage
Driving Experience (years)	Ex ₁	> 1 year	84	19%
	Ex ₂	1.0 to 2.0 years	165	37%
	Ex ₃	2.0 to 5.0 years	75	17%
	Ex ₄	5.0 to 10.0 years	78	17%
	Ex ₅	10.0 to 15.0 years	27	6%
	Ex ₆	15.0 to 20.0 years	15	3%
	Ex ₇	< 20.0 years	6	1%

Factor analysis is used to determine the questionnaire's structure and ANOVA (ANalysis Of VAriance) function is used to understand significant differences between various questionnaire groups. The mean and standard deviation (SD) of the DBQ questions are calculated and given in Table 3. From the table, it is observed that the most frequent violation committed by drivers is misjudging the speed of oncoming vehicle when passing through adjacent vehicle (mean value 3.442) and the least violation is using the cellular phone/Electric devices while driving (mean value 1.702).

Table. 3. Means and standard deviation of DBQ

Type	S. No.	Description	Mean	Standard Deviation
Errors	E1	Misjudge the speed of oncoming vehicle when passing through adjacent vehicle.	3.442	0.876
	E2	Attempt to pass a vehicle that you hadn't noticed was signaling its intention to turn left/right.	3.216	0.733
	E3	Drive especially close or flash the car in front as a signal for that driver to go faster or get out of your way.	2.920	0.834
	E4	Misjudge the road surface and when braking find the distance to stop to be longer than you expected	2.651	0.849
	E5	Without checking the vehicle condition like brakes, accelerator and other vehicle technical tools.	2.111	0.852
Lapses	L1	Try to overtake without first checking your mirror, and then get hooted at by the car behind which has already begun overtaking maneuvers.	3.302	0.953
	L2	Deliberately disregard the speed limits late at night or very early in the morning	2.880	0.926
	L3	Exceed the speed limit to catch up or avoid being late.	2.789	0.823
Ordinary Violations	OV1	Become impatient with a slow driver and try to overtake.	3.213	0.861
	OV2	Overtake a slow-moving vehicle on the inside lane or hard shoulder of a motorway.	2.893	0.922
	OV3	Forget to dip the lights when driving during dark hours and is reminded by other drivers flashing their lights.	2.458	0.714
	OV4	Long journey driving without intermediate brakes.	2.533	0.736
	OV5	Using the cellular phone/Electric devices while driving.	1.702	0.921
Aggressive Violations	AV1	Stuck behind a slow-moving vehicle on a two-lane highway, you are driven by frustration to try to overtake in risky circumstances.	2.840	0.758
	AV2	Drive back from a party, restaurant, or pub, even though you realize that you may be over the legal blood-alcohol limit.	2.460	0.840
	AV3	Get involved in unofficial 'races' with other drivers.	2.293	0.918
	AV4	Deliberately disregard the speed limits late at night or very early in the morning.	2.109	0.642

4. Factor analysis

Factor analysis highlights, where possible, the existence of underlying factors common to the quantitative variables measured in a set of observations. Factor analysis is a statistical method used to describe variability among observed, correlated variables in terms of a potentially lower number of unobserved variables called factors. In order to understand the factor structure of DBQ, the questions were tested by factor analysis using Varimax rotation method (Kontogiannis et al., 2002; Lajunen et al., 2004). The result of Cronbach's alpha test (0.712) and Kaiser-Meyer-Olkin test (0.873) is satisfactory as the values are much more than 0.5. The analysis showed that four factors are with eigen values more than one. Fig 3 shows the factor pattern for which the squared cosine is the largest.

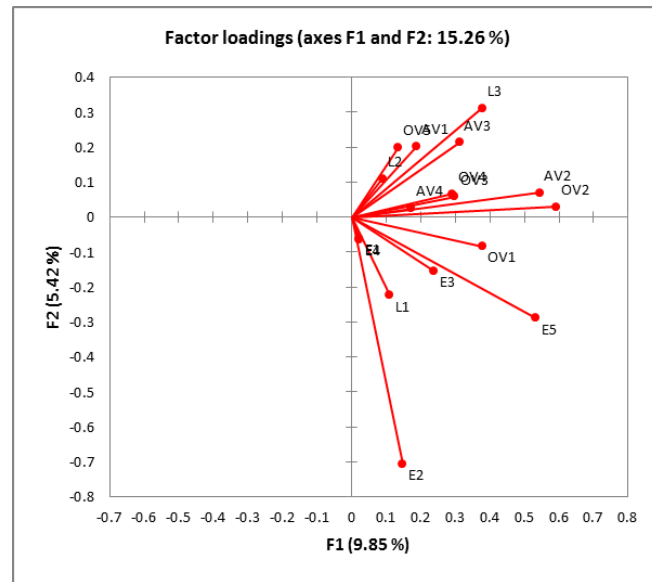


Fig. 3. Factor loadings

5. Analysis of drivers' behavior

Analysis of drivers' behaviours in terms of their experience showed that the more experienced the drivers, the fewer the number of violations, whereas the error commitment is more for experience group 1 to 2 years as shown in Fig 4. Drivers with more than 20 years of experience committed minimum violations. In other words, drivers with more than 20 years of driving experience committed about 20% fewer violations than the less experienced ones. Drivers with experience range 1 to 2 years committed more errors and lapses as shown in Fig 5. The relation between the mistake commitment with the driving experience of the driver is quantified by means of equations by considering experience group E1 has the basic effect as shown in Eq. (1) to Eq. (7).

$$L1 = 3.33 + 0.09 * E_{X2} - 0.18 * E_{X3} - 6.41E-02 * E_{X4} + 0.14 * E_{X5} - 0.33 * E_{X6} - 1.5 * E_{X7} \quad (1)$$

$$L2 = 2.83 + 0.148 * E_{X2} + 0.2066 * E_{X3} - 0.089 * E_{X4} - 0.46 * E_{X5} + 0.43 * E_{X6} - 0.99 * E_{X7} \quad (2)$$

$$L3 = 2.76 + 0.21 * E_{X2} - 0.10 * E_{X3} - 0.172 * E_{X4} + 1.58E-02 * E_{X5} + 0.17 * E_{X6} - 0.92 * E_{X7} \quad (3)$$

$$AV1 = 2.77 + 0.159 * E_{X2} + 2.61E-02 * E_{X3} + 8.51E-02 * E_{X4} + 0.115 * E_{X5} - 0.24 * E_{X6} - 0.77 * E_{X7} \quad (4)$$

$$AV2 = 2.5 - 9.09E-03 * E_{X2} + 9.99E-02 * E_{X3} - 0.12 * E_{X4} - 0.27 * E_{X5} - 3.33E-02 * E_{X6} - 1.0 * E_{X7} \quad (5)$$

$$AV3 = 2.28 + 7.79E-02 * E_{X2} - 5.71E-03 * E_{X3} + 9.15E-03 * E_{X4} - 0.32 * E_{X5} + 4.76E-02 * E_{X6} - 0.28 * E_{X7} \quad (6)$$

$$AV4 = 2.11 - 0.08 * E_{X2} + 0.04 * E_{X3} + 6.04E-02 * E_{X4} + 0.28 * E_{X5} - 0.31 * E_{X6} - 0.11 * E_{X7} \quad (7)$$

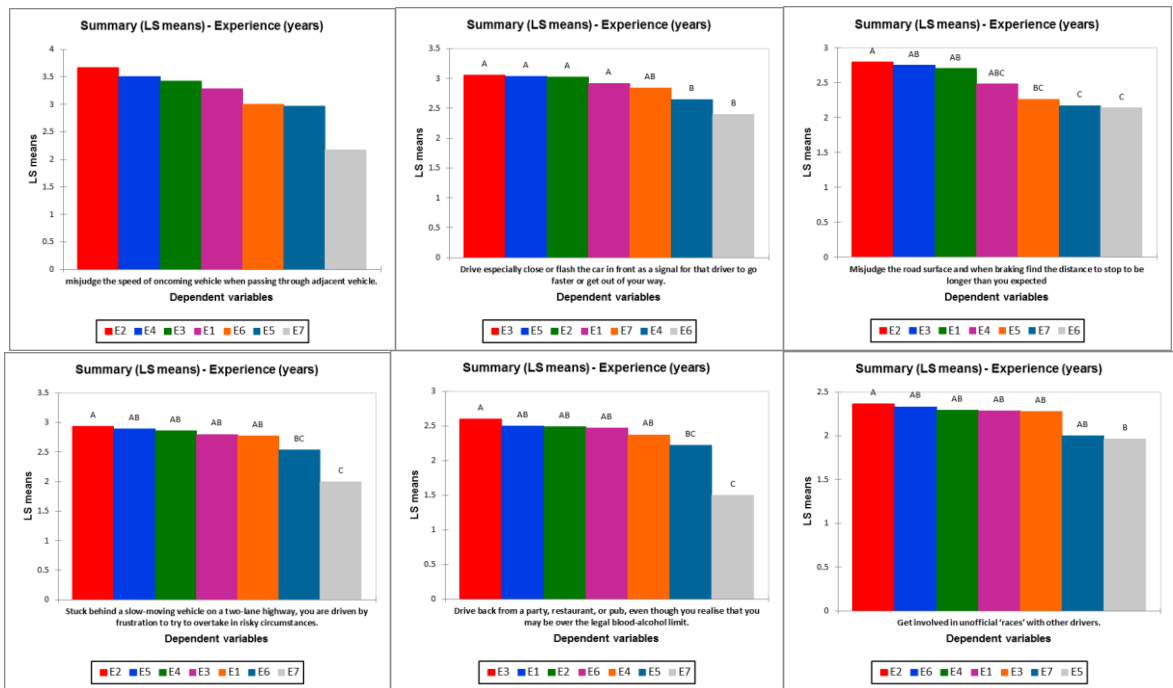


Fig. 4. Violation commitment-various scenarios

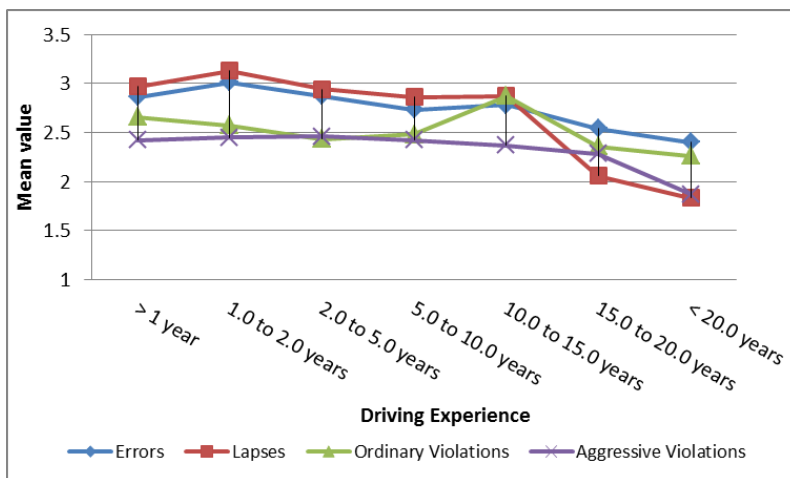


Fig. 5. Mean scores of DBQ factors in terms of driving experience

Using the Best model variable selection method, one variable has been retained for the calculation of model. Tukey's HSD (Honestly Significant Difference) test and Fisher's LSD (Least Significant Difference) test which tests the hypothesis that all the means for the various categories are equal are the most used tests in ANOVA and are performed on all variables of the questionnaire categories as shown in Table 4. It is shown that the variables are correlated with the experience range of driver up to a maximum value of 0.73 and Tukey's critical value of 4.19 enunciates the significance of variables ($Pr < 0.0001$) with a confidence interval of 95%.

Table. 4. Fisher's LSD test of DBQ

Type	Fisher's LSD test
Errors	0.175
Lapses	0.191
Ordinary Violations	0.177
Aggressive Violations	0.170

The Pearson correlation matrix in factor analysis indicated that the driver who is committing AV2 is also committing an error E3 at the same rate with a correlation value of 0.846 and the driver who is committing OV4 is also committing OV2 at the same rate with a correlation value of 0.741. The factor pattern indicated that the four factors which are highly related with the experience of the driver are “misjudge the speed of oncoming vehicle when passing through adjacent vehicle (E1)”, “Attempt to pass a vehicle that you hadn’t noticed was signaling its intention to turn left/right (E2)”, “Try to overtake without first checking your mirror, and then get hooted at by the car behind which has already begun overtaking manoeuvre (L1)” and “Become impatient with a slow driver and try to overtake (OV1)”.

6. Conclusions and recommendations

In the present study on long distance travelling cargo truck driver’s behavior, on a two-lane undivided road, following conclusions were drawn:

1. Study showed that the error committed by 62% of truck drivers is misjudging the speed of oncoming vehicle when passing through adjacent vehicle. It is the most common error that drivers committed along the highway and it can be considered as the major reason of accidents on two lane undivided roads.
2. Investigation of lapses showed that 86% of all drivers are trying to overtake without first checking the mirror and then get hooted at by the vehicle behind which has already begun overtaking.
3. Factor analysis done on the variables of questionnaire showed that driver behaviour questionnaire is a 4-factor structure with tolerable internal correlation coefficients.
4. Analysis of drivers’ behavior in terms of their experience showed that more the experience of the driver, fewer the number of violations, whereas the error commitment is more for experience group 1 to 2 years.
5. Study of drivers’ behavior showed that drivers with 10 to 15 years of experience were committed more lapses compared to other groups.
6. Less experienced drivers are committed fewer mistakes compared to more experienced ones as they are new to driving and more concentrating towards the driving and safety.
7. The inferences of the current study showed that, using driver behavior questionnaire in the field on a real sample of drivers with direct observation can be effective in recognizing drivers’ behavioral patterns and identifying improper behaviours during driving, which in turn can be used for future planning and reducing such behaviours.
8. This type of study using the above mentioned method is conducted for the first time in India and has many limitations. It is suggested that, in future studies, the relationship of other aspects of human factor such as age, strength, literacy, vision and also speed choice be studied.

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