

# Influence of Billboards on Driver's Behaviour under Mixed Traffic Condition

Bhadra J<sup>1</sup>, Karthik S<sup>2\*</sup>

<sup>1</sup>Department of Civil Engineering, TKM College of Engineering, Kerala Technical University, India

<sup>2</sup>Department of Civil Engineering, Kerala Technical University, India

\*Corresponding author

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## ABSTRACT

In the past few years, billboards on the roadside have grown rapidly, creating a change in drivers' behavior. In addition to roadside advertising being a source of distractions, there were many growing problems that pose a threat to road safety. As a competing factor that attracts drivers, it can result in vehicle collisions and accidents. The paper discusses the impact of billboards, finding those factors that influence drivers' behavior, and developing a model that can predict those characteristics that influence driver behavior. Method: A Driver Behaviour questionnaire survey was conducted to collect data for about 512 participants. The data were analysed with SEM to determine the relationship between the variables (Endogenous and Exogenous). In this model, the exogenous latent variables are the human factors (Gender, Age, Driving Experience), the billboard characteristics (Size, colour, Font size, Celebrity image, Content), and the road characteristics (intersection, Sight distance) and the endogenous variable is distraction. Results: Using SEM, it was found that the DBQ data obtained helped determine the influence of each factor that led to distraction through a coefficient of Human factor, Billboard characteristics and Road factors. Based on estimates of the coefficients for each factor, the human factor is more effective for causing driver distraction, i.e., the tendency to get distracted differs with age, gender, and driving experience.

**Keywords:** Distraction, SEM, Billboards.

## 1 Introduction

Many activities in our economy divert a driver's attention from driving. These include internal factors like talking, texting, eating, and playing music, and external factors like road signs, billboards, and other activities. Distractions tend to reduce the focus of drivers during the driving task, resulting in a variety of problems such as errors in their decision-making processes and performance [1]. Several studies have been conducted to examine the effects of billboards since they are identified as one of the sources of distraction when compared with others. Over the years, it has been reported that some multiple elements of billboards have some impact on drivers' performance and crash rates [2]. There is still not enough evidence to support the effects of billboards on road safety and therefore banning or restricting the presence of billboards is difficult [3]. In a country like India, where numerous challenges are faced related to the development of infrastructure, vehicle design policies, and public perception of danger, distractions among drivers will cause injuries and deaths until technologies such as the intelligent transportation system and driving automation are developed [2].

There are static, dynamic, and full motion billboards and a recent review found that some characteristics of billboards and characteristics of drivers can impact drivers' behavior and may differ [4]. Some studies show that there is a relation between driver's distraction and Accident rates and also there will be a decrease in mean speed of the vehicle when the driving task increases due to the billboards along the stretch [5]. With the advancement of LED technologies, billboards today are designed to attract the attention of drivers, displaying multiple messages simultaneously that are updated using computer algorithms, thus encouraging



the driver to have a glance at it, thus affecting the driver's performance [6]. Its contrast and conspicuity affect the visibility of road markings, road signs, etc. Billboards can increase the risk of driving at high speeds. In the present study, various billboard characteristics are classified based on their influence on driver's performance by taking into consideration both classic and digital billboards [7]. In order to identify the factors that affect driving behavior, Driver Behaviour Questionnaire (DBQ) surveys are the most commonly used techniques conducted to analyse how these billboards have affected driver's. Also, field experiments were also conducted in some studies. DBQ preparation is mainly done to know about the driver's perception and hence finding the characteristic that attracts them [6], [8], [9].

Research shows there is some correlation between roadside advertisements and driver behavior and the presence of billboards has a significant effect on driver attention, while others have a less detrimental effect. The possibility of an increase in distracted driving among drivers is also based on several factors [1], [3], [10]. Glazing behavior due to billboards and its duration is found to be longer than other external distractions such as road signs and is associated with road crashes [11], [12]. Some studies show that digital billboards have certain negative impacts while comparing to other types and encourage drivers to take a look and glancing time increases due to its attractive property. Routes with high density and heavy traffic can have more negative impacts than routes with a low density [2], [13]. A significant change in acceleration of the vehicle through the environment cluttered with advertising boards [14]–[16]. Studies put forward evidences that the percentage of time spends for looking billboard depends on the transition time and may differ on the basis of age [16], [17].

Objectives of the study is to:

- Test and validate the Driver behaviour questionnaire (DBQ) for knowing the behaviour of drivers and risk due to the distraction.
- Identify the billboard characteristics and other factors that affect drivers' behaviour.
- Most influencing factor that led to distraction
- Evaluation Risk factors associated with billboards through SEM

This study was carried out to investigate the influencing each factor that affect driving performance. Hence, through DBQ, estimated coefficients can show the major influencing factor that cause distraction.

## **2 Materials and Methods**

### **2.1 Pilot Study**

A Pilot study were conducted in Kollam City of Kerala to find out the characteristics that influence the driver to have a look on the advertisement board. 50 participants involved in this study include 12 women and 38 men. This study conducted helps to find out the influencing factors the distracts the drivers during their driving. Showed that Colour, Size, Celebrity image and Higher content on the billboards distracted the drivers. Additional characteristics that founded during the study include: Brand and logos, font size, sight distance, placing billboards at intersections also influence the drivers to have a look.

### **2.2 Creation of driver behaviour questionnaire**

Driver Behaviour Questionnaire (DBQ) one of the commonly known tools that were used by many researchers for assessing the road risky behaviour among the drivers or widely used to survey the behaviour of drivers around the world. Here the drivers will rate the frequency of the risk parameters committed during their drive. The Questionnaire prepared in this study involves Socio-economic characteristics, Trip characteristics of the drivers. The questionnaire in this study included a total of 22 questions that include various variables like their Age, Gender, Occupation (Socio-economic) and Mode of travel, Number of

trips, Kilometre driven per day, Driving experience (Trip characteristics) and drivers behaviour, attitude and perception related questions.

### **2.3 Data collection method**

The stratified questionnaire that was designed contained 22 questions in order to gather the data required for the analysis. The questionnaire was created using Google Forms and the data were collected through social medias and through field surveys. Sample data were collected under mixed traffic condition, to identify their perception towards billboards (Four wheelers, Three wheelers, Two wheelers and others).

### **2.4 Participants**

A total of 513 response were obtained randomly under mixed traffic, having 161 Females and 352 Males were approach to fill the survey questionnaire. Respondent from age greater than 18years with mean of 31.56 years (ranging from 26-35, SD = 1.23 years) and different types of drivers were selected randomly (car, bike, Auto and others).

### **2.5 Response statistics of billboard characteristics**

From the data collected one of the main characteristics that found to be more attracting are the Billboard characteristics include the Size, Colour, Font size, Celebrity image, Brand and logos, Higher content. The influence of these factors among the drivers through the DBQ are obtained.

### **2.6 Statistical analysis**

The DBQ factorial structure was tested for both Competitive confirmatory factor analysis (CFA) and EFA (Exploratory Factor Analysis). Aim of the exploratory Factor Analyses is to determine the smallest dimension that explain the covariation among different set of measured variables and that of Confirmatory factor analyses confirms the model fitness. These analyses were performed using SPSS (Statistical Package for Social Science) version 26.0. EFA can simply know to as a method that was conducted on observed variables and were used to recognise the number of Latent variables that were responsible for the data variability. Varimax rotation is one of the techniques that minimize the factors complexity by making small loadings smaller and larger loading larger within each factor. The model fit can be checked using coefficients of goodness of fit including RMSEA (Root mean square error of approximation), CFI (comparative fit index), TLI (Tucker Lewis index), Normal fit index (NFI), SRMSR (standard root mean square residuals), and IFI (Incremental fit index).

### **2.7 Structural Equation Modelling (SEM)**

SEM is an approach that are used to study relationship among different variables and is a kind of path analysis using measured and latent variables. Latent variables are those which cannot be observed, or it is a combination of the measured and observed variables. Here in the study, the latent variables are the exogenous (independent) and endogenous (dependent) variables. Conducting SEM through SPSS Amos gives a path analysis with the coefficients indicate the cause of the observed variable over latent variable. In this study, uses SEM for analysing the data collected and thereby identifying the factors affecting driver's behaviour using Questionnaire. In this research, driver's behaviour due to this billboard were analysed through the questionnaire. Thus, aiming to found the relation of driver behaviour and distraction can be obtained through structural equation modelling.

### 3 Results and Discussion

#### 3.1 Structural models

##### 3.1.1 EFA (Exploratory Factor Analysis)

On the basis of varimax rotation factor analysis three different factors or latent variables with their observed variables were separated. Three variables (Gender, Age, driving experience) were arranged on the first factor named as “Human factor”. Two observed variables (Size, Colour) were placed as second factor named as “Billboard factors 1”, four observed variables (Font size, celebrity image, Brand and Logo, Higher Content) were placed as Third factor named as “Billboard factors 2”. Further, two variables (Intersection, Sight distance) were placed on fourth factor, named “Road Factor”. Thus finally, from the result of factor analysis, 11 observed variables into 5 latent variables were determined including one Endogenous variable and four Exogenous variables. Human Factors (Factor 1), Billboard characteristics 1 (Factor 2), Billboard characteristics 2 (Factor 3), Road Factors (Factor 4) were the exogenous latent variable and Distraction as Endogenous. For making those different variables to separate factors KMO and Bartlett’s test should be conducted and KMO value greater than 0.5 represent the sampling is adequate to do factorial Analysis and also the Bartlett’s test should be significant. The values obtained after both test in the table 1 shows that the data collected are significant to do factor analysis.

**Table 1: KMO and Bartlett's Test**

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.712
Bartlett's Test of Sphericity	Approx. Chi-Square	1489.743
	df	78
	Sig.	.000

##### 3.1.2 Confirmatory Factor Analysis (CFA)

CFA is done to test the hypothesis that there is some relationship exist between the latent variable and Observed variable. If the coefficient found among the latent variable and observed variable are less than 0.5, dimension reduction should be done to make the model fit. SPSS Amos gives the path analysis which shows which factor among them led to distraction. From the confirmatory factor analysis founded that Environmental factor including day and night distraction are less correlated and hence removal of the factor led to model fit. Also, higher content factor loading in Billboard characteristics 2 are removed due to its value less than 0.5. Further, the Gender considered as Human factor is also removed for the model fitness and thus the factors that contain different observed variables are confirmed through SEM Amos and the model fit values are given the table 2 below.

**Table 2: Model Fitness values**

Fit indices	Acceptable limits	Model results
CMIN/DF	< 5.0	4.319
GFI	>0.9	0.945
CFI	>0.9	0.914
RMSEA	<0.08	0.073

SRMR	<0.09	0.077
IFI	>0.9	0.924
PNFI	>0.5	0.576

### 3.2 SEM Model

The SEM model for driver distraction is shown in the figure 1 below, where the numbers in the arrows represent the coefficients estimated. From the path diagram the result indicate that there is a good relation among the endogenous and exogenous variables. Thus, indicate from the analysis that the coefficient of the effect of the 4 exogenous variable namely Human factor, Billboard characteristics 1, Billboard characteristics 2, Road factor are 0.46, 0.41, 0.36, 0.17 respectively. Regarding this coefficient the most effective factor that cause driver distraction is the human factor. Thus, model shows that the distraction may vary depend upon driver's age and driving experience. Hence, comes to fact that managing those factors other than human factor that influence them based on their age (coefficient 0.92) can control the distraction tendency by reducing the billboards size and attractive colours.

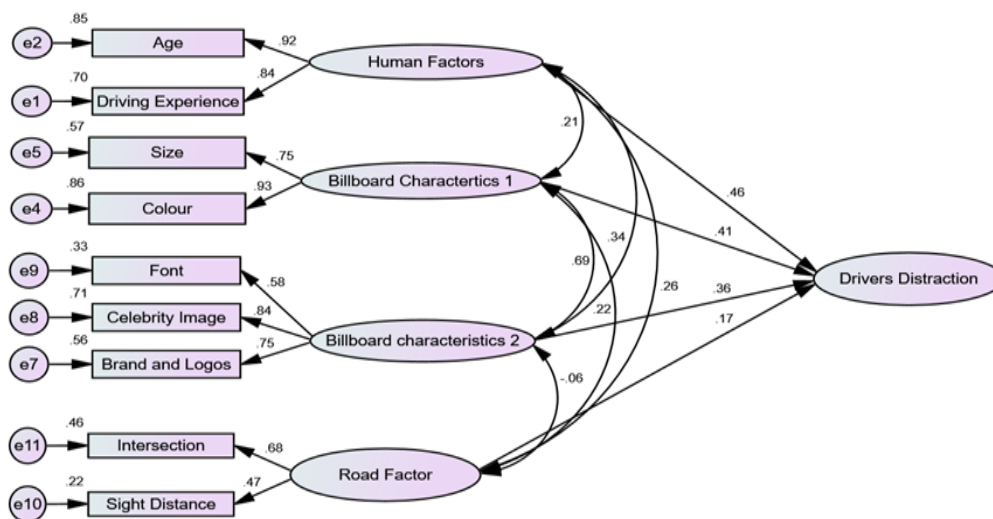


Figure 1: Path Analysis developed using SPSS Amos

### 3.3 Goodness of fit

#### 3.3.1 Reliability Analysis

Cronbach's alpha gives the coefficient of consistency which will measure how a set of items or variables will measure a single or undirect latent variable. In this study, the Cronbach's will evaluate the internal consistency of these latent variables, the result obtained from the Reliability analysis are shown in the table 3 below shows the reliability of the data.

Table 3: Model Fitness values

Cronbach's Alpha	No of Items
.719	9

### 3.3.2 Normality fit index

NFI is one of the methods that is used to check the goodness of fit is an increment measure that used in this analysis which depends on the number of parameters in this model and its value should be more than 0.9 indicate good fit. The table 4 below shows the value of NFI as 0.936 is greater than 0.9, hence model is found to be fit.

**Table 4: Model Fitness values**

Fit index	SEM model	Criteria for acceptable
NFI	0.936	>0.9

### 3.3.3 Standardise root mean square residual

Shows the difference between the observed correlation and model-implies correlation matrix. The value should be less than 0.08 in order for the Model fitness. Result gives value of about 0.077 shows good fit.

## 4 Conclusions

Billboards are the external distraction that has becoming a growing problem along the roadside and lead to affect the driver's visual behaviour which impairs the driver's ability to handle the vehicle. Studies shows there is some relationship exist between roadside advertising and drivers' behaviour. Each factors including road, human, environment and characteristics of billboard has a certain effect on driver behaviour is founded. Billboard distraction varies on the basis of age and Experiences and hence statistical analysis is made accordingly. The effect of billboard on visual behaviour is obtained through DBQ. Studies shows that DBQ can be used to access whether due to the billboard cause any errors or violations to the drivers. Understanding the mechanism in which certain roadside billboard contribute to road accidents by this naturalistic driving studies which shows a prolonged glance to the billboards increase the chance of risk involved in road accidents. Thus, the level of engagement on driving due to billboards are analysed through the creation of models. Statistical Analysis of data collected from the various studies point towards various factors that influenced the driver and identified that the coefficients obtained shows there is some relation exist between them. Exploratory factorial analysis using SPSS identified those factors which led to distraction during driving. KMO test is used to find whether the data is adequate to be used for factorial analysis and Bartlett's test gives the strength of the relationship between the variables. Obtained KMO test for sampling adequacy is found to be 0.712 and indicate better significance value since it is greater than 0.5, while in case of Bartlett's test is also find to be significant, that is the probability is found to be less than 0.05. Confirmatory factorial analysis is the next stage in order confirm those observed variable that come under latent variable are fit or not. SPSS Amos used for producing the path analysis shows the coefficients between latent and observed variable. Coefficients less than 0.5 results in problem in model fitness and hence those characteristics that found to be less correlation coefficient were removed. In the study one of the factors called Environmental factor were led to remove for model fitness and also the reduction in higher content on the boards as the load factor is less than 0.5 for model fitness. Model fitness value obtained are CMIN of 4.319. Finally obtained path analysis shows that the distraction may vary depend upon driver's age and driving experience. Hence, comes to fact that managing those factors other than human factor that influence them based on their age (coefficient 0.92) can control the distraction tendency by reducing the billboards size and attractive colours.

## 5 Publisher's Note

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## How to Cite

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