

# Antecedents and Consequences of Car Driver Behaviours towards RTA Involvement using Structural Equation Models (SEM)

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*Abstract:* - Road transport meets almost all the requirements of modern life, yet it is also a source of numerous negative effects, including road safety. Road Traffic Accident (RTA) is a combination of many factors comprising roads design, vehicles, the environment, and road users, and the way they interact. Car driver Behaviours factor is the most prevalent contributing factor of road traffic accidents. This study aims to develop a traffic safety index in a framework investigates the relationship between antecedents and consequences of car driver behavior towards road traffic accidents involvement. The data was collected through a sample of 500 questionnaire and analyzed using SPSS. A structural equation model (SEM) is adopted to capture the complex relationships among variables and their impact on driver attitudes towards traffic safety. The conceptual framework for this study identifies relationship between antecedents and consequences of car driver attitude towards RTA.

*Key-Words:* - RTA, Car driver behaviours, Fatalities and Safety.

## 1 Introduction

Road safety is a serious public problem throughout the world. Approximately 1.3 million people die each year in traffic-related accidents worldwide. Road traffic accidents are the 9th leading cause of death and are predicted to become the 5th leading cause of death by the year 2020 [1]. Road safety is also issues of social equity, more than 90 percent of the victims of these accidents, are in low- and middle-income countries. The traffic fatality rate in low- and middle-income countries is 20.2 deaths per 100,000 populations, whereas the rate is only 12.6 for high-income countries. In addition, more than half of the victims are vulnerable road users, including bicyclists, pedestrians, and other unprotected travelers.

RTAs are attributed to many factors including road, vehicle, human and environment factors. These contributory factors combine in a way that leads to a road user failing to cope in a particular situation [2]. The human factor is the most prevalent contributing factor of road traffic accidents. This includes both driving behavior (e.g., drinking and driving, speeding, traffic law violations) and

impaired skills (e.g. impaired physical perception, lack of attention, exhaustion, physical disabilities and so on) [3].

In order to design a safe transport system no serious injuries or fatalities in traffic accidents - there is a growing need for a systematic approach to this problem. The potential impacts of the selected remedial measures should also be evaluating.

Enhancing road safety is among the best remedial measures and is crucial because of the need for proper enforcement, education, and engineering. However, these measures have already been applied in a number of developed and developing countries and potentially yielded positive results in terms of changing the attitudes and behavior of drivers. Therefore, developing countries should be take advantage of the above-mentioned counter measures on the basis of experience in developed countries. However, the differences in behavioral, cultural, and economic aspects between developed and developing nations must be considered. Many researches discussed effect of car driver behavior on RTA.

Pablo Lardelli et. al, 2009 studied traffic accidents registered in Spain between 2000 and

2004, and found that the age of the driver affects road safety; young drivers are more likely to be involved in accidents than older drivers[4].

David, 1995 in his study found that, between the ages of 15 and 55, those drivers with one year of experience tended to have higher crash rates than same age drivers with two or three years of experience when at-fault road accidents were considered. The young and male drivers were found to be significantly more involved in road accidents and enforcement and education programs are very important for drivers [5]. Syed and Shamsul, 2003 found that due to lack of institutional training 90% of the drivers failed to state the basic difference between the triangular and the circular signs. 75% of the drivers could not identify important road markings [6]. About 80% of the drivers did not know that there is a relationship between the safe trailing distance and vehicular speeds. De Craen, S, 2010 in other study found that accident rates drop most dramatically during the first six months of driving [7]. According to Benekohal and Wang 1994 about the impact of the work area on the behavior of drivers, the study found that the majority (77.5%) of the drivers paid more attention to work zone signage and thought speed limits were posted correctly (97.0%) [8]. A study by Moen and Rundmo, 2005 found the weather (Heavy tropic rainfalls) also threatens surface transportation and impact road way safety, mobility and productivity. Weather impacts roadway mobility by increasing travel time delay, reducing traffic volumes, decreasing roadway capacity and change the behavior of the driver while driving [9]. Hussin and Amiruddin 2013 and Farag, 2015 analyze the traffic safety in low and middle income countries comparing to the world average and they found that the problem is not intractable and the death toll could be greatly reduced if appropriate measures were carried out by the government [10, 11]

Previous studies have separately assessed different characteristics (infrastructure, driver, vehicle, traffic, etc.) effects on safety. No comprehensive model exists that takes into account the combined effect of multiple characteristics' types on safety as well as their effect on one another.

The present study is aimed to develop a traffic safety index in a framework investigates the relationship between antecedents and consequences of car driver behavior towards road traffic accidents involvement. This framework will allow for a better understanding of the safety implication of road infrastructure and the impact of these factors on the behavior and attitudes of the driver. 75 factors were

examined in this study and the developed model suggests some correlations to complement factors as "knowledge, training, road condition, weather, road pavement, road alignment, traffic control and traffic zone" work together to influence car driver attitude towards RTA involvement. Consequently, the influence affects increase in road safety and reduces traffic accidents, through interaction of these factors which could be considered as a new dimension.

The data was collected through the use of the questionnaire, which consisted of four parts, namely, demographic, key factors affecting driver attitude towards accident involvement as knowledge, training, road condition, weather, road pavement, road alignment, traffic control and zone, as well car driver behavior and consequences of attitudes towards road traffic accidents involvement.

The information collected was analyzed using SPSS version 19. The association between variables included in the study was tested using structural equation models (SEM).

## 2 Preliminary analysis

The total number of the participants in this study was 398 drivers. Minimum age was 18 year. The highest percentage of participants was 123 (30.9 %) an age group of 26-33 years old. The proportion of males' drivers was more than females. 35% of participants answered that lack of experience for young drivers a major cause for accidents on the roads.

The analysis using SPSS indicates that skewness and kurtosis absolute values falls within the recommended levels which suggests that the normality is invariant [12]. The result indicated that the skew and kurtosis of all 75 items were laid between  $\pm 2$  and  $\pm 7$  respectively. Therefore, it can be concluded that the data set of all items were well-modelled by a normal distribution. The skew ranged from -1.347 to -0.195 and the kurtosis ranged from -0.976 to 1.366.

### 2.1 Correlation between demographic variables

The results of the Spearman Correlation test indicated that the relationship between the age, education and experience were statistically significant as their p-values were below the threshold 0.05. Also, age, education and experience were in positive correlation with each other.

It found that the strongest correlation belonged to the relationship between education and experience with the correlation coefficient of 0.244 and p-value of 0.000. The second strong correlation belonged to

the relationship between age and education with the correlation coefficient of 0.179 and p-value of 0.000. The least correlation strength belonged to the relationship between age and experience with the correlation coefficient of 0.141 and p-value of 0.005. The highest mean rating belonged to knowledge (M = 4.01), followed by road traffic accidents (M = 3.85). The lowest mean rating belonged to pavement with the mean value of 3.28.

Table1. Correlation coefficients between Demographic Variables

		Age	Education	Experience
Age	Spearman Correlation Coefficient (r)	1.000		
	Sig. (2-tailed)	.		
Education	Spearman Correlation Coefficient (r)	.179***	1.000	
	Sig. (2-tailed)	.000	.	
Experience	Spearman Correlation Coefficient (r)	.141**	.244***	1.000
	Sig. (2-tailed)	.005	.000	.

\*\* Correlation is significant at the 0.01 level (2-tailed); \*\*\* Correlation is significant at the 0.001 level (2-tailed).

### 3 Statistical methods

Structural Equation Modelling (SEM) [13, 14] analyses encompass two major stages, the measurement model or confirmatory factor analysis (CFA) and the structural equation model. The measurement model (CFA model) is used to find out the links between manifest or observed and latent or unobserved variables [15].

#### 3.1 Confirmatory Factor Analysis (CFA)

The measurement CFA model of this study includes 75 items to measure eleven constructs: Knowledge (KN), Training (TR), Condition (CN), Weather (WE), Pavement (PA), Alignment (AL), Traffic Control (CT), Traffic Zone (ZN), Car Driver Behaviours (CDBV), Road Safety (ROSF) and Road Traffic Accidents (RTA). The initial measurement CFA model with all 75 items.

The results of assessing the standardized loadings of the model's items showed that the factor loading of 6 items (i.e., PA6, CDBV1, CDBV2, CRDV16, CRDV17 and ZN1) were below the cut-off 0.5. Therefore, these items were removed from their relative constructs. The revised model with 69 reminder items was again tested to ensure whether the factor structure remained stable. As the result,

the second standardized factor loadings for all items were more than 0.5, ranged from 0.744 to 0.923.

The second measurement model provided a poor fit for the data with 38 reminder items. The chi-square is significant ( $\chi^2 = 3390.620$ ,  $df = 2222$ ,  $p = 0.000$ ). Furthermore, the model indicated covariance between the error terms of indicator variables loading on different constructs. Here the high M.I covariance value of the error of 'CDBV5, ZN5, CDBV3, PA4, AL2, TRCG3, TR2, CDBV11, KN2, CDBV7' with the items' errors of other constructs refer to between-construct error covariance.

The decision of modifying the model was to eliminate these 10 items from the model rather than drawing correlation path between the items' errors [16]. The examination of standardized residual covariance indicated that three items (i.e., ROSF5, CN2 and CN1) had unacceptably high absolute value of standardized residual covariance above 2.58 with other items in the model. Thus, the decision was to discard these two items from the model. After iteratively removing these 13 items, the CFA model with 56 reminder items was performed once again. The results of the GOF showed that the chi-square is significant at 0.000 level [17, 18]. Given that the modified measurement model fits the data adequately, no further adjustments are required.

##### 3.1.1 Reliability analysis

Reliability is assessed using Cronbach's alpha, construct reliability (CR) and average variance extracted (AVE) [19]. The remaining indicators have high factor loadings ranging from 0.749 to 0.923 indicating that the meaning of the factors has been preserved by these indicators.

The AVE, which reflects the overall amount of variance in the indicators accounted for by the latent construct, was above the cut-off 0.5 for all constructs as suggested by [20], ranged from 0.632 to 0.786. The Cronbach's Alpha values, which describes the degree to which a measure is error-free, range from 0.894 to 0.956 which were above the threshold of 0.7. Therefore, the achieved Cronbach's Alpha for all constructs was considered as sufficiently error-free.

##### 3.1.2 Discriminate validity

The discriminate validity was examined to assess how truly distinct a construct is from other constructs. The validity was checked based on comparisons of the correlations between constructs

and square root of the average variance extracted for a construct.

The inter-correlations between the deconstructs ranged from 0.260 to 0.734, which were below the threshold 0.85 [21], the squared correlations were less than the square root of the average variance extracted by the indicators, demonstrating good discriminant validity between these factors .

It can be concluded that the final modified measurement scale to assess the constructs and their relative items in this study was reliable and valid. Figure 1 depicts the modified and final measurement model with standardized factor loadings for the 56 reminder items.

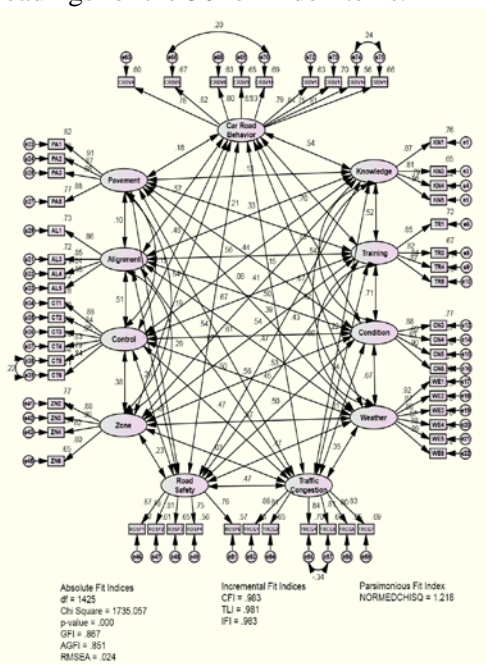


Fig.1 Modified Measurement Model for Reminder 56 Items

### 3.2 Structural model

Once the measurement model is validated, representation of the structural model can be made by specifying the relationships among the constructs. The structural model provides details on the links between the variables. It shows the specific details of the relationship between the independent or exogenous variables and dependent or endogenous variables [16, 17]. Evaluation of the structural model focuses firstly on the overall model fit, followed by the size, direction and significance of the hypothesized parameter estimates, as shown by the one-headed arrows in the path diagrams [17].

The final part involved the confirmation of the structural model of the study which was based on the proposed relationship between the variables

identified and assessed. In this study the structural model was estimated, using the maximum likelihood estimate (MLE) and regression technique, to examine the research hypothesizes.

The initial structural model provided a poor fit for the data. The chi-square was significant ( $\chi^2 = 37.605$ ,  $df = 1$ ,  $p = .000$ ). The AGFI was  $-0.090$ , below the cut-off 0.8. The TLI was  $-0.083$ , below the cut-off 0.9. The RMSEA was 0.307, above the threshold 0.1 and  $2/df$  was 37.605, above the threshold of 5. In an attempt to find a better fitting model, this study followed the approach proposed by [22] in adding the links suggested by regression coefficient modification indices. Based on modification indices, a path from traffic accidents to road safety was added to the model.

An examination of goodness-of-fit indices indicates that the modified structural model best fit the data with the value of 1 for both GFI and CFI. Although the chi-square statistic is statistically significant, this is not deemed unusual given the large sample size [23]. Figure 2 illustrates the modified structural model with this additional path together the standardized regression weights.

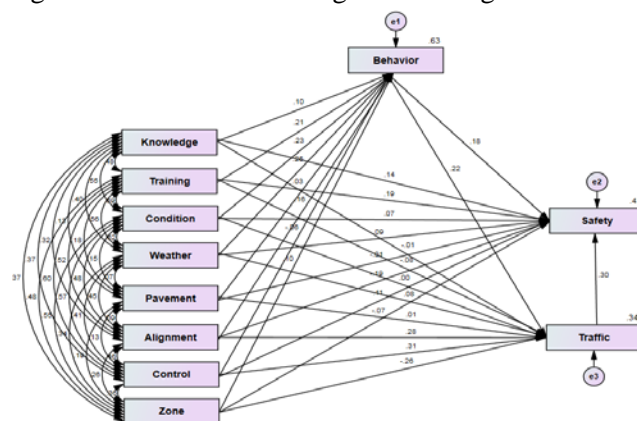


Fig. 2 Final structural equation mode

Note: \* Significant at  $p < .05$ , \*\* significant at  $p < .01$ , \*\*\* significant at  $p < .001$ .

### 4 Discussion and research findings

Overall findings showed that the scores of  $R^2$  value satisfy the requirement for the 0.10 cut off value [24], ranging from 0.34 to 0.63. This indicates, for example, the error variance of "car driver behaviour" is approximately 63 percent of the variance of Car Road Behaviour itself. In other word, 63 percent of variations in car driver behaviour are explained by its eight predictors (i.e., knowledge, training, road condition, weather, pavement, alignment, traffic control, and work zone).

As shown in figure 2, six paths from Knowledge, Training, Road Condition, Weather, Alignment and Work Zone to Car Driver Behaviour, five paths from Knowledge, Training, Alignment, Traffic Control and Car Road Behaviour to Road Safety and four paths from Alignment, Traffic Control, Work Zone and Car Road Behaviour to Traffic Accident were statistically significant ( $p$ -values  $< 0.05$ ).

In other words, SEM results show for example the knowledge and training when they go up car driver behavior goes up too. As well as work zone when they go up traffic accidents goes down as. It means when Work Zone (ZN) goes up by 1 standard deviation, Road Traffic Accidents (RTA) goes down by 0.263 standard deviations. The injury accidents in work zones seem less severe than injury accidents in non-work zones. This result has a consistency with other researches.

The final model has 11 observed variables, eight variables of antecedents that affect the behaviour of the driver, mediating (car driver behaviour) and two of consequences (road safety and road accidents) interact between them. Through the final structure equation model we find the relationship between Car driver behaviour and each observed variable. Various factors determine that affect the behaviour of the car driver towards road traffic accidents. Furthermore, all observed variables have significant effects (high  $p$ -values) on latent variables.

The SEM illustrates positive or negative effects of each variable on the car driver behavior, for example, there was a significant positive relationship between Knowledge (KN) and the Road Safety (ROSF) in the absence of Car Driver Behaviours (CDBV) as mediator; beta (total effect) = 0.157,  $P$ -value = 0.018. The relation was still significant after inclusion the mediator to the model; beta (direct effect) = 0.135,  $P$ -value = 0.004.

The results should be highly related to improve driver behavior and focus on the factors that change his behavior, as weather condition variable. In addition, SEM results show that road accidents at work zones are caused by a variety of factors, like speeding traffic, inadequate visibility of signs, poor road surface condition, inadequate traffic control, improper management of material, equipment, and personnel in work zones, not paying attention to work zone signs or flaggers indicating slow down, distraction by cellular phone calls, conversations and activities at roadside.

Speed is one of the most significant factors in road accidents. Speed of driver is affected by factors which include driver age, gender and attitude. Therefore, different drivers choose different speeds for the same conditions.

## 5 Conclusion

The conceptual framework for this study identifies relationship between antecedents and consequences of car driver attitude towards RTA involvement. The following construction has been identified so far: Antecedents (knowledge, training, road condition, weather, road pavement, road alignment, traffic control, and traffic zone), mediating (Car driver attitude) consequences (Road safety and road accidents).

The Spearman correlation was deployed to examine the importance, strength and direction of the inter-relationships between the demographical variables (e.g., age, education and experience). The relationship between the age, education and experience were statistically significant as their  $p$ -values were below the threshold 0.05 and were in positive correlation with each other.

In his study it was found that, between the ages of 15 and 55, those drivers with one year of experience tended to have higher crash rates than same age drivers with two or three years of experience when at-fault road accidents were considered.

The young and male drivers were found to be significantly more involved in road accidents and enforcement and education programmes are very important for drivers. In conclusion, age, nationality, experience and wearing seat-belts are associated with road accidents and driver characteristics affecting road safety.

It found that driver characteristics factor (Age, experience, level education, knowledge, training) are more effective than traffic, road and environment factors to decrease the traffic accident and improve road safety.

Finally, the findings in this research offer information about the relationships between factors that affect the behavior of the driver and its consequences

In future studies, new latent and observed variables such as enforcement data, awareness to signs, and so forth affecting traffic accidents should be included in the model.

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