

## Analysis of Factors Contributing to Road Accidents in Penang, Malaysia

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### ABSTRACT

*Road accidents in Malaysia impose significant public health and economic burdens. Despite national road safety initiatives, Penang's high vehicle density, complex traffic conditions, and role as a major tourist hub continue to contribute to elevated fatality rates, emphasizing the need to examine underlying risk factors. This study aims to explore the factors contributing to road accidents in Penang to inform targeted interventions and improve road safety in the region and beyond. Factors considered in this study include driving behavior, vehicle condition, traffic violation, road condition, weather condition, and traffic condition. A cross-sectional study was conducted, and convenience sampling was used to collect data from 400 licensed drivers in 5 districts of Penang via a questionnaire survey. The data were entered and analyzed via SPSS software. The results demonstrated that traffic conditions is the most significant factor impacting road accidents, while road conditions and driving behavior also contributing positively. In contrast, traffic violations have a slight negative impact.*

**Keywords:** Contributing factors, Penang, Road accident, Road safety.

### 1. INTRODUCTION

Road accidents are significant global tragedies that pose major threats to public safety and well-being [1]. According to the World Health Organization (WHO), approximately  $1.19 \times 10^6$  people lose their lives annually in road accidents worldwide, whereas 20 to  $50 \times 10^6$  individuals suffer nonfatal injuries, many of whom are left disabled [2]. Alarming, low- and middle-income countries, despite owning approximately 60% of the world's vehicles, account for 92% of global road fatalities. As a middle-income country, Malaysia is not exempt from this trend, with road accidents emerging as a critical public health issue. On average, 18 fatalities occur daily due to road accidents, reflecting the severity of the problem [3].

In 2022, Malaysia reported 545,588 road accidents, resulting in 6,080 fatalities, which was a 47% increase from 2021 [4]. By 2023, the number of road accidents had further risen by 9.7% to 598,635 [5]. Factors such as potholes, speeding and dangerous overtaking have been identified as major contributors to road fatalities, particularly on federal and state roads [6]. Recognizing the urgency of this issue, the Malaysia Road Safety Plan (MRSP) 2022–2030 aims to reduce road accident fatalities by at least 50% by 2030 [7]. Although accident records provide essential quantitative evidence, perception-based data remain valuable for capturing road users' experiences and risk perceptions that are often absent from official statistics. Such insights help

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explain behavioral and contextual factors underlying road accidents, thereby complementing recorded accident data and supporting more effective safety interventions.

The economic impact of road accidents is equally profound. [2] estimated that road accidents cost countries approximately 3% of their annual Gross Domestic Product (GDP). In Malaysia, the financial impact of each life lost due to road accidents amounts to RM3.12×10<sup>6</sup>, including medical costs, infrastructure recovery and productivity losses [7]. Overall, road accidents result in a daily economic loss of RM56.15×10<sup>6</sup>, equivalent to 1.17% of Malaysia's nominal GDP in 2022 [8]. Penang, a highly urbanized and densely populated state contributing 7.6% to the national GDP, is particularly affected by road accidents. In 2023, Penang's GDP grew by 3.3% to RM116×10<sup>9</sup>, but road accidents remain a significant economic and public health challenge for the state [9].

Despite numerous road safety measures, traffic accidents and fatalities persist in Malaysia, with Penang recording one of the highest traffic fatality rates in the country [10]. Factors such as risky driving behavior, vehicle and road condition, and adverse weather exacerbate the situation [11, 12]. However, existing studies on road accidents in Malaysia, particularly in Penang, remain limited in scope and statistical rigor, as many focus on a narrow set of variables, rely primarily on descriptive analyses, and lack the use of robust multivariate or inferential statistical methods. In addition, Penang-specific investigations are relatively scarce, despite the state's unique traffic density, urban characteristics, and tourism-related mobility patterns. The objectives of this study are: (1) to profile the sociodemographic characteristics of licensed drivers in Penang; (2) to examine the relationships between driving behavior, vehicle condition, traffic violation, road condition, weather condition, and traffic condition with road accidents; and (3) to assess the impact of these factors on road accidents. To achieve these objectives, a quantitative research approach was adopted. The data were analyzed via descriptive statistics, as well as correlation and regression analyses.

The structure of the rest of this paper is as follows: Section 2 presents a review of the literature on the 6 factors contributing to road accidents. Section 3 outlines the research framework and hypotheses derived from the literature review. Section 4 details the methodology, including the study design and data collection process. Section 5 presents the results and discussion, identifying the key factors significantly influencing road accidents. Finally, Section 6 concludes with recommendations for relevant authorities and suggestions for future research.

## **2. LITERATURE REVIEW**

Penang, as a densely populated state, experiences transportation challenges associated with complex traffic patterns and increasing vehicle ownership. Policy initiatives, such as the Penang 2030 framework, emphasize sustainable transport solutions, including light rail transit and e-mobility, to improve traffic safety and reduce environmental impacts [13]. However, existing road safety studies in Malaysia predominantly adopt a national-level perspective, with limited empirical evidence specific to Penang. The current literature therefore, suggests a need for more localized analyses to better understand the factors influencing road accident occurrences in this context.

### **2.1 Driving Behavior**

Human factors are a primary cause of road accidents, with distracted driving and fatigue being significant contributors [14, 15]. Fatigue impairs cognitive awareness, slows reaction times and reduces judgment, making drivers more prone to accidents [16, 17]. Risky driving behaviors, such as speeding and distraction, intensified during the COVID-19 pandemic, despite a reduction in overall road traffic fatalities, as decreased traffic volume encouraged more hazardous practices [18]. High-speed driving and vehicle collisions, particularly motorcycle-related accidents,

account for a substantial share of injuries in both rural and urban areas [19]. Inattention and poor situational assessment are also prevalent among accident-prone drivers, further emphasizing the role of human error [20]. Interestingly, drivers with more experience tend to exhibit safer driving behaviors than do less experienced drivers, although improper driving practices remain a common factor in traffic collisions, with at least 50% of individuals involved in accidents admitting to unsafe behaviors [21].

## **2.2 Vehicle Condition**

Vehicle conditions, such as the level of fuel, engine condition, and battery status, are important to road safety [22]. Unexpected road accidents may result from the use of second-hand spare parts, which are less expensive but often of lower quality. This is because these products do not have any warranties or guarantees. However, the high maintenance fee leads people to consider it second [23]. People's poor purchasing power may make it harder for them to buy their own cars, which would put pressure on the economy's supply of commercial motor vehicles [24].

## **2.3 Traffic Violation**

A study by [25] classified traffic violations into three main groups: administrative violations, speed limit-related violations and driver-related violations. They discovered that certain traffic violations greatly increase the likelihood of serious accidents compared to circumstances without them. Some traffic violations are related to administrative norms, including not having a valid driving license, breaking the traffic code with respect to priority, driving excessively quickly or driving carelessly [25]. All reasons for Driving Without a Valid License (DWVL) were found to be significantly correlated with the risk of causing road accidents in a retrospective case-control study. The correlation was particularly high for drivers who had never obtained a license and drivers with a suspended license [26].

Shiomi et al. [27] reported that the number of traffic violations had the greatest impact on traffic accidents. Moreover, it has been widely suggested that driving while under the influence of drugs or alcohol is the cause of young drivers' accidents [28]. In addition, most respondents agreed that they have driving behaviors that involve disobeying traffic lights [21], which constitute traffic violations. Furthermore, overload is also a main cause of road accidents. Overloaded trucks exceeding the gross vehicle weight limit and legal axle loadings may lead to loss of steering control, brake failure, severe damage to infrastructure, road damage, bridge fractures, and operational errors that increase the risk of road accidents [29].

## **2.4 Road Condition**

Febres et al. [30] classified roads into high-, medium- and low-speed roads and reported that the type of road is directly related to the severity of the driver's injury sustained in road accidents. Non-asphalted roads, in particular, are significantly associated with motorcycle accidents [19]. In addition, drivers' unfamiliarity with road conditions in relation to the frequency of driving routes is also a main cause of road accidents [29]. Zahidy et al. [31] reported a significant positive relationship between Road Service Quality (RSQ), especially road drainage, the road surface and road maintenance, and road traffic accidents. Road maintenance was identified as the most important predictor of road traffic accidents, followed by road surface and drainage. The degree of injury is substantially influenced by road category and the number of vehicles involved in accidents [32]. Another study by [33] reported that, although driver behavior has been accepted as the main cause of fatal road accidents, several other factors, including road physical factors, also contribute.

## 2.5 Weather Condition

The second major factor contributing to road accidents is the environment. Weather conditions such as rain and snow can affect the road surface [34, 35]. Extremely hazardous weather conditions have the potential to completely ruin road connections or transportation networks. Heavy rainfall, dense fog, tornadoes, cold temperatures, hot weather and windstorms are a few examples [14, 32]. Ghani et al. [36] emphasized that adverse weather conditions, such as heavy rain and wet road surfaces, are particularly dangerous for motorcyclists, increasing the likelihood of skidding and collisions, especially for food delivery riders under time pressure. Speeding during rainy seasons, hot days, or conditions with significant haze can often lead to traffic accidents, as drivers may lose control and judgment more quickly [23]. Junus et al. [12] reported that traffic accidents are more likely to occur during hot weather, as driving performance may deteriorate due to the psychological and physiological effects of high temperatures. Research has shown that Penang is experiencing more rainfall, leading to a 1% increase in traffic accidents. Interestingly, most fatalities occur during the daytime and in warm weather [37].

## 2.6 Traffic Condition

Compared with daytime, when accident rates are highest in the morning and afternoon, road accident rates are often significantly lower at night. There is a fairly obvious relationship between the number of automobiles on the road and the number of accidents, as this pattern is extremely similar to the 24-hour pattern of traffic density [38]. Junus et al. [12] reported that road accidents are more likely to occur during festival celebrations, which are typically connected to religious activities. As more people seize the opportunity to visit their homeland and reconnect with family, traffic continues to increase. In particular, during Chinese New Year, Eid al-Fitr, and Deepavali, traffic to villages increases significantly when Malaysians return. During the early phases of lockdown, characterized by travel restrictions and orders to stay at home to curb the spread of Coronavirus Disease 2019 (COVID-19), the number of road traffic accidents and traffic volumes decreased significantly. This emphasizes the distinct and infrequently noted influence on road safety during the early phases of a pandemic [18]. Ahmed et al. [32] also reported that variations in road categories and traffic density significantly influence accident rates and severity, with urban roads and weekends resulting in higher fatality rates during high-traffic conditions.

## 2.7 Road Accidents

Road accidents are unavoidable events that can occur anytime and anywhere, making them a common issue worldwide. In Malaysia, road traffic accidents frequently occur and have been steadily increasing annually, posing significant risks to both road infrastructure and users [39]. The increase in road accidents is evident not only in urban areas but also in rural regions, where infrastructure is often insufficient to meet growing traffic demands [14]. Data from previous studies indicate a growing number of fatalities and severe injuries over the years, with certain groups, such as motorcyclists and food delivery riders, being particularly vulnerable due to their high exposure to traffic risks [36]. During the COVID-19 pandemic, fluctuations in traffic patterns resulted in a temporary decline in overall road accidents during lockdown phases, although the severity of accidents increased due to risky driving behaviors [18]. Road accidents are a leading cause of death and injury worldwide, with more than  $1.35 \times 10^6$  fatalities reported annually, making them the eighth leading cause of death worldwide [30]. These trends underscore the persistent need for comprehensive strategies to mitigate road accidents in Malaysia and globally.

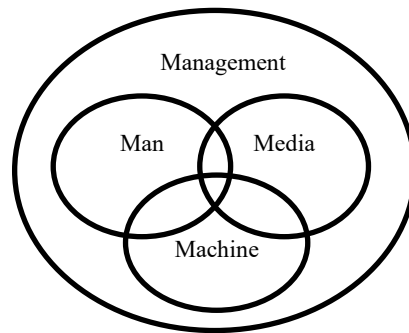
## 2.8 Theoretical Framework

In this research, the Grose multiple causation theory, which is shown in Figure 1, and Kerner's three-phase traffic theory were applied. According to Grose's theory, accidents result from combinations of circumstances involving four elements: man, media, machine, and management

[40]. In this study, man encompasses driving behavior and traffic violations, machine refers to vehicle condition, and media includes road and weather conditions. These elements help identify traits and combinations likely to cause accidents, which are analyzed through statistical and qualitative methods [41].

Kerner's three-phase traffic theory explains traffic behavior transitions among free flow, synchronized flow, and wide moving jams. Free flow is characterized by high-speed movement with minimal vehicle interaction; synchronized flow involves coordinated vehicle movement at higher densities; and wide moving jams occur under severe congestion, with stop-and-go traffic patterns [42]. In this study, Kerner's theory informs the measurement of traffic-related variables by providing a conceptual basis for operationalizing traffic conditions through observable indicators such as traffic density, speed variability, congestion frequency, and stop-and-go occurrences. By linking empirically measurable traffic characteristics to theoretically defined traffic phases, the theory ensures that traffic condition variables are conceptually grounded rather than purely descriptive.

The integration of Grose's multiple causation theory and Kerner's three-phase traffic theory supports the selection and analysis of independent variables and provides a structured theoretical foundation for understanding the multifaceted causes of road accidents.



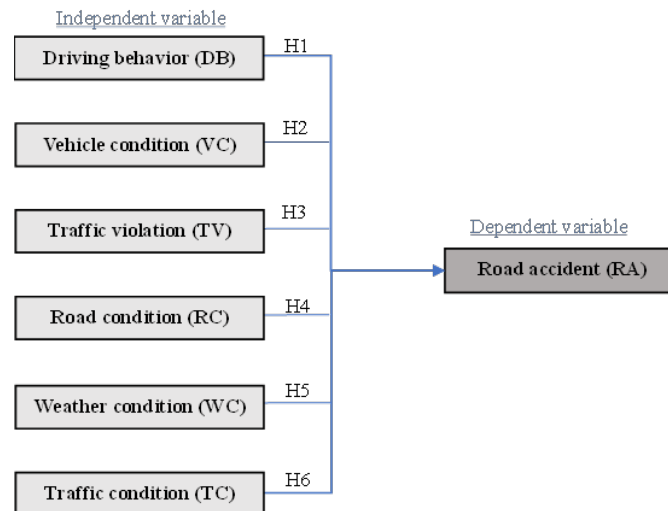
**Figure 1:** Grose multiple causation theory.

### 3. RESEARCH FRAMEWORK AND HYPOTHESES

It is undeniable that road accidents are influenced by a variety of interrelated factors (Figure 2), including driving behavior [21], vehicle condition [23], traffic violation [26], road condition [32], weather condition [30], and traffic condition [12]. This study aims to evaluate the relationships between these factors and road accidents, as well as their impacts on them.

Thus, the following hypotheses are considered:

- H1: Driving behavior has a significant relationship with road accidents.
- H2: Vehicle condition has a significant relationship with road accidents.
- H3: Traffic violations have a significant relationship with road accidents.
- H4: Road condition has a significant relationship with road accidents.
- H5: Weather conditions have a significant relationship with road accidents.
- H6: Traffic conditions have a significant relationship with road accidents.



**Figure 2:** Research framework.

#### 4. METHODOLOGY

This study adopted a quantitative descriptive research design to examine the relationships among driving behavior, vehicle condition, traffic violation, road condition, weather condition, and traffic condition in road accidents in Penang. The research design served as a conceptual framework for data collection, measurement and analysis, ensuring procedural economy and relevance [43]. Descriptive statistics, such as frequency distributions and measures of central tendency and variability, were used to summarize and describe the demographic characteristics and key variables [44, 45]. A descriptive survey strategy was employed, in which questionnaires were used to collect data from respondents and analyze trends, relationships and patterns, providing insights into the phenomena under study [46]. Data were collected during a specific period, with a cross-sectional time horizon of three weeks, targeting 400 licensed drivers in Penang. This approach ensures diverse perspectives and a comprehensive understanding of the factors influencing road accidents [47].

The research was conducted across Penang's five districts in a naturalistic field setting, allowing the collection of authentic data through observation and interaction with drivers in their everyday environments without manipulating any variables [48]. The unit of analysis was individual licensed drivers, with a focus on their behaviors, perceptions, and responses to the questionnaire. Owing to the impracticality of obtaining a complete list of all drivers in Penang, nonprobability convenience sampling was employed, with respondents selected based on their availability at data collection sites. Consequently, the sample may not be fully representative of the population of licensed drivers in Penang, limiting the generalizability of the findings. Only individuals with prior driving experience and a valid private vehicle driving license were included in the study [43]. The target population comprised approximately 1,463,600 drivers in Penang [49], and a sample size of 400 was determined using the formula proposed by [50].

The authors acknowledge the potential for Common Method Variance (CMV) arising from the use of self-reported questionnaire data collected from a single source. To mitigate this concern, several procedural remedies were implemented, including ensuring respondent anonymity, using clear, neutral item wording, and separating constructs into distinct sections of the questionnaire to reduce respondents' tendency to provide consistent responses. In addition, statistical checks were conducted to assess the presence of CMV, and the results indicated that CMV did not pose a serious threat to the validity of the findings.

A structured questionnaire was used as the research instrument, divided into three sections: demographic characteristics, the dependent variable (road accidents), and six independent variables. The instrument uses a 5-point rating scale to measure respondents' agreement or disagreement with statements [51]. A pilot test with 30 respondents was conducted to ensure validity and reliability. Data collection involved administering physical questionnaires to respondents, with each survey taking approximately 10 minutes to complete. All the questions were closed-ended to facilitate straightforward responses.

The data were analyzed via SPSS Version 29.0. Descriptive analysis was used to summarize demographic profiles, correlation analysis to examine relationships between independent variables and road accidents, and regression analysis to identify the effects of these variables on accidents. Cronbach's alpha, which quantifies internal consistency reliability by indicating the extent to which items within a scale are correlated, was used to assess reliability. Pearson's correlation coefficient was employed to evaluate the strength and nature of relationships [52], while stepwise linear regression was used to identify significant predictors and their relative contributions to road accidents [53]. Stepwise regression was selected because it systematically adds or removes variables based on statistical criteria, thereby identifying the most influential factors while reducing multicollinearity and improving model parsimony.

## **5. RESULTS AND DISCUSSION**

This section presents the findings of the data analysis. It begins with the respondents' demographic profile, followed by descriptive statistics, correlation analysis, and multiple regression analysis.

### **5.1 Demographic Characteristics**

The first objective of this study is to profile the sociodemographic characteristics of drivers in Penang. As shown in Table 1, the descriptive analysis of the respondents' demographic profiles reveals several key trends. The majority of respondents were female, with 250 out of 400, accounting for 62.5% of the total. Male respondents accounted for 150, or 37.5%, highlighting a notable gender imbalance. The age distribution of the respondents revealed that the largest group was aged 18-24, comprising 187 respondents (46.8%). In terms of ethnicity, most respondents were Chinese (222, 55.5%), followed by Malay (33%) and Indian (11.5%). Geographically, most respondents were from DTL and SPU, with both accounting for more than half of the respondents (53.8%). Regarding vehicle type, most respondents (208, 52%) reported using cars. Motorcycles were the second-most-common vehicle, with 83 respondents (20.8%). The analysis of vehicle age revealed that the largest group of respondents, 171 individuals (42.8%), owned vehicles aged 1-4 years. Driving experience varied among respondents, with 178 individuals (44.5%) reporting 1-4 years of experience and only 33 (8.3%) reporting less than 1 year. Road accident involvement within the past three years was also analyzed. Nearly half of the respondents (180, or 45%) had been involved in 1-2 road accidents, and only 16 respondents (4%) reported more than six accidents during this period.

**Table 1:** Respondent profile

<b>Demographic variables</b>		<b>Frequency</b>	<b>Percentage (%)</b>
<b>Gender</b>	Male	150	37.5
	Female	250	62.5
<b>Age</b>	18-24	187	46.8
	25-34	84	21.0
	35-44	56	14.0
	45-54	55	13.8
	55 or above	18	4.5
<b>Race</b>	Malay	132	33.0
	Chinese	222	55.5
	Indian	46	11.5
<b>Area</b>	Daerah Seberang Perai Selatan (SPS)	56	14.0
	Daerah Seberang Perai Tengah (SPT)	85	21.3
	Daerah Seberang Perai Utara (SPU)	105	26.3
	Daerah Timur Laut (DTL)	110	27.5
	Daerah Barat Daya (DBD)	44	11.0
<b>Type of vehicle used</b>	Car	208	52.0
	Motorcycle	83	20.8
	Van	40	10.0
	Bus	48	12.0
	Truck	21	5.3
<b>Vehicle Age</b>	Less than 1 year	39	9.8
	1-4 years	171	42.8
	5-9 years	113	28.2
	10-14 years	53	13.3
	15 years above	24	6.0
<b>Driving experience</b>	Less than 1 year	33	8.3
	1-4 years	178	44.5
	5-9 years	74	18.5
	10-14 years	53	13.3
	15 years above	62	15.5
<b>Previous involvement in road accidents within 3 years</b>	Never	78	19.5
	1-2 times	180	45.0
	3-4 times	99	24.8
	5-6 times	27	6.8
	More than 6 times	16	4.0

## 5.2 Descriptive Statistics, Normality Test, and Reliability Analysis

On the basis of Table 2, descriptive analysis was performed on all thirty-four questions on the basis of six independent variables (driving behavior, vehicle condition, traffic violation, road condition, weather condition, traffic condition) and one dependent variable (road accidents). The mean scores for all variables range from 3.15 to 3.69, with standard deviations ranging from 0.686 to 0.894. Among the variables, road accidents had the highest mean score ( $M=3.69$ ,  $SD=0.759$ ), whereas weather conditions had the lowest ( $M=3.15$ ,  $SD=0.686$ ). The results indicate that all the variables play a notable role in influencing road accidents.

The reliability of the data was assessed via Cronbach's alpha. Its value ranges from 0 to 1, with higher values indicating stronger inter-item consistency and suggesting that the items reliably measure the same underlying construct, whereas lower values indicate weak correlations and

poor internal consistency. The Cronbach's alpha values for all variables are above 0.7, indicating reliability [43]. The Cronbach's alpha for weather conditions is 0.829, the highest among the variables, indicating high reliability. The road condition closely follows a value of 0.798. Traffic violations have the lowest reliability score, at 0.709, but it is still within an acceptable range. Overall, these results indicate that all variables exhibit acceptable reliability.

The normality of the data was assessed via skewness and kurtosis values. The skewness values for all variables fell within  $\pm 2$ , indicating that the distributions were symmetric or only slightly skewed. Similarly, the kurtosis values ranged from -2 to 2, suggesting that the data did not exhibit significant deviations from normality [54]. On the basis of these results, the data can be considered to follow an approximately normal distribution, which is suitable for parametric statistical analyses.

**Table 2:** Descriptive analysis, reliability test and normality test

Variables	No. of items	Mean (M)	Standard deviation (SD)	Skewness	Kurtosis	Cronbach's Alpha
DB	6	3.18	0.894	-0.188	-0.704	0.769
VC	4	3.22	0.838	-0.227	-0.637	0.724
TV	6	3.22	0.732	-0.295	-0.490	0.709
RC	5	3.49	0.783	-0.325	-0.296	0.798
WC	5	3.15	0.686	-0.161	-0.355	0.829
TC	4	3.56	0.892	-0.194	-0.104	0.750
RA	4	3.69	0.759	-0.170	-0.743	0.722

Note: RA, DB, VC, TV, RC, WC, and TC are as defined in Figure 2.

### 5.3 Correlation Analysis

Table 3 shows that the correlation analysis indicated that all the variables had significant relationships with the dependent variable, with varying degrees of strength. The correlation analysis indicated that traffic conditions had the strongest positive correlation with road accidents ( $r=0.588$ ), within the range of 0.50–0.99. Traffic conditions exhibited stronger, more meaningful relationships with road accidents. Moderate correlations were observed between road condition and road accidents, with correlation coefficients of  $r=0.499$ , which fell within the range of 0.30–0.49. The correlation study findings further indicated that weather conditions, driving behavior, vehicle condition, and traffic violations were weakly correlated with road accidents, with correlations ranging from 0.10 to 0.29. The findings revealed that traffic violations ( $r=0.122$ ), driving behavior ( $r=0.249$ ), vehicle condition ( $r=0.195$ ), and weather condition ( $r=0.284$ ) showed weak, positive relationships with road accidents. These findings addressed the second objective, which was to determine the relationships among driving behavior, vehicle condition, traffic violation, road condition, weather condition, and traffic condition in road accidents. The results also showed that, while all variables were significant, their influence on the dependent variable varied in strength, from weak to strong.

**Table 3:** Correlation matrix.

Variables	RA	DB	VC	TV	RC	WC	TC
<b>RA</b>	1.000						
<b>DB</b>	0.249	1.000					
<b>VC</b>	0.195	0.661	1.000				
<b>TV</b>	0.122	0.593	0.481	1.000			
<b>RC</b>	0.499	0.184	0.220	0.162	1.000		
<b>WC</b>	0.284	0.516	0.392	0.433	0.284	1.000	
<b>TC</b>	0.588	0.306	0.264	0.260	0.531	0.365	1.000

Notes: RA, DB, VC, TV, RC, WC, and TC as defined in Figure 2; the correlation is significant at the 0.05 level (2-tailed).

#### 5.4 Multiple linear regression analysis

On the basis of the model summary in Table 4, the R-squared value of 0.409 implies that the six independent variables explain approximately 40.9% of the accidents, implying that this is a good and respectable model. The F statistic in the ANOVA table is significant ( $p < 0.001$ ), confirming the overall model’s validity and indicating a linear relationship between the independent variables and road accidents.

**Table 4:** Model summary.

Model Summary <sup>b</sup>									
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	Change Statistics			
						F Change	df1	df2	Sig. F Change
1	.640 <sup>a</sup>	.409	.400	.58781	.409	45.338	6	393	<.001

a. Predictors: (Constant), TC, TV, VC, WC, RC, DB

b. Dependent Variable: RA

The ANOVA results in Table 5 indicated that the F statistic of 45.338 was significant, supporting the regression model’s ability to predict road accidents ( $p < 0.001$ ). This demonstrated that the independent variables collectively had a meaningful and statistically significant effect on the dependent variable. These findings validated the model’s reliability in understanding the factors influencing road accidents, providing a robust foundation for further analysis and interventions. Additionally, the slope of the estimated linear regression line was not equal to zero, confirming a linear relationship between road accidents and the following six independent variables.

**Table 5:** ANOVA (Analysis of variance).

ANOVA <sup>a</sup>						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	93.991	6	15.665	45.338	<.001 <sup>b</sup>
	Residual	135.789	393	.346		
	Total	229.780	399			

a. Dependent Variable: RA

b. Predictors: (Constant), TC, TV, VC, WC, RC, DB

On the basis of the coefficients in Table 6, four independent variables, i.e., driving behavior ( $p=0.028$ ), traffic violation ( $p=0.018$ ), road condition ( $p<0.001$ ), and traffic condition ( $p<0.001$ ), were found to be significant ( $p<0.05$ ) in explaining road accidents. Among these factors, traffic condition exhibited the strongest positive association ( $\beta=0.431$ ), followed by road condition ( $\beta=0.257$ ) and driving behavior ( $\beta=0.131$ ). Traffic violation exhibited a significant negative association ( $\beta=-0.118$ ), indicating an inverse relationship within the perception-based model rather than a reduction in actual accident occurrence. Note that these findings reflect statistical associations based on subjective assessments and should not be interpreted as causal. Vehicle condition and weather condition were not significant predictors, as their  $p$ -values exceeded 0.05. The results of the multiple linear regression analysis address objective 3, examining how the six independent variables influence road accidents. The findings revealed that these variables collectively explained 40.9% of the variance in road accidents, indicating a moderately strong model fit. The significant  $F$  statistic confirmed the model's validity, suggesting that the predictors are meaningfully associated with the dependent variable.

**Table 6:** Coefficients of multiple regression analysis.

Hypothesis Path	Standardized Coefficients Beta	P value	Result
TC → RA	0.431	< 0.001	Supported
RC → RA	0.257	< 0.001	Supported
DB → RA	0.131	0.028	Supported
TV → RA	-0.118	0.018	Supported
WC → RA	0.046	0.334	Not supported
VC → RA	-0.024	0.653	Not supported

Note: RA, DB, VC, TV, RC, WC, and TC are as defined in Figure 2.

H1: Driving behavior has a significant relationship with road accidents.

The first hypothesis (H1) evaluated the significant relationship between driving behavior and road accidents. Driving behavior was found to have a significant positive effect on road accidents ( $p=0.028$ ), with a beta coefficient indicating a moderate contribution to the model. [20, 21] identified behaviors such as speeding, improper overtaking, disobeying traffic signals and other risky or negligent driving practices as major contributors to accidents, reinforcing the hypothesis that increases in such behaviors directly impact accident rates, which aligns closely with the observed positive correlation. [15] emphasized distracted driving, particularly mobile phone use, as a significant factor disrupting driving behavior and increasing collision risk, whereas [17] highlighted fatigue and drowsiness as critical behavioral factors contributing to road accidents. These findings underscore the need for targeted interventions related to driver behavior, including awareness campaigns, stricter traffic law enforcement, and the promotion of safer driving habits to effectively mitigate accident rates.

The second hypothesis (H2) evaluated the significant relationship between vehicle condition and road accidents. Vehicle condition was not a significant predictor ( $p=0.653$ ), suggesting that vehicle condition did not substantially influence the occurrence of road accidents in this study. This finding may indicate that vehicle maintenance standards among respondents were relatively uniform, minimizing variability in their impact. Previous studies often highlight vehicle condition

as a secondary factor when driver-related issues or road conditions are more critical. When vehicle faults are noted, factors such as infrastructure quality and human negligence are more critical in predicting accidents [1, 24]. Elias et al. [23] also noted that financial constraints that indirectly affect maintenance increase risks, but these risks are mediated by broader environmental and behavioral factors. [22] emphasized that the impact of vehicle condition is often overshadowed by more dynamic variables such as traffic flow and road quality. While vehicle condition plays a role in road safety, its importance is generally secondary or context-specific, emphasizing the need to focus on broader systemic issues to effectively reduce the number of road accidents.

The third hypothesis (H3) evaluated the significant relationship between traffic violations and road accidents. Traffic violations were significant ( $p=0.018$ ) but had a negative beta coefficient, indicating an inverse relationship with road accidents. This could be interpreted as stricter enforcement of traffic laws, leading to reduced accidents. This finding further validates that traffic violations, such as driving without a valid license and failing to obey traffic signals, significantly increase the frequency and severity of road accidents [26, 27]. Drivers with suspended or no licenses are particularly at high risk, emphasizing the critical need for strict enforcement to increase road safety.

The fourth hypothesis (H4) evaluated the significant relationship between road condition and road accidents. Road condition was found to have a significant positive effect on road accidents ( $p<0.001$ ). The analysis revealed that poor road conditions are positively associated with a higher frequency of road accidents. Consistent with these findings, Oltaye et al. [19] highlighted that nonasphalted roads are particularly associated with motorcycle accidents. Other studies have demonstrated that the type of road and the number of vehicles involved directly and significantly influence the severity of injuries sustained by drivers in road accidents [30, 32]. In addition, drivers' unfamiliarity with road conditions, especially in relation to the frequency of driving specific routes, has been identified as a significant cause of accidents [29]. Zahidy et al. [31] further emphasized the role of RSQ and reported a strong positive relationship between RSQ and road accidents.

The fifth hypothesis (H5) evaluated the significant relationship between weather conditions and road accidents. Weather condition was not a significant predictor ( $p=0.334$ ), suggesting that weather condition did not substantially influence the occurrence of road accidents in this study. Although adverse weather conditions can contribute to road accidents, they may not be the primary factors that contribute to road accidents in Malaysia. A recent study reported that while various factors contribute to an increased risk of road accidents and fatalities, the major contributor is unsafe road behavior, such as driving dangerously, disregarding road signs and signals, driving while tired or sleepy, and exceeding the speed limit [11], rather than weather conditions. Rainfall is a common weather parameter that has been frequently considered in previous studies, and some findings report that rainfall is generally associated with an increased number of Road Traffic Injuries (RTIs) [55]. It is often assumed to increase RTIs because of factors such as reduced road friction, difficulty in vehicle handling, and restricted visibility [56]. However, a study by [57] reported no significant association between rainfall and RTIs. This discrepancy may stem from several factors, such as drivers exercising greater caution by reducing speed and maintaining safe distances during rain; rainy weather might reduce pedestrian and traffic activity, as more people opt for public transport or stay home; and in some regions where the plum rain season occurs regularly, locals may have adapted to driving condition, mitigating the impact of rainfall on RTIs [57]. These findings suggest that while adverse weather can pose challenges to drivers, it may not be a predominant factor in the occurrence of road accidents.

The sixth hypothesis (H6) evaluated the significant relationship between traffic conditions and road accidents. Traffic conditions were found to have a significant effect on road accidents, indicating the strongest positive contribution to the model in this study. The analysis revealed

that poor traffic conditions significantly increase the likelihood of road accidents. This finding aligns with those of several prior studies. A study by [38] demonstrated a clear correlation between the number of automobiles on roads and accident frequency, noting that the pattern of accidents closely mirrors the 24-hour pattern of traffic density. Ahmed et al. [32] further established that variations in traffic density and road categories significantly affect accident rates and severity. Urban roads, particularly during high-traffic weekends, were found to have higher fatality rates, underscoring the critical role of traffic density in accident outcomes [32]. Another study by [12] on the effects of climate and festivals on road accidents in Penang found that road accidents are more prevalent during festival celebrations, particularly those tied to religious activities, as traffic surges when people travel to visit their hometowns and families. Supramaniam et al. [18] noted the reduction in accidents during early COVID-19 pandemic lockdowns, highlighting how the distinct and infrequently noted influences of drastic reductions in traffic volume and travel restrictions can profoundly influence road safety.

## 6. CONCLUSION

In alignment with Objective 1, this study profiled the sociodemographic characteristics of drivers in Penang. The respondents were licensed drivers from various areas of the state, and data were collected via convenience sampling. The findings revealed that most drivers were female, predominantly young adults of Chinese ethnicity. Most respondents resided in urban areas and primarily used cars, with many owning relatively new vehicles. Driving experience varied, with a significant proportion reporting moderate levels of experience. These insights enhance understanding of driver characteristics in Penang and their potential influence on road safety. By analyzing these factors, the study helps identify key areas for targeted interventions and provides a foundation for strategies to improve road safety in the state.

The findings of this study address Objective 2, which aimed to determine the relationships between independent variables and road accidents. The results revealed that all variables are significantly related to road accidents, indicating that road safety is influenced by a combination of individual behaviors and external conditions, with traffic and road conditions playing more substantial roles. Traffic conditions were found to have the strongest positive correlation with road accidents, followed by road condition, weather condition, driving behavior, vehicle condition, and traffic violations. These findings underscore the importance of targeted measures, such as addressing traffic conditions and improving road infrastructure, alongside initiatives to enhance driver behavior and vehicle maintenance, to effectively reduce road accidents in Penang.

The findings also address Objective 3, which aimed to examine the impacts of independent variables on road accidents. The analysis demonstrated that the model reliably explained road accidents, confirming a significant linear relationship between the independent variables and accident risk. Among the variables, traffic condition was identified as the most influential factor, with road condition and driving behavior also contributing positively, while traffic violation had a slight negative impact. In contrast, vehicle and weather conditions were not significant contributors, likely due to well-maintained road infrastructure, effective vehicle roadworthiness enforcement, and drivers' familiarity with local weather conditions. As the analysis is perception-based, respondents appear to emphasize immediate factors such as traffic conditions, road quality, and driving behavior, leading to perceived accident risk being shaped more by traffic dynamics and human factors than by vehicle or weather conditions.

The findings of this study have significant implications for improving road safety in Penang. By identifying key demographic groups and factors influencing road accidents, this study provides a basis for developing targeted policies and interventions. Policymakers can design customized awareness campaigns and training programs to address driving behavior and traffic violations, particularly among high-risk groups. The significant influence of road and traffic conditions on

accidents underscores the need for infrastructure improvements, such as better road maintenance, enhanced traffic management systems, and safer urban road networks. While vehicle condition has a limited impact, promoting regular maintenance and vehicle checks can indirectly enhance safety. The data-driven insights from this study enable authorities to prioritize interventions, allocate resources effectively, and assess the outcomes of safety measures.

To effectively reduce road accidents in Penang, it is essential to implement stricter traffic regulations, optimize traffic management, and enhance public awareness campaigns focused on traffic-related issues. Since traffic conditions were identified as the most significant contributor to road accidents, these measures can help create a safer and more efficient road environment. Future studies could expand the geographical scope beyond Penang to provide a more comprehensive understanding of the factors influencing road accidents across Malaysia.

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## REFERENCES

- [1] Mohd Azami, M. F. A., Misro, M. Y., & Hamidun, R. Road crash dynamics in Malaysia: analysis of trends and patterns. *Heliyon*, vol 10, issue 18 (2024) p. e37457.
- [2] World Health Organization. Road traffic injuries. (2023) Available at: <https://www.who.int/news-room/fact-sheets/detail/road-traffic-injuries>
- [3] Ministry of Transport Malaysia. Malaysia road fatalities index. (2024) Available at: <https://www.mot.gov.my/en/land/safety/malaysia-road-fatalities-index>
- [4] Alexander, W. Malaysia recorded one road accident per minute in 2022. (2023) Available at: <https://soyacincau.com/2023/06/15/malaysia-records-one-road-accident-per-minute-in-2022/#:~:text=In%202022%20alone%2C%20there%20were,one%20death%20every%2086%20minutes>
- [5] Awani International. Reducing traffic accidents and deaths: Addressing human, environmental and vehicle factors. (2024) Available at: <https://international.astroawani.com/malaysia-news/columnist-reducing-traffic-accidents-and-deaths-addressing-human-environmental-and-vehicle-factors-460137>
- [6] Kader, M. A. War on the roads killed people. (2024) Available at: <https://consumer.org.my/cap-war-on-the-roads-killed-people/>
- [7] Ministry of Transport Malaysia. Malaysia road safety plan 2022-2030. (2022) Available at: <https://www.mot.gov.my/en/land/safety/road-safety-plan-2021-2030>
- [8] FocusEconomics. Malaysia GDP. (2024) Available at: <https://www.focus-economics.com/country-indicator/malaysia/gdp/>
- [9] Bernama. Penang's GDP grows 3% to RM116bil in 2023. (2024) Available at: <https://www.freemalaysiatoday.com/category/business/2024/08/05/penangs-gdp-grows-3-to-rm116bil-in-2023/>
- [10] Negin, V. Penang's progress towards the development sustainable goals by 2030. (2024) Available at: <https://penanginstitute.org/publications/monographs/penangs-progress-towards-the-sustainable-development-goals-by-2030/>
- [11] Bernama. Unsafe road behaviour still primary cause of road crashes: expert. (2024) Available at: <https://www.nst.com.my/news-cars-bikes-trucks/2024/04/1034586/unsafe-road-behaviour-still-primary-cause-road-crashes->



- [30] Febres, J. D., García-Herrero, S., Herrera, S., Gutiérrez, J. M., López-García, J. R., & Mariscal, M. A. Influence of seat-belt use on the severity of injury in traffic accidents. *European Transport Research Review*, vol 12, issue 9 (2020).
- [31] Zahidy, A. A., Sutanto, M. H., & Sorooshian, S. Examining the relationship between road service quality and road traffic accidents: a case study on an expressway in Malaysia. *Traffic Safety Research*, vol 8, (2024) p. e000056.
- [32] Ahmed, S., Hossain, M. A., Ray, S. K., Bhuiyan, M. M. I., & Sabuj, S. R. A study on road accident prediction and contributing factors using explainable machine learning models: analysis and performance. *Transportation Research Interdisciplinary Perspectives*, vol 19, (2023) p. 100814.
- [33] Masron, T., Yaakub, N. F., Hussin, W. M. T. W., Yusuf, A., & Perumal, C. Spatial analysis on causes of fatal road accidents in black spot area: a case study in the northeast district of Penang, Malaysia. *Malaysian Journal of Tropical Geography*, vol 46, issue 1-2 (2020) pp. 1-16.
- [34] Chen, F., & Chen, S. Injury severities of truck drivers in single- and multi-vehicle accidents on rural highways. *Accident Analysis and Prevention*, vol 43, issue 5 (2011) pp. 1677-1688.
- [35] Malim, M. R., Abdul Halim, F., & Abd Rahman, S. S. Optimising traffic flow at a signalized intersection using simulation. *Malaysian Journal of Computing*, vol 4, issue 2 (2019) p. 261.
- [36] Ghani, A. R. A., Malek, A. A. I., Yusoff, W. A. A. Z. W. M., Taujuddin, N. S. A. M., & Ambak, K. Road crashes among food delivery riders (P-Hailing) during pandemic in Kuala Lumpur. in *Proceedings of AWAM International Conference on Civil Engineering*, vol 3, (2022) pp. 309-320.
- [37] Abdul Manan, M. M., Várhelyi, A., Çelik, A. K., & Hashim, H. H. Road characteristics and environment factors associated with motorcycle fatal crashes in Malaysia. *IATSS Research*, vol 42, issue 4 (2018) 207-220.
- [38] Åkerstedt, T., Kecklund, G., & Hörte, L. G. Night driving, season, and the risk of highway accidents. *Sleep*, vol 24, issue 4 (2001) p. 401-406.
- [39] Saifullizan, M. B., Nur, A. F. M. F., Nazirah, M. A., & Anuar, M. S. Analysis of severity level types and trends in road accident cases at Johor Inter State Road using Analytical Hierarchy Process (AHP) and geographical information system. *International Journal of Integrated Engineering*, vol 14, issue 9 (2022) pp. 66-73.
- [40] Brauer, R. L. *Safety and Health for Engineers* (2nd ed.). John Wiley & Sons, Inc (2006).
- [41] Friend, M. A., & Kohn, J. P. *Fundamentals of occupational safety and health*. In *Electrons, Neutrons and Protons in Engineering* (4th ed). Government Institutes, an imprint of The Scarecrow Press (2007).
- [42] Kerner, B. S. Three-phase traffic theory and highway capacity. *Physica A: Statistical Mechanics and Its Applications*, vol 333, issue 1-4 (2004) pp. 379-440.
- [43] Kothari, C. R. *Research Methodology: Methods and Techniques*. New Age International (2004).
- [44] Feroze, K., & Kulkarni, V. Types of variables, descriptive statistics, and sample size abstract. *Indian Dermatology Online Journal*, vol 10, issue 1 (2019) pp. 82-86.
- [45] Fulk, G. Descriptive statistics, an important first step. *Journal of Neurologic Physical Therapy*, vol 47, issue 2 (2023) p. 63.
- [46] Duevel, C. *SAGE research methods*. *Annual Reviews*, vol 19, issue 4 (2028) pp. 38-41.
- [47] Wang, X., & Cheng, Z. Cross-sectional studies: strengths, weaknesses, and recommendations. *Chest*, vol 158, issue 1 (2020) pp. S65-S71.
- [48] VisitSelangor. Map of Penang State. (2021) Available at: [https://www.visitselangor.com/information/malaysia-maps/map-of-penang-state/#google\\_vignette](https://www.visitselangor.com/information/malaysia-maps/map-of-penang-state/#google_vignette)
- [49] Penang Institute. Penang: population and demographics. (2024) Available at: <https://statistics.penanginstitute.org/dashboards/social/pop.html>
- [50] Krejcie, R. V., & Morgan, D. W. Determining sample size for research activities. *Educational and Psychological Measurement*, vol 30, (1970) pp. 607-610.

- [51] Joshi, A., Kale, S., Chandel, S., & Pal, D. Likert scale: explored and explained. *British Journal of Applied Science & Technology*, vol 7, issue 4 (2015) pp. 396–403.
- [52] Cohen, J. A power primer. *Psychological Bulletin*, vol 112, issue 1 (1992) pp. 155–159.
- [53] Guetterman, T. C. Basics of statistics for primary care research. *Family Medicine and Community Health*, vol 7, issue 2 (2019) pp. 11–17.
- [54] George, D., & Mallery, P. *IBM SPSS Statistics 23 Step by Step*. New York: Routledge, (2016).
- [55] Theofilatos, A., & Yannis, G. A review of the effect of traffic and weather characteristics on road safety. *Accident Analysis and Prevention*, vol 72, (2014) pp. 244-256.
- [56] Lio, C. F., Cheong, H. H., Un, C. H., Lo, I. L., & Tsai, S. Y. The association between meteorological variables and road traffic injuries: A study from Macao. *PeerJ*, vol 2019, issue 2 (2019) pp. 1–13.
- [57] Gao, J., Chen, X., Woodward, A., Liu, X., Wu, H., Lu, Y., Li, L., & Liu, Q. The association between meteorological factors and road traffic injuries: A case analysis from Shantou city, China. *Scientific Reports*, vol 6, issue 22 (2016) pp. 1–10.

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## Appendix: Questionnaire



### **SURVEY QUESTIONNAIRE ON ANALYSIS OF FACTORS CONTRIBUTING TO ROAD ACCIDENTS IN PENANG, MALAYSIA**

Dear Respondent.

Thank you for agreeing to participate in our research study titled “Analysis of Factors Contributing to Road Accidents in Penang, Malaysia”.

This research aims to examine how various factors, such as driving behavior, vehicle condition, traffic violation, road condition, weather condition and traffic condition influence the road accident in Penang. I’m pleased to invite you to participate in this survey. This questionnaire prepared in three sections (A, B, and C), and will take approximately 5-10 minutes to complete.

This questionnaire aims to collect important insights from your perspective. Your responses will remain confidential and will be used exclusively for academic research. We kindly ask that you answer all questions truthfully and thoughtfully.

Your participation is crucial for the success of our research and we greatly appreciate your involvement.

**Section A – Demographic data:** respondents' profile. Please answer the following by crossing (/) one box only.

## 1. Gender

1	Male	
2	Female	

## 2. Age

1	18-24	
2	25-34	
3	35-44	
4	45-54	
5	55 or above	

## 3. Race

1	Malay	
2	Chinese	
3	Indian	
4	Others	

## 4. Area

1	Daerah Seberang Perai Selatan (SPS)	
2	Daerah Seberang Perai Tengah (SPT)	
3	Daerah Seberang Perai Utara (SPU)	
4	Daerah Timur Laut (DTL)	
5	Daerah Barat Daya (DBD)	

## 5. Type of vehicle used

1	Car	
2	Motorcycle	
3	Van	
4	Bus	
5	Truck	

## 6. Driving experience

1	Less than 1 year	
2	1-2 years	
3	5-9 years	
4	10-14 years	
5	15 years above	

## 7. Previous involvement in road accident between 3 years

1	Never	
2	1-2 times	
3	3-4 times	
4	5-6 times	
5	More than 6 times	

**Section B: Road accidents in Penang, Malaysia.**

You're required to use the following scale to respond to the statement.

1 <b>Strongly Disagree (SD)</b>	2 <b>Disagree (D)</b>	3 <b>Neither Agree nor Disagree (N)</b>	4 <b>Agree (A)</b>	5 <b>Strongly Agree (SA)</b>
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**(i) Road accident**

No.	Questions	1	2	3	4	5
RA1	I feel that road accidents are a frequent problem in Penang.					
RA2	I often notice that road accidents repeatedly occur at the same locations.					
RA3	I feel that driving in Penang is dangerous.					
RA4	I often feel unsafe when other vehicles are surrounding my vehicle.					

**Section C: Factors contributing to road accidents in Penang, Malaysia.** You're required to use the following scale to respond to the statement.

1 <b>Strongly Disagree (SD)</b>	2 <b>Disagree (D)</b>	3 <b>Neither Agree nor Disagree (N)</b>	4 <b>Agree (A)</b>	5 <b>Strongly Agree (SA)</b>
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**(ii) Driving behavior**

No.	Questions	1	2	3	4	5
DB1	I often drive at a high speed.					
DB2	I often use mobile phone while driving.					
DB3	I often drive even I feel drowsy or fatigue.					
DB4	I often drive without keeping a safe distance from other vehicles.					
DB5	I often forget to use my turn signals while driving.					
DB6	I often overtake other vehicles while driving.					

**(iii) Vehicle condition**

No.	Questions	1	2	3	4	5
VC1	I often use second-hand spare parts for my vehicle.					
VC2	I rarely notice when my vehicle's indicators or signals aren't working.					
VC3	I rarely perform routine maintenance or service on my vehicle include long distance driving.					
VC4	I believe that old or poorly maintained vehicles are riskier to drive.					

**(iv) Traffic violation**

No.	Questions	1	2	3	4	5
TV1	I often speed up when the traffic light is about to turn orange or red.					
TV2	I often double park or illegal park.					
TV3	I often drive after taking alcohol, drugs, medicines or other inhibitory substances.					
TV4	I often ignore road signs and pavement markings while driving.					
TV5	I often drive with excess weight or more passengers than permitted.					
TV6	I had been driving without a valid license or with an expired license.					

**(v) Road condition**

No.	Questions	1	2	3	4	5
RC1	I often encounter road lighting deficiencies.					
RC2	I often encounter poorly maintained road signs and markings.					
RC3	I often encounter rough road surfaces and potholes in my area.					
RC4	I often encounter narrow roads in rural and urban areas contributes to accident frequency.					
RC5	I often encounter steep slopes and sharp curves road in hilly areas.					

**(vi) Weather condition**

No.	Questions	1	2	3	4	5
WC1	I often drive my vehicle at excessive speeds in adverse weather conditions.					
WC2	I often encounter reduced visibility while driving in heavy rain.					
WC3	I often come across flooded roads while driving.					
WC4	I often struggle to maintain control of my vehicle due to strong winds while driving.					
WC5	I feel impatient or aggressive when the temperature is high.					

**(vii) Traffic condition**

No.	Questions	1	2	3	4	5
TC1	I often encounter more accident during festival seasons and holiday.					
TC2	I feel that driving in the early morning or late at night is more dangerous.					
TC3	I encounter more aggressive driving behaviors during peak hours.					
TC4	I feel impatient when dealing with congestion.					