Understanding Attitudes and Perceptions of Motorcyclists and Car drivers Towards Traffic Safety: A Case Study of Hanoi, Vietnam

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Abstract:

This research delves into the awareness of traffic safety among motorcyclists and drivers in Hanoi using the data collected by a questionnaire survey. Through Principal Component Analysis (PCA), five key components were identified: ***non-compliance with traffic regulations***, ***aggressive driving behaviour***, ***traffic signal issues***, ***road quality and infrastructure***, and ***preventive measures***. Using Multiple Correspondence Analysis (MCA) and Two-Step Cluster Analysis (TCA), three distinct clusters emerged based on socio-demographic factors: ***young adults in employment riding motorcycles***, ***young adults in education riding motorcycles***, and ***mature adults in employment driving cars***. The Multinomial Logistic Regression (MLR) analysis revealed that while young adults in education riding motorcycles and mature adults driving cars do not view aggressive driving as a significant issue, they do recognise the risks associated with ignoring traffic signals. Additionally, mature adults driving cars perceive poor infrastructure quality as a safety concern. The study highlights critical gaps in public awareness that could be addressed to enhance road safety.

Keywords: *Keywords*: Road Safety, Transport User Perceptions, Principal Component Analysis, Cluster Analysis, Multinomial Logistic Regression

1. INTRODUCTION

With population growth, transportation systems continue to evolve to meet the increasing travel demands of people. Although transportation brings economic and social benefits, road safety remains a world challenge because, as reported in WHO (2015), approximately 1.3 million people die and 50 million are permanently disabled each year because of road traffic accidents. The causes of motorised vehicle accidents are complex but largely depend on the

characteristics of drivers, for example, inexperience (McCartt *et al*., 2003), drinking alcohol (Nishitani, 2019), speed limit (Kanitpong, 2013) or risk-taking behaviour (Rolison *et al*., 2014). Previous research suggested that driver behaviour is a contributory factor in more than 90% of crashes (Petridou and Moustaki, 2000). This can be because humans are almost inadvertently prone to making mistakes and commit violations.

In recent decades, a rapid growth rate was witnessed for the development of motorization in Southeast Asian countries such as Indonesia, Vietnam and Thailand. According to Vietnam's National Traffic Safety Committee, an estimated 30–35 people die daily in traffic accidents (Nguyen, 2024). In South-East Asia, the group of riders or motorized two-three wheelers accounted for the highest proportion of death among other vulnerable road users at 43%, while the percentage of 4-wheeled vehicles was 16%. Thus, the proportion of motorized vehicle users is 59% in total, which can be considered as the highest number in comparison to this in other regions. Furthermore, WHO (2018) also stated that more than 90% of road traffic deaths occur in low- and middle-income countries.

The human factor is the most significant contributor to traffic collisions, alongside other factors such as vehicle-related and environmental factors. (Haddon, 1980; Zhang *et al.*, 2013). Human factors include many components, but the one found to be largely effective is road users' behaviour (Nguyen, 2024). Research on road users' behaviour is essential for identifying effective solutions to reduce road collisions. Understanding the factors influencing people's perceptions of road safety is crucial for assessing their awareness of traffic safety. This, in turn, enables the development of targeted recommendations to address each factor and improve road users' safety.

The purpose of this research is to identify transport users' awareness of road safety issues in Hanoi, the capital city of Vietnam, with more attention to the motorization user group. The objectives of the study are listed as follows:

1. To identify key human factors influencing road safety through a comprehensive literature review, develop a well-structured questionnaire, and gather data on transport users' attitudes and perceptions towards traffic safety in Hanoi, Vietnam.
2. To perform detailed analysis to explore underlying patterns and insights into transport users' perceptions and awareness related to traffic safety.
3. To highlight priority issues for future policies that can effectively enhance transport users' safety in Hanoi, Vietnam.

Using Hanoi, the capital city of Vietnam, as a case study, this research aims to provide insights into road users' behaviour and awareness of traffic safety. The findings are expected to enhance understanding not only of road user behaviour in Vietnam but also in other developing countries, particularly regarding public awareness of traffic safety norms.

2. LITERATURE REVIEW

The Asian Development Bank (ADB) and Association of Southeast Asian Nations (ASEAN) member countries have expressed great concern towards the severe lack of road safety in the ASEAN region, mostly developing countries, and its detrimental impacts on the development of the society (Asian Development Bank, 2012). Vietnam, the case study of this research, locating in the South-East Asia, a member of ASEAN, is a country in a group of low-income to middle-income countries, also developing countries according to global statistics (2017). Each year, there are approximately 14 000 fatalities, mostly of people who are from 25 to 49 years old, due to road traffic accidents. Additionally, the leading cause of these deaths was motorcyclists, with approximately 59%. A significant concern is also rising towards Vietnamese traffic law and enforcement (WHO, 2018). Even in recent years, while the

Government has put much emphasis on traffic accidents, the number of the accidents remains high and keeps growing. Having said that, in developing countries, without surprise, motorcycles are also the dominating vehicles on every street (Worley, 2006). Also, motorcyclists are at high risk in traffic crashes, particularly for head injury (Liu *et al*., 2003).

2.1 Factors influencing Road safety

Because of the crucial role of road safety and gaps in research, factors influencing road safety are focused on this study and a summary of previous literature is presented in Table 1.

Table 1: Summary table of research and factors have been found

Title of the research	Authors	Influencing variables & findings
Environmental condition		
Road geometry-related crash distribution, economic losses, and an alternative severity level analysis	Jima & Sipos (2025)	The quality of the road pavement, and reducing the speed below the design limit will bring safer traffic movement
Road infrastructure		
The characteristics of road crashes on Indonesian national roads based on integrated road safety management system data	Tanan, *et.al.* (2025)	Accident types and road characteristics
Identifying the roadway infrastructure factors affecting road accidents using interpretable machine learning and data augmentation	Lee, *et al*. (2025)	Establish guidelines for minimum lane and shoulder width standards, especially on high-traffic routes
Cyclist casualty severity at roundabouts with attention to geometric characteristics using logistic regression methods	Akgun *et al.* (2018)	speed limit, sociodemographic, and meteorological conditions, geometric design parameters and their influence on roundabout safety
Urban Arterial Lane Width Versus Speed and Crash Rates	Azin, *et.al.* (2025)	Narrower lane widths as a strategy to improve road safety for arterials in highly urbanized areas
Analysing Pedestrian Perceptions towards Traffic Safety Using Discrete Choice Models	Wedagama *et al.* (2020)	Reckless or careless driving/riding contributed significantly to pedestrian accidents; junctions and pedestrian crossings were perceived to be dangerous for pedestrians
Road user's behaviour		
A comparative study of road traffic violation between Thai and Japanese teenagers	Katanararoj, *et.al.* (2024)	bicycle/motorcycle stunt, instrumental attitude, , traffic errors, and descriptive norm, were significant affecting violation behaviour
Characteristics and severity of motorcycle crashes resulting in hospitalization in Ho Chi Minh City, Vietnam	Doan and Hobday (2019)	Being unlicensed and crashing at night were associated with higher injury severity among hospitalised motorcyclists.
Risks of speeding behaviour by investigating the dynamics of driver injury severity	Islam, *et.al.* (2024)	The significance of driving behaviour and roadway design to speeding behaviour
Social characteristics		
Nonlinear analysis of the effects of socioeconomic, demographic, and technological factors on the number of fatal traffic accidents	Sohaee & Bohluli (2024)	Alcohol consumption, unemployment rate, minimum wage, and vehicle miles travelled (VMT), among others, have a substantial impact on the frequency of fatal accident rates.
Unveiling the road to safety: Understanding the factors influencing motorcycle accidents among riders in rural Chiang Mai, Thailand	Panumasvivat, *et al.* (2024)	drunk-driving and traffic laws as well as motorcycle rider education and safety training are needed to encourage responsible riding.

2.2 Motorcycles' behaviour in developing countries

As shown by the statistics, the developing countries are dominated by motorcycles, which is supposed to be the main cause of traffic collisions in those regions. There are many complicated causes of the occurrence of motorcycle accidents (Yen *et al.,* 1999). Riders' balance loss in the travel process, small size of the vehicle leading to higher possibilities of being hit by others in the road (Masuri *et al*., 2012). By examining the parameters, the study on the factors influencing motorcyclist's speed on Malaysian roads revealed that motorcyclist's characteristics and riding behaviours are the most two pivotal factors (Manan *et al.,* 2017). On the global scale, the usage of the helmet during road travel may aid to lessen the injuries and death, up to 72%, according to Liu *et al.* (2003) empirical findings. Hongsranagon (2011), on investigating the traffic risk behaviours of motorcyclists in Thailand, noted that one of the responsibilities of traffic risk perception was to use the helmet in a precise way.

With regards to motorcycle helmet usage in Vietnam, Hung *et al*. (2008) argued that there are many factors linked with the usage of helmets, such as the law of helmet usage officially being put in the legislation or the outside weather conditions which may impact the riders' willingness to wear the helmets. Interestingly, this research found out that although up to 95% riders using motorcycles, on the survey, agreed that wearing helmets could help lower the chances of suffering from severe injuries, they still thought that it is undesired to wear them in a short trip. The same authors, hence, bring to conclusion that it is imperative for government to make the helmet wearing mandatory during road travel and put further emphasis on the education to lessen the negative attitudes towards helmet usage, especially in the conditions of uncomfortable weather. Vietnamese researchers (Trinh and Le, 2010) discovered that either the motorcycle riders wear the low-quality helmet or wear the helmet in the wrong way, reducing its effectiveness in protecting the wearers' heads.

Awareness campaigns to address this issue are often voluntary initiatives led by social organizations rather than mandatory measures enforced by law. To better understand road users' behaviour, Hoekstra and Wegman (2011) highlights the importance of incorporating insights from other disciplines, such as social psychology and economics, for more effective outcomes. He also stresses the critical role of education in improving road users' awareness of traffic safety.

3. METHODOLOGY

3.1 Data Collection

This study was conducted in Hanoi, the capital city of Vietnam to analyse transport users' awareness and perception towards to road safety. Targeted road users included car drivers, motorcyclists and bus passengers, living in the central districts. The data was collected using questionnaire survey that was designed with particular attention to the survey conducted by the Japan International Cooperation Agency (JICA) for similar research in Kampala, Uganda in 2014. This agency is a governmental agency with responsibility for assisting economic and social growth in developing countries and the promotion of international cooperation. Because of its purpose, the questionnaire created by JICA is suitable and realistic for a developing country like Vietnam. Therefore, it was used as a basis for the questionnaire design in this study with some adjustment to ensure the applicability in the context of Hanoi, Vietnam.

Online data collection is a widely used method for gathering data in a larger area compared to other methods, such as telephone surveys, mail, or in-person data collection.

Following the survey purpose, the questionnaire includes a major part of close-ended questions by multiple choice, check box or Likert scale, and two last open-ended questions for respondents to provide their opinions about the measures on reducing traffic collisions and comments on road safety in Hanoi. In detail, the survey of this research includes 29 questions and is divided into 6 parts, which are (1) responder's socio-economic characteristics including living district, age, gender, occupation, income, vehicle ownership, driving habit, etc.; (2) some traffic safety issues experienced by responders; (3) questions about traffic signals and responder's reaction; (4) traffic collisions; (5) solutions for traffic collisions in Hanoi in responder's opinion; (6) comments of responders about traffic safety issues in Hanoi. The last question in part 5 and a question in part 6 are designed to gain travellers' views about road safety in Hanoi as well as their suggestions to tackle the traffic safety problems remaining in Hanoi.

The sample size required for the questionnaire survey was estimated by the method proposed by Ortuzar and Williamsen (2006). With a total of 393 complete responses, the minimum requirement of the sample size was met. Therefore, it is safe to say that the sample represents the population of transport users in Hanoi with 5% of errors being considered in the result.

3.2 Methodology for Data Analysis

Prior to undertaking analysis, data was thoroughly coded. The answer was assigned as a serial number, and this formed the primary dataset for any statistical analyses. For dichotomous questions such as gender or road safety education, the answers were coded as "1" or "2". Additionally, another type of question allows respondents to choose only one answer from more than just two options to be coded in a similar way to dichotomous questions, including living district, occupation, income, driving experience and frequency. Then, for the questions that allow the responder to choose more than one choice, the ordered numbers corresponding to a respondent's answers were shown in the choice's column and could be coded as "0". Socio-demographic variables were coded as nominal data, whereas perception of traveller variables was set as ordinal data.

After the descriptive analysis, two groups including socio-demographic characteristics and perceptions are formed to gain an in-depth understanding of the data. While cluster and multiple correspondence analysis are used to divide the travellers into groups to investigate the differences between groups, factor analysis diminishes the perception variables and groups them as factors. Afterwards, the significant relationship between factors and clusters was investigated using Multinomial Logistic Regression model. This would produce an output that allows for a generation of a fundamental understanding of road users that have concerns about road safety. All these analyses were undertaken by using Statistical Package for the Social Sciences (SPSS) 24. Figure 1 shows the methodology steps in this study.

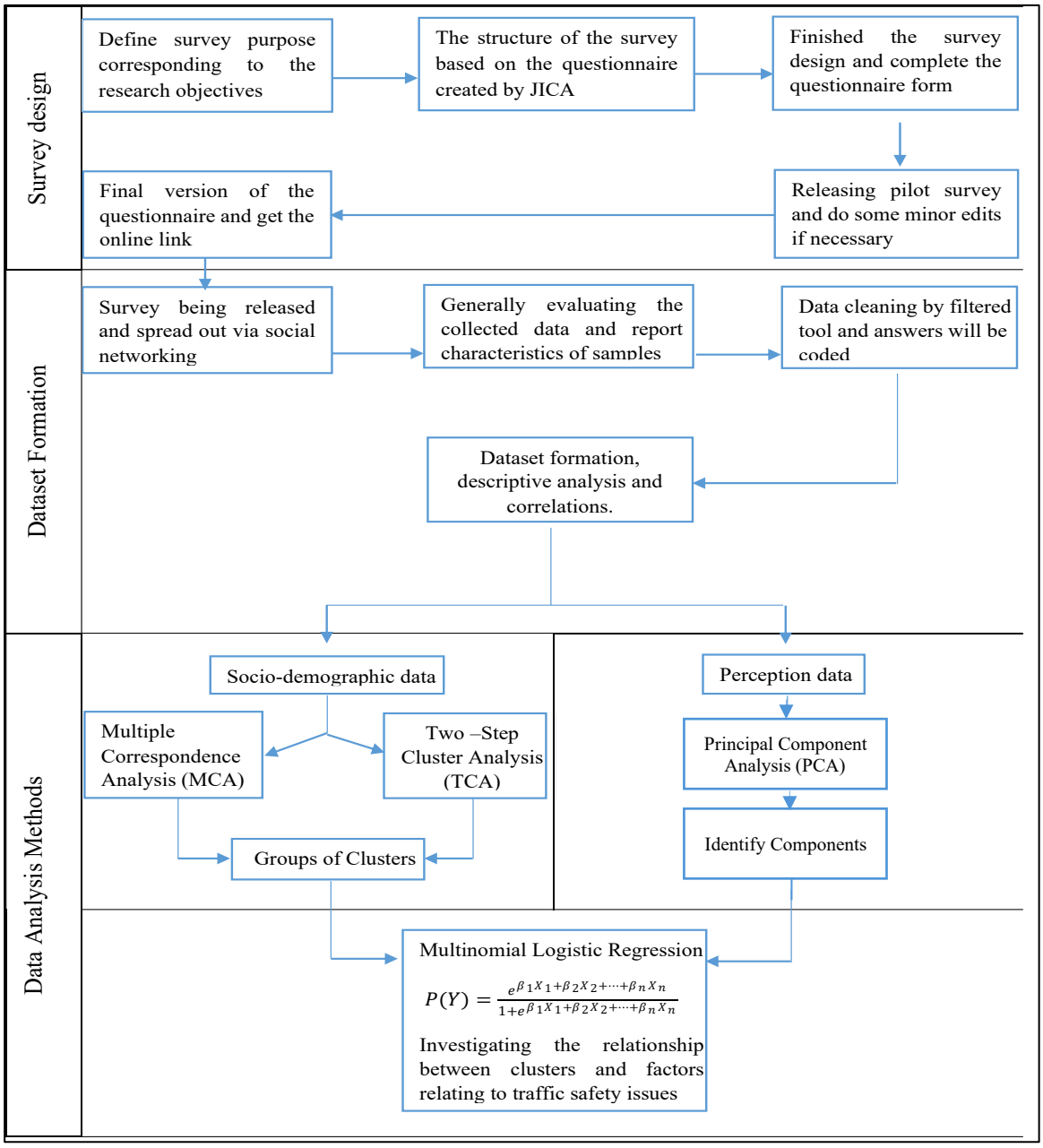


Figure 1: Methodology Flowchart

4. ANALYSIS AND RESULTS

4.1 Descriptive Analysis

4.1.1 Socio-demographic data

The result from 393 completed responses shows that more than 60% people chose motorcycle as the main transport mode for daily commute whereas there were only 14.56% using cars and 19.59% using bus for trips in and around Hanoi, Vietnam. The number of male respondents was higher than female respondents corresponding to up to 55 %. Sixty percent of the respondents were in the age range of 19-29 years. According to previous studies about the influence of age on road safety, younger drivers are more likely to cause collisions compared to older drivers (McKnight, 2003). The next two main age ranges of respondents are lower

than 19 years old and range from 29-39 years, these people in age range are the main daily commuters. Most respondents are full-time or part-time working or students, adding up to a total of 83.71 %. These dominant groups clearly are the main commuters in the urban area by their daily activities such as going to work, shopping, etc.

The respondents' qualification results reveal that over 60% are highly educated, having either graduated from university or completed a master's degree. This aligns with the data collected on traffic safety education, where 75.57% of respondents indicated they had received road safety education at school. However, a significant proportion still lacked such education. Factors such as the absence of road safety education for many drivers, combined with relatively low economic development, contribute to the prevalence of road traffic collisions (Sarpong, 2010).

Vehicle ownership results show that 66% respondents own two or more than two motorcycles and this is true to the fact pointed out in the Literature Review about the area as Vietnam is dominated by motorcycles and this is also a main problem in other Asian countries (Hsu *et al.,* 2003). Asked about experience in riding/driving vehicles, almost 50 % of respondents have 1-5 years of driving experience.

When asked whether traffic safety in Hanoi is an important issue that requires attention, respondents gave an overall rating of 4.1 out of 5. When being asked about the behaviour relating to traffic signals, 52.93% respondents chose that they would reduce their speed when crossing the intersections when the traffic signal is green and 77.86% respondents chose that they would reduce their speed when they see the traffic light turn from amber to red then wait for the red light; surprisingly, the other 22.14% chose to cross the amber light even if the red light would appear a few seconds later.

Many people (78.81%) found that they experienced traffic collisions in Hanoi at least a few times per year. Then, when being asked about one to two main factors that cause traffic collisions in Hanoi, 81.42% of respondents think that motorcycles are the main cause, while 47.58% of people blame cars for their mistakes regarding traffic collisions. In addition, when the topic comes to the time that collisions normally happen, most people (36.4%) choose the time frame from 4pm to 9pm. This matches with the Literature Review concerning the rush hour in Hanoi when people go home from work and school, which leads to a dramatic rise in travelling demand and consequently increases the potential of causing traffic collisions.

Open ended questions revealed the respondents suggested measures to reduce traffic collisions in Hanoi, which included awareness campaigns, stricter enforcement of traffic laws with higher fines, and improved traffic facilities like road widening and cameras. Limiting vehicles per family was also proposed. Most respondents rated Hanoi's road safety quality as low, requiring urgent improvements.

The top 3 cases of traffic safety issues according to respondents' opinion are "Driving/riding exceeding the maximum limit speed", "Do not follow the traffic signal or police's instruction" and "overtaking other lanes". For the question asking about safety behaviour (Figure 2) that people usually do, most answers went to the option "Drive while fastening your seat belt/ riding wearing helmet.

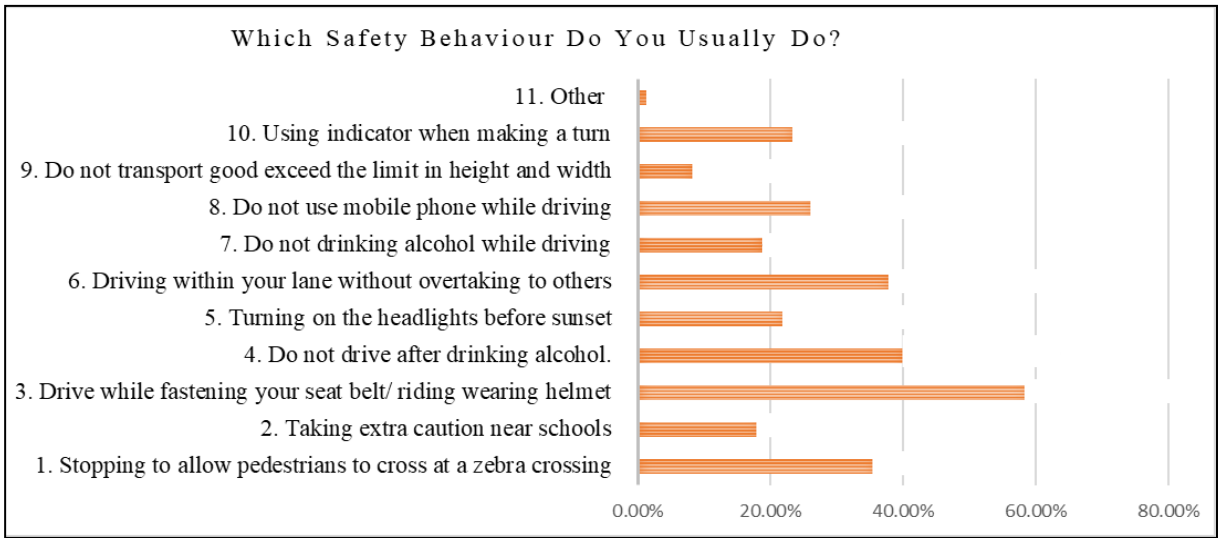


Figure 2: Safety precautions that people take

Regarding the traffic signal issue, most people choose to ignore the traffic signal with a frequency of one to two times a year. Then, the reason for this violation is mostly because they are in a hurry. Furthermore, approximately 60 % of the respondents suggested that the two places that normally have collisions are intersections or roundabouts without traffic signals or traffic police and sharp-curved roads. In addition, when asked about the main reason that causes traffic collisions, most answers blame careless or inattentive driving/riding; for example, using alcohol, using cell phone while driving/ riding and unnecessary overtaking by other vehicles.

Given the measures to tackle the remaining problems of road traffic collisions (Figure 3), the larger part of respondents think that the government should raise the fine for any cases that break the traffic rules and regulations. Another majority opinion is to give more education on road safety.

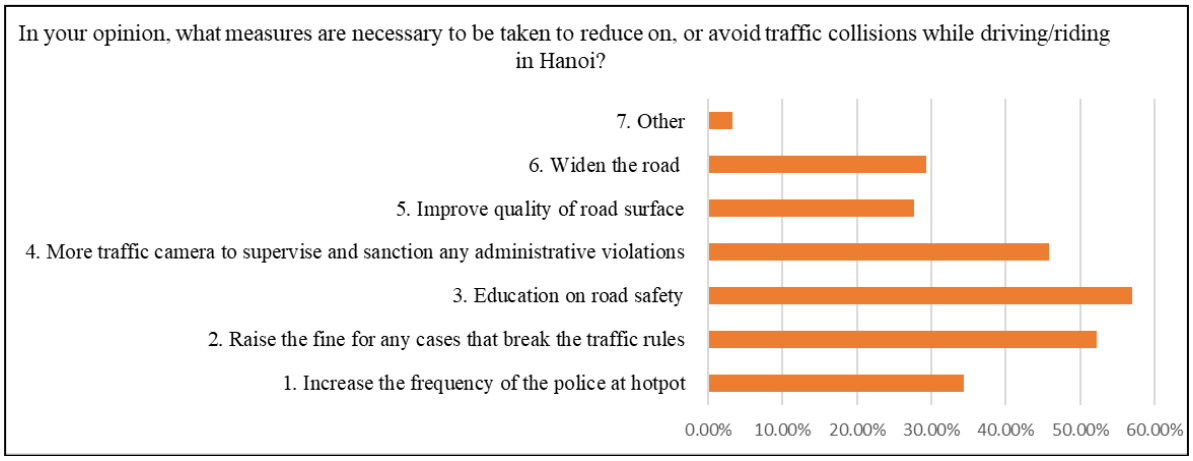


Figure 3: Measures to reduce or avoid traffic collisions

4.1.2 Variables correlation

The correlation factors act as a measurement of how closely variables are related to the others. Among various methods, the most popular method to find the correlation is the Pearson Correlation for normally distributed data, which gives a linear relationship between two variables (Gogtay and Thatte, 2017). Because the dataset is not normally distributed, the

Spearman's was chosen to measure the direction of association between two variables. In addition, Spearman's coefficient is applicable for both continuous and discrete ordinal variables (Khamis, H., 2008). The correlation analysis of socio-demographic variables is shown in the Table 2.

The relationship correlated at the 99% level of confidence significance value less than 0.01 can be considered as strong due to the hypothesis testing. However, the values which are less than 0.4 showed that they indicate weak correlations. The result shows that most correlations are significant at the 0.01 level whereas some are at 0.05 level. Thus, the correlation between socio-demographic variables is relatively strong.

Table 2 Correlation table of socio-demographic variables

Classification	G	A	O	I	Q	DM	DE	DF	TSE
G	1.00	0.04	-0.01	-0.08	0.01	**0.12**	-0.09	0.04	0.03
A		1.00	**0.50**	**0.54**	**0.51**	0.01	**0.52**	-0.09	0.**15**
O			1.00	**0.52**	**0.44**	-0.07	**0.44**	-0.04	0.**16**
I				1.00	0.**58**	-0.05	**0.41**	**-0.12**	0.09
Q					1.00	-0.09	**0.36**	-0.07	**0.10**
DM						1.00	0.10	**0.25**	-0.04
DE							1.00	**-1.22**	**0.18**
DF								1.00	0.04
TSE									1.00

Notes: Bold figures are significant at 95%

Gender (G)	Age (A)	Occupation (O)
Driving Mode (DM)	Driving Experience (DE)	Driving Frequency (DF)
TS Education (TSE)	Qualification (Q)	Income (I)

4.2 Principal Component Analysis (PCA)

Exploratory factor analysis is used to reduce the dimensions, and it is also called as dimension reduction process. Previous research demonstrated Principal Component Analysis (PCA) are popular method for dimension reduction (Saw *et al*., 2017; Ali, *et al*, 2018). Principal Component Analysis (PCA) is used to group variables by identifying the highest component loading value for each element. However, it is necessary to further use a rotation method to avoid ambiguity during the classification process and provide a clearer differentiation for the aim of dividing variables into groups of similar components. Promax was selected for component rotation since it was likely that there is a correlation between components that explain drivers' perception towards road safety (Thibenda *et al*., 2022). Component loading values between 0.3 and 0.4 were acceptable, even though it was preferred to have values greater than 0.5 (Field, 2017).

4.2.1 Results of the PCA

As shown in Table 3, five components were identified: ***Non-compliance with the traffic regulations***, ***aggressive driving behaviour***, ***traffic signal issues***, ***road quality in infrastructure and facilities***, and ***actions and measures for prevention***. To assess the internal consistency of variables within each group, a reliability test was conducted using Cronbach's alpha. A higher Cronbach's alpha (α) indicates a stronger correlation among items. This approach ensures the components are both meaningful and reliable, supporting the analysis of the identified groups. According to Taber (2017) α values have greater variation and the values need to be interpreted carefully. Components 1-4 have reasonable α values. Low α value related to Component 5 may be attributed to the -ve and +ve signs of the statements belong to

that component.

Table 3: Results of the PCA analysis

Statement	Mean	Std. Deviation	Factor loading
Component 1: Non-compliance with the traffic regulations (α=0.752)			
• Which most case below do you usually observe for traffic safety issue in Hanoi? Do not follow the traffic signal or police's instruction	1.21	0.980	**-0.747**
• Which most case below do you usually observe for traffic safety issue in Hanoi? Driving/riding exceeding the maximum limit speed	0.38	0.487	**0.823**
Component 2: Aggressive driving/riding behaviour (α=0.501)			
• Which are the main reasons for collisions in Hanoi? Unnecessary overtaking by other vehicles	1.23	1.477	**-0.750**
• Which are the main reasons for collisions in Hanoi? Careless or inattentive driving/riding	2.78	1.845	**0.738**
Component 3: Traffic signal issue (α=0.541)			
• Have you ever ignored traffic signals?	2.36	1.091	**0.809**
• What is the likely reason of for ignoring of the traffic signals? Was in a hurry	0.83	0.987	**0.763**
Component 4: Road quality and infrastructure (α=0.484)			
• Intersection/ roundabout without traffic signals or police	1.19	0.983	**0.786**
• Sharp-curved roads	2.85	2.479	**-0.708**
Component 5: Preventive measures (α=0.25)			
• Drive while fastening your seat belt/ wearing helmet	1.77	1.477	**-0.379**
• Education on road safety	1.71	1.487	**-0.423**
• Raise the fine for any cases that break the traffic rules	1.04	1.000	**0.846**

Component 1, observing the breaking of traffic regulations, emerged as a key aspect of respondents' perceptions. This includes instances where road users ignore traffic or police instructions, exceeding speed limits, or both. Such behaviour, observed objectively, highlights a significant traffic safety issue, like challenges in Thailand, where speeding is a major concern (Kunnawee, 2012). In Vietnam, this issue may stem from low enforcement levels, particularly in Hanoi. Strengthening traffic regulation enforcement is crucial, alongside raising fines and penalties for aggressive actions, to enhance compliance and improve road safety.

Aggressive driving behaviours (Component 2), including unnecessary overtaking by other vehicles and careless or inattentive driving/riding, are another important factor in road user thinking toward road safety. The situation of suddenly having unnecessary overtaking by other vehicles normally causes incidents for people who are moving on the street. This leads to high potential resulting in slight collisions. Besides, careless or inattentive driving is one other component that can be defined as the situations when driver/rider are distracted or not fully concentrated in driving/riding, for example consuming alcohol, using cell phones or speaking to another person while driving/riding.

Component 3, the traffic signal issue can be explained by the increasing number of cases violating the traffic signals in Hanoi. There are numerous reasons for this action, but most road users justify this as an unexpected situation caused by their hurry. However, the action of disobeying traffic signals happens because road users haven't known either the potential for being involved in a crash or how to drive safely in this situation. Therefore, the recommendation for this circumstance is to provide traffic safety education to everyone and enhance their knowledge about dangerous situations.

Road quality and infrastructure (Component 4) is relating to the places where

collisions normally occur in Hanoi. This component relates to traffic lights, road signage, lane markings, design geometry and other characteristics of the road. Based on respondents' answers, the two places that were found to be most associated with collisions were intersections or roundabouts without traffic signals or traffic police and sharp-curved roads. This is consistent with the findings of Tanan, et.al (2025) showed that there is a relationship between accident types and road infrastructures characteristics and the potential for the occurrence of traffic collisions. This finding suggests that it is necessary to provide adequate facilities and traffic police, as well as improving road quality, to reduce the number of collisions.

4.3 Cluster Analysis

Multiple Correspondence Analysis (MCA) and Two-step Clustering Analysis (TCA) were employed to allocate respondents into clusters based on their socio-demographic characteristics.

4.3.1 Multiple Correspondence Analysis (MCA)

MCA is one of the statistical approaches used to determine, represent and model basic structures in a dataset, especially for categorical data (LeRoux and Rouanetm, 2010; Ali, *et al*, 2018; Cotet, *et al*., 2025). The main application of MCA in this research is to identify the interrelationships between categorical variables by putting variables into continuous data based on its coordinates on a two-dimensional graph.

The numbers that variables yield for each dimension was considered and evaluated regarding whether they might cause any effect or not. Furthermore, MCA is able to calculate the correlation between socio-demographic variables giving an insight into the relationship among those variables in the study. For this purpose, socio-demographic variables (living district, age, gender, monthly self-income, occupation, highest qualification, driving mode, driving frequency, traffic safety education) have been selected to classify the transport users with similar characteristics.

a) Cronbach's alpha

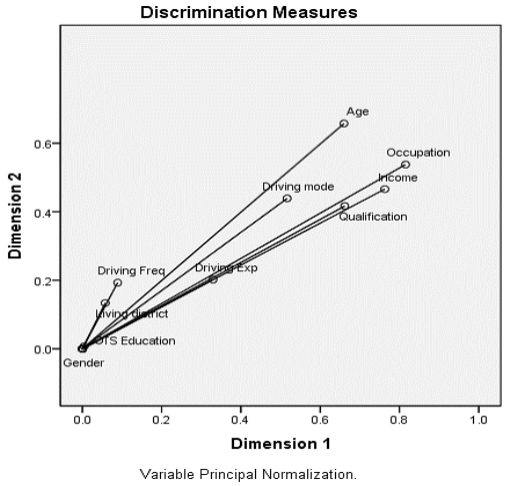
Table 4 of model summary, the MCA method yields Cronbach's alpha numbers of 0.829 for dimension 1 and 0.75 for dimension 2. Thus, the mean Cronbach's alpha coefficient is of 0.794, which is close to a high satisfactory level of 0.8.

Table 4: Model summary in MCA

Dimension	Cronbach's Alpha	Variance Accounted For	
		Total (Eigenvalue)	Inertia
1	0.829	3.940	0.394
2	0.750	3.077	0.308
Total		7.016	0.702
Mean	**0.794**	3.508	0.351
a. Mean Cronbach's Alpha is based on the mean Eigenvalue.			

b) Discrimination measures

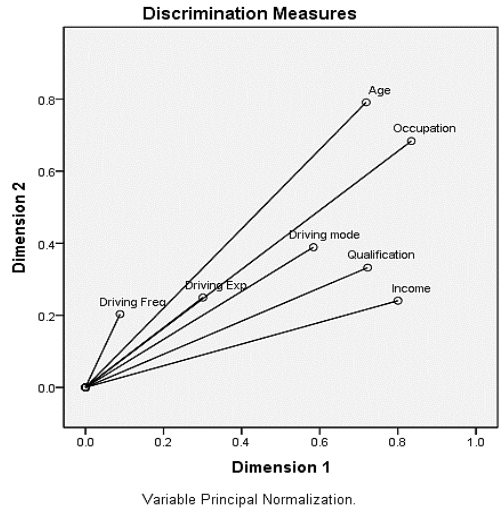
Discrimination measures were extracted from MCA analysis (Figure 5).



Discrimination Measures			
	Dimension		Mean
	1	2	
Living district	0.058	0.133	0.096
Gender	0.005	0.007	0.006
Age	0.660	0.658	0.659
Occupation	0.815	0.538	0.676
Income	0.763	0.466	0.615
Qualification	0.662	0.417	0.539
Driving mode	0.517	0.439	0.478
Driving Exp.	0.330	0.202	0.266
Driving Freq.	0.089	0.193	0.141
TS Education	0.042	0.024	0.033
Active Total	3.940	3.077	3.508

Figure 4: Discrimination measures 1

The values of Living district, Gender and TS Education are rather low so they might not make a significant impact. Thus, after rerunning the discrimination measure without those variables, following results were obtained (Figure 5):



Discrimination Measures			
	Dimension		Mean
	1	2	
Age	0.719	**0.791**	0.755
Occupation	0.**834**	0.684	0.759
Income	**0.800**	0.241	0.520
Qualification	**0.723**	0.332	0.527
Driving mode	**0.584**	0.389	0.486
Driving Exp.	**0.301**	0.249	0.275
Driving Freq.	0.089	**0.203**	0.146
Active Total	4.049	2.889	3.469

Figure 5: Discrimination measures 2

The first dimension contains ‘Occupation’, ‘Income’, ‘Qualification’, ‘Driving mode’ and ‘Driving Experience’. The second dimension includes ‘Age’ and ‘Driving Frequency’. Two-step cluster analysis was then undertaken to group drivers with similar sociodemographic characteristics together with object scores from MCA and the number of clusters determined by hierarchical clustering. Identification of number of clusters is a step forward before carrying out two-step cluster analysis.

4.3.2 Two-step Cluster Analysis (TCA)

Two-step cluster was chosen for this research because of two main reasons. The first reason is that two-step cluster analysis is a statistical approach that can automatically classify similar

clusters of people or objects within a dataset (Norusis, 2012). The second reason is its accuracy, and reliability is superior to among other traditional clustering methods such as the technique of means clustering algorithm (Norusis, 2008). In accordance with the study of (de Oña *et al.,* 2013b), the clusters were identified and named based on their variable distributions. Three clusters were identified and the details of three clusters are shown in
Table 5.

Table 5: Cluster characteristics for all respondents aggregated

	Categories	Clusters					
		1		2		3	
		#	%	#	%	#	%
Age	Under 19	0	0%	22	27.85%	2	1.83%
	19-29	**126**	**98.44%**	**56**	**70.88%**	15	13.76%
	29-39	2	1.56%	0	0%	**57**	**52.29%**
	39-49	0	0%	0	0%	29	26.61%
	50+	0	0%	1	1.27%	6	5.50%
Occupation	Student	38	29.69%	**77**	**97.47%**	0	0%
	Public employee	10	7.81%	0	0%	**34**	**29.31%**
	Private employment	**74**	**57.81%**	0	0%	32	27.59%
	Self-employed	0	0.00%	0	0%	29	25.00%
	Housewife/ Househusband	1	0.78%	0	0%	6	5.17%
	Retired	0	0.00%	0	0%	3	2.59%
	No employment	4	3.13%	2	2.53%	8	6.90%
	Other	1	0.78%	0	0%	4	3.45%
Income	< 5 million VND	31	24.22%	**68**	**86.08%**	9	8.26%
	5 to 10 million VND	**50**	**39.06%**	10	12.66%	16	14.68%
	10 to 15 million VND	41	32.03%	0	0.00%	22	20.18%
	15 to 30 million VND	6	4.69%	0	0.00%	**49**	**44.95%**
	30 to 50 million VND	0	0.00%	1	1.27%	10	9.17%
	More than 50 million VND	0	0.00%	0	0.00%	3	2.75%
Qualification	High school	0	0.00%	**73**	**92.41%**	2	1.83%
	Vocational school	2	1.56%	1	1.27%	9	8.26%
	Undergraduate	**110**	**85.94%**	4	5.06%	**52**	**47.71%**
	Postgraduate	16	12.50%	0	0.00%	43	39.45%
	Other	0	0.00%	1	1.27%	3	2.75%
Mode	Motorbike	**127**	**99.22%**	**77**	**97.47%**	54	49.54%
	Car	1	0.78%	2	2.53%	**55**	**50.46%**
	Bus	0	0.00%	0	0.00%	0	0.00%
Driving Experience	Less than 1 year	2	1.56%	22	27.85%	1	0.92%
	1 to 5 years	**75**	**58.59%**	**50**	**63.29%**	28	25.69%
	5 to 10 years	46	35.94%	7	8.86%	**43**	**39.45%**
	10 to 20 years	4	3.135%	0	0.00%	30	27.52%
	More than 20 years	1	0.78%	0	0.00%	7	6.42%
Driving Frequency	Everyday	**121**	**94.53%**	**56**	**70.89%**	**86**	**78.90%**
	2 or 3 time in a week	7	5.47%	19	24.05%	16	14.68%
	1 time in a week	0	0.00%	2	2.53%	1	0.92%
	Once a month	0	0.00%	0	0.00%	0	0.00%
	Sometime in a year	0	0.00%	0	0.00%	5	4.59%
	Never	0	0.00%	2	2.53%	1	0.92%

From the table, any variables having the highest frequency or the highest proportion were selected, and classifications of each cluster are given in Table 6:

Table 6 Classification of clusters

Classification	Cluster 1	Cluster 2	Cluster 3
Age	19-29	19-29	29-39
Occupation	Private employment	Student	Public employee
Income	5 to 10 million VND	< 5 million VND	15-30 million VND
Highest Qualification	Undergraduate	High school	Undergraduate
Mode	Motorbike	Motorbike	Car
Driving Experience	1 to 5 years	1 to 5 years	5 to 10 years
Driving Frequency	Everyday	Everyday	Everyday

Cluster 1 (Young-Adult in Employment Riding Motorcycles) is dominated by young-adults who use motorbike as a daily commute and have 1-5 years riding experience. They have already graduated from college and are working in private employment with an average level of monthly income at 5 to 10 million VND.

Cluster 2 (Young-Adult in Education Riding Motorcycles) is quite like cluster 1 as it is also predominantly young-adult motorcyclists who ride daily and have 1-5 years' experience in riding. The differences are that they are mostly still studying in college with a wage of lower than 5 million VND per month.

Cluster 3 (Mature-Adult in Employment Driving cars) The last cluster represents mature adult drivers using cars as daily transport mode and having relatively long experience from 5 to 10 years in commuting. They have bachelor's degrees and currently work in the public domain and earn 15-30 million VND a month.

4.4 Multinomial Logistic Regression (MLR)

The MLR is taken to explore the relationship between three clusters obtained from cluster analysis and five components obtained from factoring analysis (Figure 6) Because the characteristics between Cluster 1 (Young-Adult in Employment Riding Motorcycles) and Cluster 2 (Young-Adult in Education Riding Motorcycles) are quite similar, Cluster 1 was considered as reference category for the MLR model.

Table 7 shows the results of the logistic regression analysis. It benchmarks Cluster 1 (Young-Adult in Employment Riding Motorcycles) as a reference category.

Table 7: Results of the Logistic Regression Analysis
taking Cluster 1 as a reference category

		B	Sig.	Exp(B)
Cluster 2	Intercept	**-0.40**	0.01	
	Comp 1: Non-compliance with the traffic regulations	-0.24	0.12	0.79
	Comp 2: Aggressive driving behaviour	**-0.37**	0.01	0.69
	Comp 3: Traffic signal issue	**0.33**	0.03	1.40
	Comp 4: Road quality and infrastructure	0.08	0.59	1.08
	Comp 5: Preventive measures	0.01	0.92	1.01
Cluster 3	Intercept	-0.12	0.39	
	Comp 1: Non-compliance with the traffic regulations	**-0.70**	0.00	0.50
	Comp 2: Aggressive driving behaviour	**-0.26**	0.07	0.77
	Comp 3: Traffic signal issue	**0.24**	0.08	1.28
	Comp 4: Road quality and infrastructure	**0.26**	0.06	1.30
	Comp 5: Preventive measures	-0.17	0.22	0.85

Cluster 2 and 3 do not perceive that aggressive driving behaviour is an issue as the parameters related to component 2 are negative and significant (-0.37 and -0.26). But they perceive that ignorance of traffic signals can impose a risk in safety (Component 3) indicating positive and significant parameters (0.33 and 0.24). This can be explained by the increasing number of cases of violating the traffic signals in Hanoi. This is also related to the first factor, but this is subjective breaking of the traffic regulations as the respondent is the person who doesn't observe the traffic lights. There are numerous reasons for this action, but most road users justify this as an unexpected situation caused by their hurry. However, the action of disobeying traffic signals happens because road users haven't known either the potential for being involved in a crash or how to drive safely in this situation. Therefore, the recommendation for this circumstance is to provide traffic safety education to everyone and enhance their knowledge about dangerous situations.

Cluster 3 particularly perceives that poor quality of roads and infrastructure (Component 4) would pose negative impacts on safety (0.26). This factor encompasses traffic lights, road signage, lane markings, road geometry, and other design elements. Respondents identified intersections or roundabouts lacking traffic signals or police presence and sharp-curved roads as the most frequent collision sites. These findings align with previous research by Gomes (2013) and Kaygisiz and Yildiz (2024), which established a strong link between inadequate road infrastructure and the likelihood of traffic accidents. To mitigate collisions, it is crucial to enhance road quality, provide sufficient traffic management facilities, and ensure the presence of traffic police at critical locations. Ahmed (2013) also confirms that roadway and roadside parameters were significantly linked to road crash occurrence and severity. Car drivers (Cluster 3) do not perceive non-compliance with the traffic regulations (Component 1) is a safety concern.

5. CONCLUSIONS

This study focuses mainly on the awareness of drivers and motorcycle riders, and aspects that are associated with their perception relating to road safety issues. This research has taken a case study in Hanoi, Vietnam. The respondents who filled in the questionnaire survey came from a variety of parts of Hanoi and have several years of driving and/or riding experience so that they will have different knowledge, background and various points of view on the traffic safety issue. They are either students or employees, the two groups that are the main daily commuters. As per the result, the most popular mode of transport that has been used and owned is motorcycles. Additionally, most responses pointed out that they have at least two motorbikes in their house. The number of respondents that haven't had any road safety education at school remains relatively high. However, talking about the traffic safety issue in Hanoi, most people think it is important and is a cause for concern.

Principal Component Analysis (PCA), Correspondence Analysis (MCA), Two-step Cluster Analysis (TCA) and Multinomial Logistic Regression (MLR) were employed as analytical methods. By performing PCA the key components related to road safety issues based on respondents' perceptions were revealed: ***non-compliance with the traffic regulations***, ***aggressive driving behaviour***, ***traffic signal issues***, ***quality in roads and infrastructure and facilities*** and ***preventive measures***.

MCA and TCA classified 393 respondents into three socio-demographic clusters: ***(1) Young-Adult in Employment Riding Motorcycles***, ***(2) Young-Adult in Education Riding Motorcycles***, and ***(3) Mature-Adult in Employment Driving cars***. The relationships between components and clusters were analysed using MLR. These findings provide valuable insights into road safety perceptions and challenges from users' perspectives.

Overall, the results of this study provide significant insight into the road users' awareness of traffic safety in Hanoi, which is presented as a case taken in a developing country. To summarise, after considering the analysis results and the open-ended questions, the level of public awareness of road safety in Hanoi lies between low and moderate. The factors above still present the gap of the acknowledgement towards how to enhance the safety of road users in Hanoi. Thus, from the results of this research, there are several solutions that have been recommended to improve the current situation. Improved road conditions and facilities and transport user behaviour in signalized junctions would be important to enhance road safety in Hanoi.

6. RECOMMENDATION FOR FUTURE RESEARCH

The need for further study is necessary to fulfil the limitations of this research. Because the survey of this research was conducted based on the knowledge and perceptions of road users about components relating to road safety in central districts of Hanoi, it is necessary to widen the case study area to the surrounding areas of central business districts. In addition to that, the human component plays an important role in road safety issues, so it is found necessary to undertake a study to understand the significant components and solutions to raise awareness of other types of road users including pedestrians, cyclists and bus passengers. The way data is collected should also be improved to achieve more accuracy. When it comes to future research in the same field of studies, the research would be applied in other cities in developing or developed countries.

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