# Effect of attitudes towards traffic safety and risk perceptions on pedestrian behaviours in Vietnam

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**Abstract:** This study explores the relationships between attitudes towards traffic safety, risk perceptions and pedestrian behaviours in Vietnam. A questionnaire survey was conducted with a sample of 835 Vietnamese road users. The results from regression analyses and a structural equation model showed that safer attitudes toward traffic safety and higher levels of traffic risk perception are associated with safer pedestrian behaviours. In addition, traffic safety attitudes were found to partially mediate the association between traffic risk perception and pedestrian behaviour. Furthermore, traffic risk perception was significantly predicted by non-traffic risk perception, and people who had higher level of risk perceptions of both kinds were also prone to report safer attitudes towards traffic safety. The practical implications for traffic safety interventions in Vietnam are also discussed.

**Key words:** pedestrian behaviour, traffic safety attitudes, risk perception.

## 1. Introduction

Concern about pedestrian fatalities is increasing all over the world, especially in low and middle income countries such as Vietnam. Road safety is a complex problem, with many different factors affecting overall safety [1]. Although there are no available statistics on the exact number of pedestrian fatalities nationwide, the issues surrounding pedestrian-related safety have been voiced widely in the Vietnamese media and likely contribute to the very serious traffic safety issues in the country in general. Despite a lot of effort having been made on traffic safety improvement, the traffic safety situation in Vietnam is still a serious problem, with more than 8000 fatalities caused by traffic accidents in 2017 [3,4]. Focusing on pedestrian safety, therefore, is a potential area for reducing the number of deaths caused by traffic accidents in the country.

To combat the pedestrian safety problem, it is essential to understand pedestrian behaviour and its influencing factors. Previous studies, e.g., [4,5,6] have focused on the effects of demographic and personality characteristics on pedestrian behaviours. In addition, the existing literature also sheds lights on the important roles of social factors such as attitudes and the perception of risk.

Attitudes are defined as 'tendencies to evaluate an entity with some degree of favour or disfavour, ordinarily expressed in cognitive, affective and behavioural responses' [7] and have often been found to be a significant predictor of behaviour (see [8]). In the domain of traffic safety, a number of studies have shown the significant effects of attitudes towards traffic safety on driver behaviours (e.g., [9,10,11]). Past research has also shed lights on the relationship between traffic safety attitudes and pedestrian behaviours although the number of works focusing on pedestrian have been still rather limited. Under the framework of the Theory of Planned Behaviour [12], previous research has documented the predictive capacity of attitudes on behavioural intentions related to several pedestrian behaviours, such as road crossing [13,14] and rule violations [4]. Nordfjærn and Şimşekoğlu [15] concluded that safer attitudes toward pedestrian safety were related to lower levels of risk-taking. Attitudes toward rule violation and risk, and attitudes toward pragmatic violation or rules were also found as significant predictors of pedestrian behaviours [16]. Despite of the aforementioned studies, up to date there has been no published research deeply examining the relationship between attitudes towards traffic safety and pedestrian behaviours. Since Papadimitriou et al. [6] revealed that pedestrians with negative attitudes toward safety measures and in-vehicle devices, such as speed-limiting devices, also show more risky pedestrian behaviours, there is a good reason for the present study to investigate the associations between attitudes towards traffic safety and pedestrian behaviours.

Traffic risk perception is defined as a subjective interpretation of the risk involved in various traffic situations [17]. Previous works have paid much attention to the relationship between traffic risk perception and driver behaviours, with much of it concluding that traffic risk perception significantly predicts driver behaviours (e.g., [17,18,19,20,21]). However, several studies have found only a weak correlation between traffic risk perception and self-reported driver behaviour (see [22,23]). As argued by Nordfjærn and Rundmo [24], the weak relationship between traffic risk perception and driver behaviour in some studies may come from the fact that in these studies perceptions of general traffic risk were measured instead of risk perception related to specific traffic accidents and situations.

To date, studies that have focused on the association of traffic risk perception and pedestrian behaviours have been scarce. Only two related studies [14,25] reported that perceived risk is a significant predictor of pedestrians' intentions to cross the road in risky situations. Although past research [26] showed the significant correlation between perception of risk of pedestrian behaviour and pedestrian behaviour itself, there has been no published research exploring the role of perception of traffic risk on pedestrian behaviour.

Non-traffic risk perception, which refers to individuals' probability assessments of general hazards such as health and environmental risks [27,28], has been found to be correlated with traffic risk perception [29]. This result supports Sjöberg et al.'s risk amplification attenuation theory [28], which states that people who rate risk as high or low in one domain tend to have corresponding perceptions of risk in other domains.

Risk perceptions could be also related to attitudes. In a domain of working environment, attitudes and risk perception were found to be correlated with each other as well as with behaviour [30]. Similarly, in the field of traffic safety, Ulleberg and Rundmo [9] found that perception of traffic accident risks was associated with attitudes towards traffic safety, and that both perception of traffic accident risks and traffic safety attitudes affected driving behaviour. Traffic risk perception was also proven to have a significant effect on drivers' attitudes regarding traffic rules, non-driving activities and driving responsibility [31]. Recently, [32] concluded that drivers' risk perception of traffic accidents together with perception of driving tasks was significantly associated with drivers' road safety attitudes. As shown, previous research has provided some evidences on the significant correlation between traffic risk perceptions and traffic safety attitudes, however it could be seen that past studies have only focused on drivers rather than on pedestrians. In addition, there has been no published research showed the significant association between non-traffic risk perception and pedestrian behaviour.

Although a number of studies that have examined the role of attitudes and risk perception on road users' behaviour in high-income Western countries with much of them focusing on drivers' behaviour, those studies from low- or middle-income countries are still limited (see [16,29]). To date, there has been almost no published research investigating the correlations of traffic safety attitudes, risk perceptions and pedestrian behaviours from low- or middle-income countries in Asia. Because cultural factors have been found to have effects on pedestrian behaviour [15], most pedestrian safety interventions being used in low- or middle-income countries in Asia which often base on research carried out in high-income, Western contexts, may or may not be applicable to the countries' settings. Therefore, an investigation on the relationship between attitudes toward traffic safety, risk perceptions and pedestrian behaviours with a sample of road users in Vietnam – a developing middle-income country in Asia with poor pedestrian facilities - might yield useful results that could be used to inform traffic safety interventions in those settings.

## 2. Research objectives

The aim of this study is to examine the relationship between attitudes towards traffic safety, risk perceptions and pedestrian behaviours among road users in Vietnam. Based on the literature reviewed above, at first, it is hypothesized that non-traffic risk perception will not directly relate to pedestrian behaviour but non-traffic risk perception will directly associate with both traffic risk perception and traffic safety attitudes. Specifically, a higher level of non-traffic risk perception will be related to a higher level of traffic risk perception, and that a higher level of both types of risk perceptions will be significantly associated with safer attitudes towards traffic safety. Although the existing literature has shown no information regarding the relationship between non-traffic risk perception and attitude towards traffic safety, the effect of non-traffic risk perception on attitude towards traffic safety are expected since as aforementioned, previous research has shown that traffic risk perception successfully predicts traffic safety attitudes and that there is a significant correlation between non-traffic risk perception and traffic risk perception. Secondly, it is also hypothesised that road users with safer attitudes towards traffic safety and people who have a higher level of traffic risk perception will report performing safer pedestrian behaviours. The relationship between attitudes towards traffic safety, risk perceptions and pedestrian behaviours is hypothesized in the conceptual model shown in Figure 1.

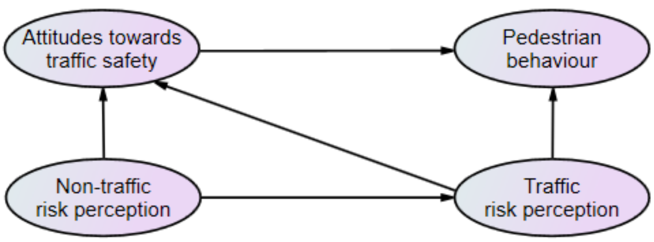


Figure 1: A conceptual model to represent the hypothesized relationship between attitudes towards traffic safety, risk perceptions and pedestrian behaviours

## 3. Method

3.1. Measures

The survey instrument used in the present research included sections to measure attitudes towards traffic safety, risk perceptions and pedestrian behaviours, as well as questions concerning demographics information.

Attitudes toward traffic safety were measured by 22 items. Respondents were asked to rate to what extent they agree with statements of behaviours that violate rules or could be considered as risky on a five-point Likert scale, ranging from ‘Strongly agree’ to ‘Strongly disagree’. Of the 22 items, 15 items were adopted from a questionnaire previously used for measuring attitudes towards traffic safety by Iversen and Rundmo [10] (e.g. “Many traffic rules must be ignored to ensure flow”, “I will ride with someone who speeds if others do”). To capture a broader range of traffic safety attitudes, the current study also added four items taken from Peltzer and Renner [33] and three newly developed items. The four items from Peltzer and Renner [33] included “One should be able to drive at the car’s maximum speed”, “When the road is clear, there is no need to stop at a stop sign”, “Towards the crest of a hill, a driver should overtake the vehicle in front if they are going faster” and “During a long trip a driver should stop as little as possible in order not to lose time”. The remaining three newly developed items are statements related to riding a motorbike without a helmet, riding a bicycle without a helmet, and wearing a seatbelt when travelling in a car.

As aforementioned, risk perceptions were broadly separated into two categories: non-traffic risk perception and traffic risk perception. The measures of non-traffic risk perception included 19 items asking respondents what they thought was the general likelihood of a person’s health being negatively affected as a result of various incidents or events, including political unrest, global warming, outbreaks of disease, a lack of exercise, drinking too much alcohol, etc. Responses were measured using a five-point scale, from ‘Extremely unlikely’ to ‘Extremely likely’. This section was based partly on works reported by Fischoff, Slovic, Lichtenstein, Read, & Combs [34] and Lund and Rundmo [11].

Fifteen items were used to measure traffic risk perception. These items were mainly adopted from the study by Nordfjærn and Rundmo [24] with some small modifications. Respondents were asked to indicate what they think is the general likelihood of a person being seriously or fatally injured due to various traffic accidents or road traffic situations (for example ‘head-on accidents’ or ‘car over-turning’) and more generally when interacting with the road system in different road user roles (including as a pedestrian, a driver, a cyclist, or a passenger). Again, the possible answers for all items of traffic risk perception were in the Likert format with five point scales ranging from "Extremely unlikely" to "Extremely likely".

For the measurement of self-reported pedestrian behaviour, a slightly modified version of the short version of the Pedestrian Behaviour Questionnaire described by Deb, Strawderman, DuBien, Smith, Carruth, & Garrison [35] was used (see also Granié et al. [36]). The questionnaire, containing 20 items (the long version contains 50), uses four questions to measure each of five factors; violations, errors, lapses, aggressive behaviours, and positive behaviours. A six point Likert scale used in the questionnaire reported by Deb et al. [35] was maintained in the present study but the wording altered slightly categories such that responses ranged from 'extremely frequently or always' to 'extremely infrequently or never'.

Finally, demographics information was also collected, including: age, gender, education, and the primary/most commonly used mode of transport.

## 3.2. Survey administration

The questionnaire used in this study was initially developed in English, and then translated into Vietnamese in accordance with Brislin [37]. To ensure its accuracy, the first Vietnamese translation of the questionnaire was translated back to English. The two English versions (original and back-translated) were then compared and any discrepancies discussed between researchers in Vietnam and the UK. A pilot survey was also conducted to about 15 people to ensure all the items in the questionnaire could be well understood by respondents.

To collect responses, 12 students of the National University of Civil Engineering in Hanoi, Vietnam, were recruited to work as surveyors. During the survey, the surveyors asked people in public places (i.e., bus stop, coach station, park, public spaces in resident areas, etc...) and their houses/offices to participate in the survey with some explanation about the survey purpose and content. If informed consent was obtained, the surveyor gave participants the questionnaire and waited to collect them once they were filled in. In some cases, where a participant preferred to do so, surveyors interviewed the participant, filling out the questions for them on the paper questionnaire. If participants preferred to complete the questionnaires later at their home or office, an appointment was made for collecting the filled questionnaires on a subsequent day. When the filled questionnaires were returned to the surveyors, the surveyors checked the questionnaire completion and asked the participants to fill all the uncompleted questions. During the survey, if participants did not understand any question in the questionnaire, they were encouraged to ask the surveyors to clarify any misunderstandings. The survey was conducted from March 2018 to September 2018. Each surveyor was asked to collect about 70 completed questionnaires; in total, 835 usable responses were obtained. All participants provided fully informed consent, and ethical approval was sought from, and granted by the University of Southampton's ethics board (ID: 40682).

### 3.3. Participants

The sample consisted of 835 respondents; age and gender splits are displayed in Table 1. In the sample 65.4% (n = 546) had higher education (completed a university degree or higher), 20.8% (n = 244) completed high school or college, and 13.8% (n = 115) had lower level of education (finished secondary school or lower). Regarding to the primary/most commonly used mode of transport, only 5% of respondents selected "pedestrian" while two third of the sample (66.6%) answered "motorcycle rider.

Table 1: Age and gender splits (and percentages)

| | Age | | | | | | |
|---|---|---|---|---|---|---|---|
| | 18-24 | 25-34 | 35-44 | 45-54 | 54-55 | Over 64 | *Total* |
| Male | 178 | 105 | 81 | 74 | 42 | 12 | *492 (58.9)* |
| Female | 80 | 89 | 77 | 64 | 19 | 14 | *343 (41.1)* |
| *Total* | *258 (30.9)* | *194 (23.2)* | *158 (18.9)* | *138 (16.5)* | *61 (7.3)* | *26 (3.1)* | *835* |

### 3.4. Statistical analysis

To conduct statistical analyses, SPSS Version 24.0 and AMOS Version 24.0 were used. Because the attitudes towards traffic safety, non-traffic risk perception, and traffic risk perception sub-scales had not been previously validated in the literature, principal component analysis (PCA) with iteration and varimax rotation were carried out to examine the underlying dimensions. An eigenvalue greater than 1.0 based on a scree test was used as a criterion to determine the number of extracted factors.

This was also undertaken for the pedestrian behaviour questionnaire as there have been questions raised regarding the cross-cultural applicability of the five-factor structure described by Deb et al. [35] (see McIlroy et al. forthcoming). Cronbach's alpha coefficients and average corrected inter-item correlations were used to evaluate the reliability and internal consistency of the factors identified. The value of Cronbach's alpha coefficients of 0.7 or above indicates sufficient internal reliability for established scale; values above 0.6 are acceptable for new scales [38]. The average corrected inter-item correlations should be above 0.30 [39].

Bi-variate correlations were calculated to investigate the associations between the factors of interest in the present study. In order to test the capability of attitudes and risk perceptions to explain variance in pedestrian behaviour, a hierarchical block regression analysis (enter method) was performed as suggested by previous research with a similar type of research questions (e.g., [15]). In the regression model, demographic variables were entered in the first block, attitudes towards traffic safety were added as independent variables in the second block, and then traffic risk perception and non-traffic risk perception were entered in the third and fourth block, respectively. By this, several regression models will be built by adding variables to a previous model at each step in order to investigate if the newly added variables at each block could explain a statistically significant amount of variance on pedestrian behaviour after accounting for all other variables that have been in the previous model. For example, it is possible to test whether traffic risk perception added the explained variance on pedestrian behaviour above and beyond demographic variables and attitudes.

A Structural Equation Model (SEM) was also used to test the hypothesized model as presented in Figure 1. A number of previous studies (e.g., [10], [15], [43]) that analysed similar data as the data used in this current study also applied SEM to test their hypothesized models. In the SEM model of this present research, all the four constructs (i.e. pedestrian behaviour, attitudes towards traffic safety, traffic risk perception, and non-traffic risk perception) were used as latent factors and the composite scores of their respective dimensions were used as manifest indicator variables receiving loadings from these latent factors. To examine the SEM model, several fit indexes were used including the root-mean-square error of approximation (RMSEA), the goodness-of-fit index (GFI), the adjusted goodness-of-fit index (AGFI), and the comparative fit index (CFI). According to Hu and Bentler [40] and Hair et al. [39], a RMSEA of 0.08 or less and a GFI, an AGFI, and a CFI of 0.90 or above indicated a good fit between the model and the data. The chi-square ( $\chi^2$) with corresponding degrees of freedom (df) and significance level was also calculated and reported, although the $\chi^2$ tends to be inflated towards significance and is as such not considered to be a reliable indicator of model fit [41].

## 4. Results

4.1. Reliability of measurement instruments

Table 2 presents the results of the PCA for the attitudes towards traffic safety scale. The results indicated a six-factor solution with a total explained variance of 55.7%. Two items, i.e. '*During a long trip a driver should stop as little as possible in order not to lose time*' and '*It is acceptable to ride a bicycle without a helmet*' were excluded because of low factor loadings or having high factor loadings on two or more factors.

As can be seen in Table 2, except for one item with a factor loading of 0.38 that nearly reaches the cut-off value of 0.4, all other items have factor loadings of above 0.4 indicating that each item can be considered as measuring the same dimension as the other indicators in the same factor. The Cronbach's alpha of two of the attitudes factors are higher than 0.65, whereas the other four factors have Cronbach's alphas of just under 0.65. Although all are lower than the generally accepted threshold of 0.7 for established scales [38], thresholds lower than 0.7 are often used in the literature, with 0.6 suggested as a threshold for new scales [38]. Moreover, all are higher than the George and Mallery's threshold of 0.5 [42]. In addition, all average corrected inter-item correlations were higher than 0.30, hence the sub-scales were considered acceptable.

Apart from using the six-factor solution to depict attitudes towards traffic safety, the current study also used the overall scale which had good reliability (Cronbach's alpha of 0.811) to assess the overall picture of attitudes towards traffic safety. Participants' mean scores of the overall scale for attitudes towards traffic safety were obtained by averaging the scores with regards to 20 items shown in Table 2. The higher the mean scores, the safer a participant's attitudes.

Table 3 presents the results of the PCA for the traffic risk perception section. The 15 items were divided into 5 factors which together explained about 61.7 % of the variance. As shown in Table 3, the factor loadings of all items are higher than 0.4. Three factors of traffic risk perception have Cronbach's alpha higher than the satisfactory threshold of 0.7 and one factor has an $\alpha$-value of nearly 0.7. In addition, all the three factors had satisfactory average corrected inter-item correlations (all values higher than 0.30).

Table 4 shows the summary results of the PCA for non-traffic risk perception scale. A five-factor solution with all 19 items was obtained. The PCA model explained 67.7% of the total variance. Most of the Cronbach's alpha values are high (above 0.80) indicating internal consistency for the dimensions. Factor NR5 returned a lower Cronbach's alpha of 0.631. The low Cronbach's alpha of this factor may come from the fact that the factor consists of only two items. All average corrected inter-item correlations of the dimensions were higher than 0.30.

## Table 2: Summary of PCA model for attitudes towards traffic safety

| Measurement | Dimension 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| *Factor 1 (A1): Attitude towards traffic rule violations in chance taking* (Cronbach's alpha 0.66, average corrected inter-item correlation 0.33) | | | | | | |
| Taking chances and breaking a few rules does not necessarily make bad drivers | 0.75 | | | | | |
| It is acceptable to take chances when no other people are involved | 0.71 | | | | | |
| It is acceptable to drive when traffic lights shift from yellow to red | 0.66 | | | | | |
| If you are a good driver it is acceptable to drive a little faster | 0.38 | | | 0.31 | | |
| *Factor 2 (A2): Attitude towards the careless driving of others* (Cronbach's alpha 0.63, average corrected inter-item correlation 0.37) | | | | | | |
| I will ride with someone who speeds if that's the only way to get home at night | | 0.77 | | | | |
| I will ride with someone who speeds if others do | | 0.70 | | | | |
| Towards the crest of a hill, a driver should overtake the vehicle in front if they are going faster | | 0.64 | | | | |
| *Factor 3 (A3): Attitude towards traffic rule violation in specific situations* (Cronbach's alpha 0.70, average corrected inter-item correlation 0.32) | | | | | | |
| You should always wear your seatbelt when travelling in a car (*) | | | 0.68 | | | |
| Traffic rules must be respected regardless of road and weather conditions (*) | | | 0.66 | | | |
| Punishments for speeding should be more severe (*) | | | 0.66 | | | |
| When the road is clear, there is no need to stop at a stop sign | | | 0.61 | | | |
| It is acceptable to ride on a motorbike without a helmet | | | 0.60 | | | |
| *Factor 4 (A4): Attitude towards defensive riding* (Cronbach's alpha 0.63, average corrected inter-item correlation 0.46) | | | | | | |
| I don't want to risk my life and health by riding with an irresponsible driver (*) | | | | 0.84 | | |
| I would never ride with someone I knew has been drinking alcohol (*) | | | | 0.81 | | |
| *Factor 5 (A5): Attitude towards speeding* (Cronbach's alpha 0.63, average corrected inter-item correlation 0.46) | | | | | | |
| When road conditions are good and nobody is around driving at 100 mph (~160 kmh) is ok | | | | | 0.82 | |
| One should be able to drive at the car's maximum speed | | | | | 0.79 | |
| *Factor 6 (A6): Attitude towards traffic rules and speed limits in general* (Cronbach's alpha 0.62, average corrected inter-item correlation 0.31) | | | | | | |
| Many traffic rules must be ignored to ensure traffic flow | | | | | | 0.76 |
| It makes sense to exceed speed limits to get ahead of slow drivers | | | | | | 0.69 |
| Traffic rules are often too complicated to be carried out in practice | | | | | | 0.59 |
| Speed limits are exceeded because they are too restrictive | | | | | | 0.55 |
| Varience explained (%) | 22.8 | 8.8 | 7.0 | 6.0 | 5.6 | 5.4 |

Factor loadings below 0.30 are hidden. (*) means the score of the item is reversed.

## Table 3: Summary of PCA model for traffic risk perception

| Measurement | Dimension 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| *Factor 1 (TR1): General traffic risks as using motorized vehicles* (Cronbach's alpha 0.79, average corrected inter-item correlation 0.44) | | | | |
| As a driver of a car | 0.78 | | | |
| As a passenger of a car | 0.76 | | | |
| As a passenger of a motorcycle or motorised three-wheeler | 0.74 | | | |
| As a rider of a motorcycle | 0.70 | | | |
| As a passenger of a bus or coach | 0.65 | | | |
| *Factor 2 (TR2): Risks associated to vulnerable road users* (Cronbach's alpha 0.74, average corrected inter-item correlation 0.50) | | | | |
| As a pedestrian | | 0.88 | | |
| As a rider of a bicycle | | 0.87 | | |
| Collision with a pedestrian | | 0.59 | | |
| *Factor 3 (TR3): Traffic accident risks No.1* (Cronbach's alpha 0.74, average corrected inter-item correlation 0.44) | | | | |
| Vehicle overturns in the roadway | | | 0.82 | |
| Vehicle explosion following collision | | | 0.76 | |
| Vehicle running off the road | | | 0.70 | |
| Head on collision | | | 0.69 | |

| Measurement | Dimension | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| *Factor 4 (TR4): Traffic accident risks No.2* (Cronbach's alpha 0.68, average corrected inter-item correlation 0.42) | | | | |
| Collision with another vehicle from behind | | | | 0.76 |
| Collision caused by changing lane | | | | 0.73 |
| Collision with another vehicle at a road junction | | | | 0.72 |
| Variance explained (%) | 26.1 | 14.9 | 11.2 | 9.5 |

Factor loadings below 0.30 are hidden. (*) means the score of the item is reversed.

Table 4: Summary of PCA model for non-traffic risk perception

| Measurement | Dimension | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| *Factor 1 (NR1): Food and health related risks* (Cronbach's alpha 0.82, average corrected inter-item correlation 0.44) | | | | | |
| Outbreaks of contagious disease | 0.75 | | 0.31 | | |
| Pesticides in food | 0.74 | | | | |
| Infections | 0.73 | | | | |
| Genetically modified food | 0.65 | | | | |
| Getting a cold | 0.60 | 0.31 | | | |
| Falling over in the street | 0.56 | | | | |
| *Factor 2 (NR2): Living style related risks* (Cronbach's alpha 0.84, average corrected inter-item correlation 0.56) | | | | | |
| Unhealthy eating habits | | 0.82 | | | |
| Smoking | | 0.79 | | | |
| Not enough exercise | | 0.78 | | | |
| Drinking too much alcohol | | 0.75 | | | |
| *Factor 3 (NR3): Environment related risks* (Cronbach's alpha 0.84, average corrected inter-item correlation 0.58) | | | | | |
| Holes in the ozone layer | | | 0.86 | | |
| Global warming | | | 0.80 | | |
| Radioactivity from a nuclear plant | | | 0.77 | | |
| Contamination by industrial waste | | | 0.62 | | |
| *Factor 4 (NR4): Radiation related risks* (Cronbach's alpha 0.80, average corrected inter-item correlation 0.59) | | | | | |
| Radiation from mobile phone transmitters | | | | 0.85 | |
| Radiation from mobile phones | | | | 0.85 | |
| Radiation from high voltage power line | | | | 0.63 | |
| *Factor 5 (NR5): Risks caused by street crime and political unrest* (Cronbach's alpha 0.63, average corrected inter-item correlation 0.46) | | | | | |
| Street crime | | | | | 0.82 |
| Political unrest | | | | | 0.76 |
| Variance explained (%) | 33.5 | 12.8 | 8.0 | 7.4 | 5.9 |

Factor loadings below 0.30 are hidden.

The results of PCA of the 20-item instrument measuring pedestrian behaviour are shown in Table 5. A four-factor solution was obtained, explaining 66.6% of the total variance. Five items were excluded because they failed to load consistently on the identified factors, including (1) 'I thank a driver who stops to let me cross', (2) 'I take passageways forbidden to pedestrians to save time', (3) 'I realize that I have crossed several streets and intersections without paying attention to traffic', (4) 'I run across the street without looking because I am in a hurry', and (5) 'I let a car go by, even if I have the right-of-way, if there is no other vehicle behind it'. Although the factors showed some differences to those seen in Granié et al. (2013) and Deb et al. (2017), many similarities exist. Given these similar groupings, the factor labels used in those studies are also used here, namely; (B1) Violations and Errors; (B2) Lapses; (B3) Aggressive Behaviours; and (B4) Positive Behaviours.

As shown in Table 5, all factor loadings were higher than 0.6. Most of the Cronbach's alpha values were high (above 0.80) indicating internal consistency for the dimensions. Factor B4, which included two measurement items, a Cronbach's alpha of 0.678 was found. All dimensions of pedestrian behaviour had average corrected inter-item correlations of higher than 0.30.

Again, besides using the four-factor solution to depict pedestrian behaviour, the current study also used the overall scale which had good reliability (Cronbach's alpha of 0.863) to assess the overall picture of pedestrian behaviour. Participants' mean scores of the overall scale for pedestrian behaviour were obtained by averaging the scores with regards to 15 items shown in Table 5. The higher the mean scores, the safer the participant's pedestrian behaviours were.

Table 5: Summary of PCA model for pedestrian behaviour

| Measurement | Dimension | | | |
|---|---|---|---|---|
| | 1 | 2 | 3 | 4 |
| *Factor 1 (B1): Violations and errors* (Cronbach's alpha 0.82, average corrected inter-item correlation 0.43) | | | | |
| I cross outside the pedestrian crossing even if there is one (e.g. a crosswalk or zebra crossing) less than 50m away | 0.78 | | | |
| I cross diagonally to save time | 0.77 | | | |
| I cross between vehicles stopped on the roadway in traffic jams | 0.71 | | | |
| I cross even if vehicles are coming because I think they will stop for me | 0.69 | | | |
| I walk on cycling paths when I could walk on the sidewalk pavement | 0.65 | | | |
| I avoid using pedestrian bridges or underpasses for convenience, even if one is located nearby | 0.61 | | | |
| *Factor 2 (B2): Lapses* (Cronbach's alpha 0.87, average corrected inter-item correlation 0.69) | | | | |
| I forget to look before crossing because I am thinking about something else | | 0.86 | | |
| I cross without looking because I am talking with someone | | 0.84 | | |
| I forget to look before crossing because I want to join someone on the pavement on the other side | | 0.79 | | |
| *Factor 3 (B3): Aggressive behaviours* (Cronbach's alpha 0.86, average corrected inter-item correlation 0.60) | | | | |
| I have gotten angry with a driver and hit their vehicle | | | 0.81 | |
| I get angry with another road user (pedestrian, driver, cyclist, etc.), and I make a hand gesture | | | 0.81 | |
| I cross very slowly to annoy a driver | | | 0.79 | |
| I get angry with another road user (pedestrian, driver, cyclist, etc.), and I yell at them | | | 0.74 | |
| *Factor 4 (B4): Positive behaviours* (Cronbach's alpha 0.68, average corrected inter-item correlation 0.51) | | | | |
| When I am accompanied by other pedestrians, I walk in single file on narrow pavements so as not to bother the pedestrians I meet (*) | | | | 0.86 |
| I walk on the right-hand side of the pavement so as not to bother the pedestrians I meet (*) | | | | 0.83 |
| Variance explained (%) | 36.5 | 13.4 | 8.9 | 7.8 |

Factor loadings below 0.30 are hidden. (*) means the score of the item is reversed.

## 4.2. Descriptive analysis and bivariate correlations between dimensions of instruments

Table 6 presents means, standard deviations, and zero-order Pearson correlations between all dimensions of the four instruments (i.e., attitudes towards traffic safety, traffic risk perception, non-traffic risk perception, and pedestrian behaviour).

The high mean scores of all dimensions of pedestrian behaviours and attitudes towards traffic safety indicated that respondents reported safe pedestrian behaviours and safe attitudes towards traffic safety. The sample showed relatively low mean score on perceived risks associated with vulnerable road users compared to other dimensions of traffic risk perception. Low mean scores also suggest that respondents estimated relatively low levels of risks associated with radiation, street crime, and political unrest.

As shown in Table 6, there were some significant correlations between dimensions of attitudes towards traffic safety and pedestrian behaviour as well as other variables. The strengths of the correlation coefficients varied from small to moderate.

Table 6: Means, standard deviations, and correlations between dimensions of attitudes towards traffic safety, traffic risk perception, non-traffic risk perception, and pedestrian behaviour

| Dimensions | Mean | SD | A1 | A2 | A3 | A4 | A5 | A6 | TR1 | TR2 | TR3 | TR4 | NR1 | NR2 | NR3 | NR4 | NR5 | B1 | B2 | B3 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| (A1) Attitude towards traffic rule violations in favourable conditions | 3.53 | 0.70 | 1 | | | | | | | | | | | | | | | | | |
| (A2) Attitude towards the careless driving of others | 3.69 | 0.68 | .42** | 1 | | | | | | | | | | | | | | | | |
| (A3) Attitude towards traffic rule violation in specific situations | 3.85 | 0.62 | .38** | .31** | 1 | | | | | | | | | | | | | | | |
| (A4) Attitude towards defensive riding | 4.05 | 0.84 | .18** | .18** | .27** | 1 | | | | | | | | | | | | | | |
| (A5) Attitude towards speeding | 4.11 | 0.72 | .33** | .33** | .25** | .19** | 1 | | | | | | | | | | | | | |
| (A6) Attitude towards traffic rules and speed limits in general | 3.19 | 0.72 | .39** | .32** | .24** | .07* | .20** | 1 | | | | | | | | | | | | |
| (TR1) General traffic risks as using motorized vehicles | 3.19 | 0.57 | .08* | .10** | .19** | .09* | .08* | .00 | 1 | | | | | | | | | | | |
| (TR2) Risks associated to vulnerable road users | 2.54 | 0.69 | .02 | .14** | .05 | .05 | -.07* | .06 | .29** | 1 | | | | | | | | | | |
| (TR3) Traffic accident risks No.1 | 3.34 | 0.78 | .08* | .12** | .11** | .09** | .08* | .10** | .12** | .13** | 1 | | | | | | | | | |
| (TR4) Traffic accident risks No.2 | 3.23 | 0.64 | .08* | .14** | .12** | .13** | .08* | .08* | .32** | .33** | .21** | 1 | | | | | | | | |
| (NR1) Food and health related risks | 3.27 | 0.74 | .08* | .10** | .16** | .12** | .08* | .08* | .19** | .16** | .20** | .10** | 1 | | | | | | | |
| (NR2) Living style related risks | 3.45 | 0.80 | .10** | .03 | .11** | .11** | .21** | .05 | .24** | .08* | -.02 | .21** | .40** | 1 | | | | | | |
| (NR3) Environment related risks | 3.22 | 0.97 | .10** | .08* | .17** | .08* | .07* | .11** | .08* | .11** | .28** | .10** | .50** | .22** | 1 | | | | | |
| (NR4) Radiation related risks | 2.53 | 0.82 | .07 | .04 | .10** | .01 | .01 | .11** | .17** | .24** | .10** | .08* | .46** | .29** | .43** | 1 | | | | |
| (NR5) Risks caused by street crime and political unrest | 2.74 | 0.80 | .07 | .10** | .06 | .05 | .04 | .01 | .23** | .23** | .14** | .15** | .35** | .23** | .39** | .34** | 1 | | | |
| (B1) Violations and errors | 4.47 | 0.83 | .31** | .37** | .33** | .13** | .14** | .28** | .09** | .09** | .16** | .13** | .18** | .08* | .14** | .12** | .09** | 1 | | |
| (B2) Lapses | 5.02 | 0.87 | .13** | .22** | .20** | .06 | .15** | .19** | .03 | .07* | .06 | .08* | .09* | .02 | .09** | .05 | .06 | .40** | 1 | |
| (B3) Aggressive behaviours | 5.52 | 0.79 | .15** | .21** | .23** | .16** | .21** | .17** | .10** | -.05 | .19** | .17** | .13** | .11** | .12** | .00 | .04 | .39** | .53** | 1 |
| (B4) Positive behaviours | 4.22 | 1.10 | .07* | .12** | .21** | .13** | .11** | .07 | -.02 | -.03 | .05 | .08* | .10** | .09* | -.01 | -.01 | -.02 | .23** | .25** | .32** |

* p < .05; ** p < .01; *** p < .001.

4.3. Regressions on attitudes towards traffic safety and pedestrian behaviours

A hierarchical block regression analysis was used to identify the determinants of attitudes towards traffic safety above and beyond demographic variables. In this regression analysis, the dependent variable was the mean score of overall scale of attitudes towards traffic safety. This mean score of traffic safety attitudes was obtained by averaging the scores with regards to 20 items shown in Table 2. As shown in Table 7, demographic variables (i.e., age and gender) were entered into the model in the first step. In the second step, four indicators of traffic risk perception were added to model. These indicators were the mean scores of the four factors of traffic risk perception presented in Table 3, in which the mean score of each indicator was obtained by averaging the scores with regards to their items of the corresponding factor as showed in Table 3. In the last step, five indicators of non-traffic risk perception were added to the model. These five indicators of non-traffic risk perception were the mean scores of the five factors of non-traffic risk perception as presented in Table 4. Again, these mean scores were computed by averaging their items of the corresponding factor.

It could be seen in Table 7 that demographic variables did not account for a statistically significant proportion of the variance in pedestrian behaviour while both traffic risk perception and non-traffic risk perception significantly contributed to the model improvement. The final model explained only 7% of the variance in attitudes towards traffic safety.

Table 7: Regression analysis on attitudes towards traffic safety

| Block | Indicators | □ | F-change | Adjusted $R^2$ |
|---|---|---|---|---|
| 1 | | | 2.00 | 0.00 |
| | Gender (*0. Male, 1. Female*) | 0.046 | | |
| | Age (*1. 18-24; 2. 25-34; 3. 35-44; 4. 45-54; 5. 55-64; 6. Over 64*) | 0.043 | | |
| 2 | | | **10.53** | 0.05 |
| | (TR1) General traffic risks as using motorized vehicles | 0.077* | | |
| | (TR2) Risks associated to vulnerable road users | -0.013 | | |
| | (TR3) Traffic accident risks No.1 | 0.089* | | |
| | (TR4) Traffic accident risks No.2 | 0.097* | | |
| 3 | | | **4.47** | 0.07 |
| | (NR1) Food and health related risks | 0.060 | | |
| | (NR2) Living style related risks | 0.068 | | |
| | (NR3) Environment related risks | 0.105* | | |
| | (NR4) Radiation related risks | -0.019 | | |
| | (NR5) Risks caused by street crime and political unrest | -0.048 | | |

Dependent variable = mean score of attitudes towards traffic safety (higher scores indicating safer attitudes)
Significant (p <.001 F-change in bold)
*p < .05; **p < .01; ***p < .001

Again, a hierarchical block regression analysis was used to examine whether attitudes towards traffic safety, traffic risk perception and general risk perception added to the explained variance in pedestrian behaviour above and beyond demographic variables. The dependent variable of this regression analysis was the mean score of the overall scale of pedestrian behaviour. This mean score of pedestrian behaviour was computed by averaging the scores averaging the scores with regards to 15 items shown in Table 5. As presented in Table 8, the independent variables included age and gender (entered into the model in the first step); six indicators of traffic safety attitudes (added in the second step); four indicators of traffic risk perception (added in the third step); and five indicators of non-traffic risk perception (entered into the model in the last step). The six indicators of traffic safety attitudes were the mean scores of the five factors showed in Table 2, in which the mean score of each indicator was archived by averaging the scores with regards to their items of the corresponding factor as showed in Table 2. The indicators of traffic risk perception and non-traffic risk perception were already mentioned in the regression on traffic safety attitudes.

It could be seen from the results showed in Table 8 that demographic variables (i.e., age and gender), attitudes towards traffic safety and traffic risk perception accounted for a statistically significant proportion of the variance in pedestrian behaviour, while non-traffic risk perception did not contribute to a significant improvement to the model fit. The final model explained 23% of the variance in pedestrian behaviour.

Table 8: Regression analysis on pedestrian behaviour

| Block | Indicators | □ | F-change | Adjusted $R^2$ |
|---|---|---|---|---|
| 1 | | | **7.24** | 0.02 |
| | Gender (*0. Male, 1. Female*) | 0.063* | | |
| | Age (*1. 18-24; 2. 25-34; 3. 35-44; 4. 45-54; 5. 55-64; 6. Over 64*) | 0.075* | | |
| 2 | | | **36.24** | 0.21 |
| | (A1) Attitude towards traffic rule violations in favourable conditions | 0.016 | | |
| | (A2) Attitude towards the careless driving of others | 0.199*** | | |
| | (A3) Attitude towards traffic rule violation in specific situations | 0.216*** | | |
| | (A4) Attitude towards defensive riding | 0.030 | | |
| | (A5) Attitude towards speeding | 0.031 | | |
| | (A6) Attitude towards traffic rules and speed limits in general | 0.107** | | |
| 3 | | | **4.60** | 0.23 |
| | (TR1) General traffic risks as using motorized vehicles | -0.019 | | |
| | (TR2) Risks associated to vulnerable road users | -0.045 | | |
| | (TR3) Traffic accident risks No.1 | 0.078* | | |
| | (TR4) Traffic accident risks No.2 | 0.089* | | |
| 4 | | | 1.94 | 0.23 |
| | (NR1) Food and health related risks | 0.104** | | |
| | (NR2) Living style related risks | 0.001 | | |
| | (NR3) Environment related risks | 0.006 | | |
| | (NR4) Radiation related risks | -0.018 | | |
| | (NR5) Risks caused by street crime and political unrest | -0.006 | | |

Dependent variable = mean score of pedestrian behaviour (higher scores indicating safer behaviour)
Significant (p <.001 F-change in bold)
*p < .05; **p < .01; ***p < .001

4.4. Structural equation model of the relationships between attitudes, risk perceptions and pedestrian behaviour

Structural Equation Modelling (SEM) was conducted to test the developed hypotheses on the relationships between attitudes towards traffic safety, traffic risk perception, non-traffic risk perception and pedestrian behaviour. As showed in Figure 2, the latent variables of the SEM model were the four constructs under this study (i.e. pedestrian behaviour, attitudes towards traffic safety, traffic risk perception, and non-traffic risk perception) and the composite scores of their respective dimensions were used as manifest indicator variables receiving loadings from these latent factors as suggested by previous research [15]. For example, attitudes towards traffic safety consisted of six indicator variables in which each indicator variable was a factor of attitudes towards traffic safety as showed in Table 2 and these indicator variables of traffic safety attitudes were computed by averaging their items of the corresponding factor presented in the same table.

Figure 2 presents the estimated model with standardized path coefficients. The model had an acceptable fit to the data, with most model fit indices satisfying the conventionally acceptable levels ($\chi^2/df = 4.30$, $p <.001$ ($n = 835$), RMSEA = 0.063, CFI = 0.841, GFI = 0.924, AGFI = 0.901). Attitudes towards traffic safety strongly predicted pedestrian behaviour ($\beta = .52$, $p < .001$); road users who had safer attitudes towards traffic safety reported performing safer pedestrian behaviours. Increased traffic risk perception weakly predicted safer pedestrian behaviour ($\beta = .10$, $p = .057$). Non-traffic risk perception was found to be a significant predictor of the traffic risk perception ($\beta = .45$, $p < .001$) in which road users who perceived higher non-traffic risks also perceived higher traffic risks. Furthermore, both types of risk perceptions were significant determinants of attitudes towards traffic safety ($\beta = .15$, $p < .001$ and $\beta = .22$, $p < .001$ for non-traffic risk perception and traffic risk perception, respectively); respondents who perceived higher risks also reported safer attitudes towards traffic safety. The model could explain 31% of the variance in pedestrian behaviour and 10% of the variance in attitudes towards traffic safety.

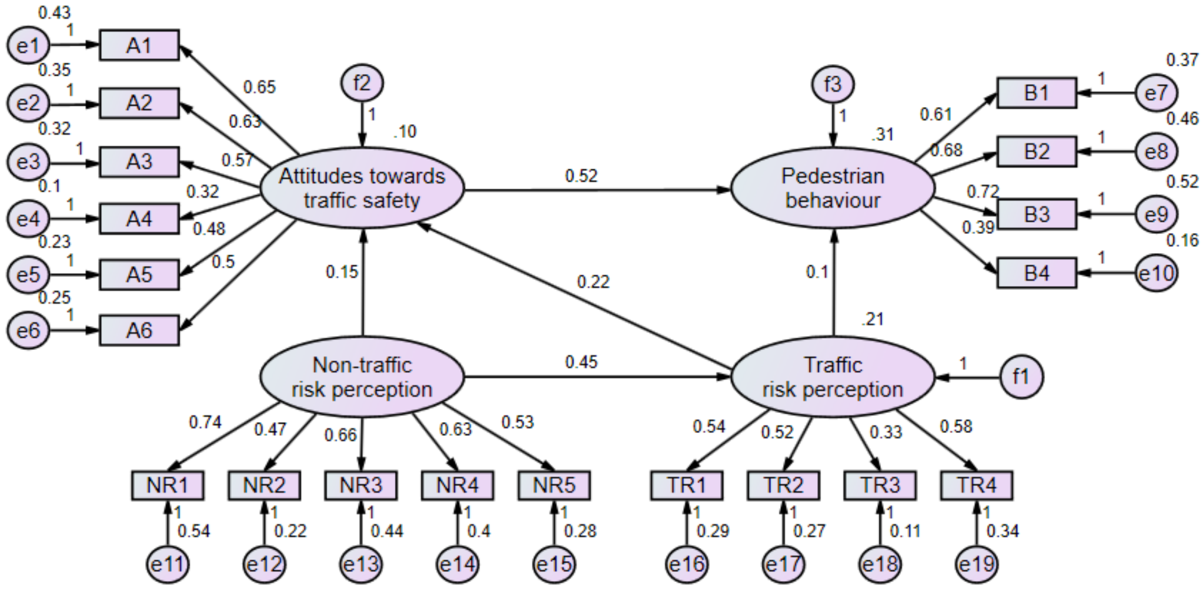


Figure 2: Structural equation model of the relationships between attitudes towards traffic safety, traffic risk perception, non-traffic risk perception and pedestrian behaviour ($\chi^2$/df = 4.30, p <.001 (n = 835), RMSEA = 0.063, CFI = 0.841, GFI = 0.924, AGFI = 0.901)

## 5. Discussion

The primary objective of the present research was to explore the associations between attitudes towards traffic safety, risk perceptions and pedestrian behaviours. The results of structural equation modelling (SEM) and regression analyses, using data from a survey of 835 road users in Vietnam (a middle-income, developing country in Asia) have indicated that these relationships do indeed exist.

As expected, this study found that safer attitudes towards traffic safety were associated with safer self-reported pedestrian behaviours. Previous studies found attitudes towards traffic safety as strong predictors of driver behaviours (e.g., [9,10,11]); the current research has shown that this is also true in the case of pedestrian behaviours. More specifically, three facets of attitudes towards traffic safety (i.e., attitude towards the careless driving of others, attitude towards traffic rule violation in specific situations, and attitude towards traffic rules and speed limits in general) were found to significantly predict self-reported pedestrian behaviour. These attitudes should be targeted in road safety interventions in Vietnam aimed at changing pedestrian behaviour.

As showed in Table 8, the addition of all four factors of non-traffic risk perceptions do not contribute to a significant improvement of the regression models on pedestrian behaviour. This result supported for the hypothesis that non-traffic risk perceptions do not directly relate to pedestrian behaviours. In contrast, traffic risk traffic risk perception was found to have a direct effect on the behaviour. As can be seen from the results of both the regression analysis (seen Table 8) and the SEM model (see Figure 2), road users who stated higher level of traffic risk perceptions tended to report performing safer pedestrian behaviours. This result is similar to the findings of previous works in the field of driver behaviours (e.g., [17,18,19,20,21]). As presented in Table 8, among the four dimensions of traffic risk perceptions, the two related to traffic accidents did predict self-reported pedestrian behaviours in a statistically significant way. This finding indicates that risk perception pertaining to specific traffic accidents and situations plays a more significant role on pedestrian behaviour than the perception of general traffic risk (i.e., general traffic risks when interacting with the road system in a particular role, e.g., driver, pedestrian, passenger, etc.). This result supports the argument by Nordfjærn and Rundmo [24] who suggested that the relationship between traffic risk perception and driver behaviour found in some previous research was weak because those studies measured general risk perceptions, not perceptions or risk pertaining to specific traffic accidents and situations.

The current research also revealed a role of traffic risk perception on pedestrian behaviour through its influence on attitudes towards traffic safety. These findings were consistent with the findings from the study of Yao and Wu [43] in which risk perception had a direct impact on e-bike riders' aberrant riding behaviour, and safety attitude partially mediated the association between risk perception and behaviour.

Both traffic risk perception and non-traffic risk perception were found as determinants of attitudes towards traffic safety, and traffic risk perception was found to partially mediate the relationship between non-traffic risk perception and the attitudes (as shown in the SEM model, Figure 1). The results showed that a higher perception of risk is associated with safer attitudes towards traffic safety. This finding is consistent with findings from research by Ram and Chand [32] in which drivers who perceived higher levels of risk also reported more positive road safety attitudes.

A strong correlation between non-traffic risk perception and traffic risk perception was found in the present study. Similar to the finding of Şimşekoğlu et al. [29], risk perception in traffic is associated with risk perception in other domains, such as health and the environment. In the present study, road users who perceived higher non-traffic risks also had a tendency to perceive higher traffic risks. The results can be explained according to the theory of risk amplification attenuation [28]; people who rate risk as high or low in one domain tend to have corresponding perceptions of risk in other domains.

Regarding demographic variables, in line with previous works [25,6,26,44], males and younger road users had a tendency to report less safe pedestrian behaviour.

The findings of this present research provide useful information for road safety interventions and the development of education and training programs for road users in Vietnam. First, since traffic safety attitudes and traffic risk perceptions were found as the two significant factors influencing pedestrian behaviour, road safety campaigns that target traffic safety attitudes and traffic risk perceptions should be conducted to obtain safer pedestrian behaviours. Specifically, several factors of attitudes towards traffic safety (i.e., attitude towards the careless driving of others, attitude towards traffic rule violation in specific situations, and attitude towards traffic rules and speed limits in general) significantly associated with pedestrian behaviour as showed in Table 8 should be focused. In other words, efforts to educate road users about traffic safety should be emphasized on obeying traffic rules and regulations and opposing against drivers who had careless driving behaviour. In addition, road users should be well informed about the risk of traffic accidents and their consequences to reinforce their favourable traffic risk perceptions since the corresponding factors of risk perception have been found as significant variables of both traffic safety attitudes and pedestrian behaviour as illustrated in Table 7 and Table 8. Furthermore, at a less extent, improving general risk perceptions may also produce desirable pedestrian behaviours because general risk perceptions affected both traffic safety attitudes and traffic risk perceptions.

This current research is the first effort to measure and analyse several variables including self-reported pedestrian behaviour, attitudes towards traffic safety, traffic risk perception, and non-traffic risk perception using a road user sample in Vietnam – a developing middle-income country in Asia with poor pedestrian facilities. While low- and middle-income countries differ much with high-income countries on local circumstances as respect to road safety [45], therefore, it should be noted some similarities and differences on factor structures of each variable found in this study sample as compared to the factor structures as shown in literature. This current study identified four factors for pedestrian behaviour (i.e., violations and errors; lapses; aggressive behaviours; and positive behaviours) which are similar to those factors found in the work of Granié et al. [36]. Previous research [10,11] identified three factors for attitudes towards traffic safety (i.e., attitudes towards rule violations; attitudes towards responsibility in traffic; and attitudes towards drinking and driving), while this study sample produced a six-factor solution to depict this variable (see Table 2). With regards to traffic risk perception, past research [11,18,24] showed two factors for this variable (i.e., traffic accident risks or risk perception related to specific traffic situations; and general traffic risks or role-related risk perception), whereas four factors for this variable were found in this study sample (see Table 3). Differences were also observed for the factor structure of non-traffic risk perception in this current study (see Table 4) as compared to the structures found in the previous work [29]. These aforementioned differences in factor structures of the studied variables may partly come from the fact that some more items were added to the tools for measuring the variables (as the case of attitudes towards traffic safety); however, it may also come from cultural differences. This would require additional, targeted research to clarify.

It is important to bring attention to the limitations of the present study. First, despite the attempt to reassure respondents about data confidentiality and anonymity, the self-reported nature of the data may lead to social desirability bias. Second, the study sample seems to be somewhat weighted to younger and highly educated groups, therefore it would be beneficial to replicate this research with a more representative sample. Also, 66.6% of participants in the current study stated that the motorcycle is their main means of transport. Although this accurately reflects the case of traffic flow in Vietnam, these individuals may have different views of safety and risk than people travelling mainly on foot, for example. Furthermore, this is the first study conducted in Vietnam that examines the relationships between attitudes towards traffic safety, risk perceptions, and pedestrian behaviours; as such, the measurement scales used in this study have not been previously validated with Vietnamese road users, and had differences as compared to those found in previous studies as aforementioned. Further research on validating these measurement scales in Vietnam is highly recommended.

## 6. Conclusions

The limitations notwithstanding, the present paper has demonstrated the existence of relationships between attitudes towards traffic safety, risk perceptions, and pedestrian behaviours in a sample of Vietnamese road users. The results showed that safer attitudes towards traffic safety were associated with safer pedestrian behaviours. At a more specific level, attitudes towards the careless driving of others, attitudes towards traffic rule violation in specific situations, and attitudes towards traffic rules and speed limits in general were found to be significant predictors of self-reported pedestrian behaviour. Traffic risk perception was found to have a direct effect on pedestrian behaviour in which road users who perceived higher level of traffic risk tended to also report performing safer pedestrian behaviour. The study results also demonstrated the role of traffic safety attitudes as a mediator between traffic risk perception and pedestrian behaviour. In addition, non-traffic risk perception positively impacted on traffic risk perception. Furthermore, people who had higher level of risk perceptions, either non-traffic risk perception or traffic risk perception, were also prone to report safer attitudes towards traffic safety. The findings provide a useful framework for traffic safety interventions aimed at changing pedestrian behaviour through the alterations of attitudes towards traffic safety as well as risk perceptions. Further research is recommended to evaluate the changes in objectively-measured pedestrian behaviour resulting from the manipulations of the significant variables identified in this study.

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