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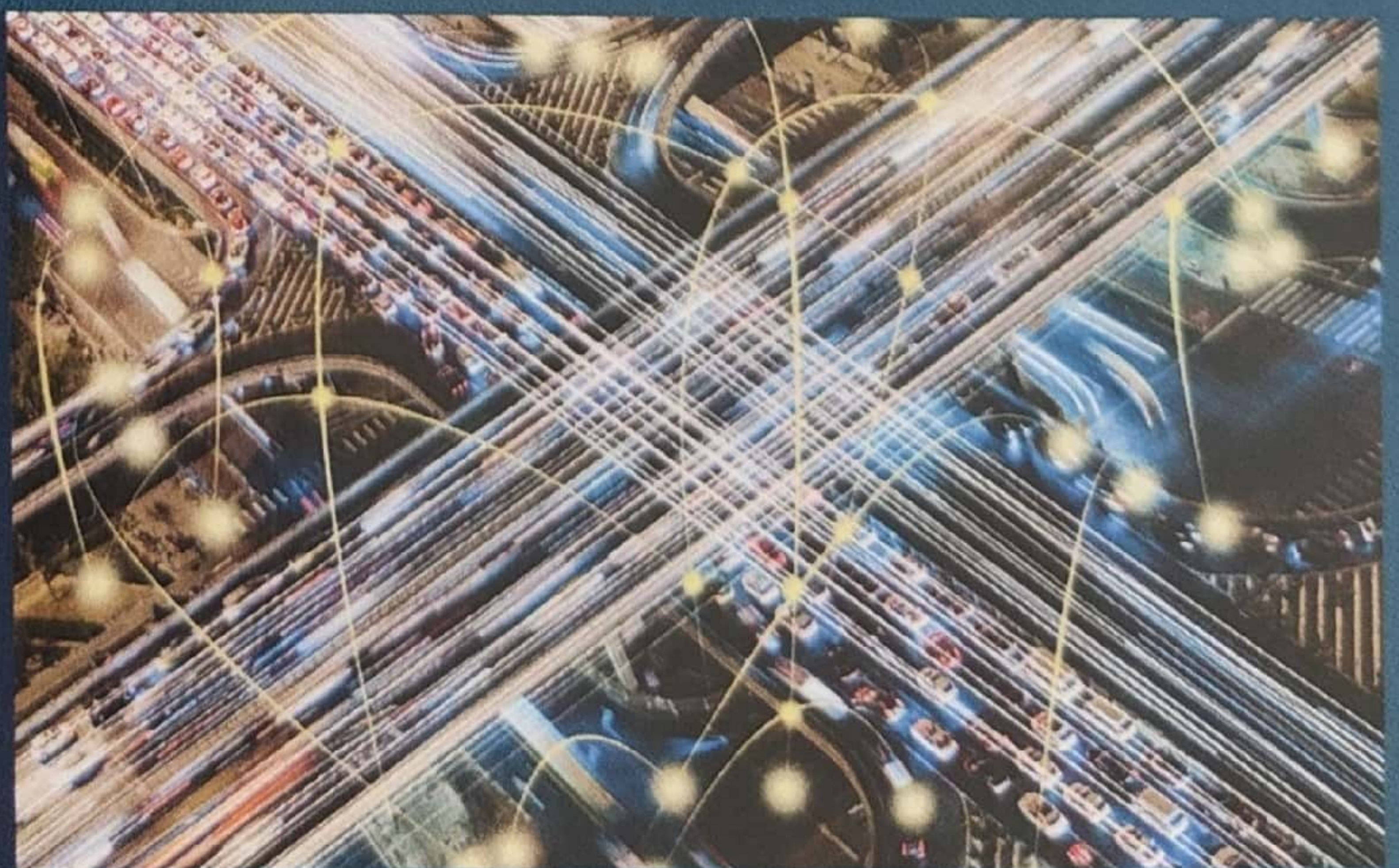


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System and Human Errors in Vietnam Motorcycle Road Traffic: A Study Using the Extended Driving Behaviour Questionnaire (DBQ)

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Abstract: Accidents on the road are a global problem affecting public health and the economy. According to the World Health Organization (WHO), the number of people who are killed in traffic accidents around the world reaches 1.35 million per year, with more than 90 per cent of those deaths occurring in low- and middle-income nations, with one fatality for every 23 per cent of the population. Most people in Vietnam get around on motorcycles, which account for 95% of the country's vehicle fleet and have the highest ownership rate per capita of any country in South-East Asia. This mode of transport contributes to a high proportion of road traffic collisions, accounting for about 60% of all road traffic accidents. The primary objective of the present study is to offer a thorough understanding of riding behaviours in Vietnam through the integration of the driving behaviour questionnaire (DBQ), which focuses on human errors, and the Traffic Climate Scale, which addresses system errors, to examine their association with risk-taking attitudes in relation to motorcycling. The study bears significant relevance for policymakers and traffic managers, as it offers valuable insights to help them design effective interventions to enhance motorcycle safety in Vietnam.

Keywords: "Driving behaviour", "Traffic climate", "Risk-taking attitude", "Motorcyclist", "Young adult", Vietnam".

1. Introduction

The increasing prevalence of motorcycles has led to their widespread use in various social and economic activities. However, the high number of motorcycles on the roads and the risky nature of the motorcycle-traffic environment pose significant threats to road users. These threats are well documented in previous studies (Bui et al, 2020; Ha et al., 2018; WHO, 2015) and are exemplified by the alarming statistic that motorcyclists account for 43% of all deaths in the South-East Asia region according to the World Health Organization (WHO, 2018). Vietnam has over 50 million motorcycles in use, with up to 79% of the population relying on them for transportation, making it one of the countries with the highest motorcycle dependence worldwide. The Vietnamese National Traffic Safety Committee has reported an average of 8,500 fatalities on the roads each year, with over 90% of the victims being motorcyclists and their passengers (Bui et al., 2020). The economic impact of these fatalities is enormous, with losses exceeding \$2 billion per year (UN, 2018). Seventy-five per cent of the blame for these losses can be placed on motorcyclists. Given these numbers, there is an immediate need to improve the safety of people who ride motorcycles.

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		Mean	SD
1. Lapses (Koppel et al., 2018)			
LAP1	Forget where you left your motorbike in a parking lot	2.69	1.298
LAP2	I often missed turns and had to take a detour	3.03	1.197
LAP3	Get into the wrong lane to make a left or right hand turn at an intersection	2.29	1.137
LAP4	Intending to drive to destination A, you wake up and realise you are driving to destination B	2.47	1.217
LAP5	I often get confused when I turn on my signal light to ask for permission to turn right, but then I actually need to turn left	1.83	1.074
2. Violations (Koppel et al., 2018)			
VI01	Become impatient with a slow driver in the right lane and pass in the right lane	2.99	1.221
VI02	When I drive, I often don't wear a helmet	1.42	0.903
VI03	Drive with only half an eye on the road while looking at a road map, dialling/text messaging on a cell phone	2.01	1.075
VI04	Deliberately disregard the speed limits late at night or very early in the morning	2.45	1.339
VI05	Drive especially close or flash the car in front as a signal to drive faster or get out of your way	2.00	1.070
VI06	Stuck behind a slow-moving vehicle on a two-lane highway, you are driven to frustration to try to pass under risky circumstances	2.13	1.127
VI07	Race oncoming vehicles for a one-car gap on a narrow or obstructed road	1.91	1.173
3. Errors (Koppel et al., 2018)			
ERR1	Misjudge the speed of an oncoming vehicle when passing	2.23	1.045
ERR2	Try to pass a car without first checking in your mirror, and then get honked at by the car behind you which has already begun to pass	1.90	1.024
ERR3	Turn left on to a main road into the path of an oncoming vehicle that you hadn't seen or who's speed you had misjudged	2.12	1.003
ERR4	Fail to notice pedestrians crossing when turning into a side-street from a main road	2.08	1.062
ERR5	Fail to check your mirror before pulling out, changing lanes, turning etc.	1.92	1.047
ERR6	Lost in thought or distracted, you fail to notice someone waiting at a crosswalk light that has just turned red	1.99	1.020
ERR7	Fail to notice someone stepping out from behind a bus or parked vehicle until it is nearly too late	2.30	1.098
ERR8	Attempt to pass a vehicle that you hadn't noticed was signalling its intention to turn right	1.98	1.058
4. Risk-taking attitude (Iversen, 2004; Neal & Griffin, 2006)			
RTA1	If you are a good driver, it is acceptable to engage in risky driving behaviours sometimes	2.29	1.179
RTA2	Taking chances and breaking a few rules does not necessarily make bad drivers	2.56	1.244
RTA3	Traffic rules are often too complicated to be carried out in practice	2.58	1.102
RTA4	Traffic rules do not need to be respected in bad conditions of road and weather	1.86	1.057
RTA5	I consider myself to be a risk-taker	2.21	1.170
5. External affective demands (UZUMCUOGLU, 2020)			
EAD1	Aggressive	3.43	1.175
EAD2	Stressful	3.25	1.111
EAD3	Depend on luck	3.46	1.116
EAD4	Putting pressure on you	3.18	1.125
EAD5	Chaotic	3.46	1.191
EAD6	Making irritated	3.25	1.158
EAD7	Time-consuming	3.15	1.198
EAD8	Annoying	2.99	1.203

6. Functionality (UZUMCUOGLU, 2020)			
FNC1	Planned	3.38	1.088
FNC2	Harmonious	3.05	1.110
FNC3	Safe	3.18	1.127
FNC4	Functional	3.29	1.100
FNC5	Free-flowing	3.15	1.141
Internal requirements (UZUMCUOGLU, 2020)			
IRQ1	Requiring you on the alert	4.14	1.035
IRQ2	Requiring cautiousness	4.27	0.978
IRQ3	Requiring vigilance	4.36	0.940
IRQ4	Requiring experience	4.01	1.032
IRQ5	Requiring patience	4.06	1.042
IRQ6	Requiring skillfulness	4.11	1.000

Table 1 : Constructs and measurements items

(The items in italics have been adjusted to reflect the reality in Vietnam and for motorcyclists)

3.3. Data analysis

The study developed six hypotheses that highlight the causal links among five concepts: internal requirements, functionality, external affective demands, risk-taking attitude, errors, violations, and lapses. To investigate all of the interdependencies that exist between latent variables in a single go, structural equation modelling (SEM) was determined to be the most effective method. SEM is a modelling strategy that maps pathways to multiple dependent variables in the same research model and examines all of the paths concurrently rather than one at a time. This technique is used to reduce the amount of time spent on the modelling process. There are two different kinds of SEM: covariance-based SEM (also known as CB-SEM) and least squares-based SEM (also known as PLS-SEM). CB-SEM should be performed when determining whether or not well-established ideas are consistent with reality. In contrast, PLS-SEM is utilised for exploratory analysis and when putting developing hypotheses to the test. PLS-SEM was utilised so that we could accomplish the objectives of this investigation. To analyse the data, we used a two-stage process that was powered by SmartPLS 3.0. It was important to establish the discriminant and convergent validity of the measuring instruments (the measurement model) before evaluating the suggested linkages among theoretical components (the structural model). This was done so that the structural model could test the proposed correlations.

4. Results

4.1. Demographic characteristics

Demographic characteristics of the participants were collected to provide a better understanding of the study sample. As shown in Table 2, of the 292 participants, 163 (55.8%) were male, and 129 (44.2%) were female. Regarding licensing status, 234 (80.1%) participants held a driver's license, while 58 (19.9%) did not.

Participants' driving experience was also assessed, with 51 (17.5%) reporting less than two years of experience, 181 (62%) reporting two to less than five years of experience, and 60 (20.6%) reporting over five years of experience.

Regarding crash history, most participants (64.4%) reported no crashes in the last 12 months, while 31.8% reported 1-2 crashes, and only 3.8% reported 3-4 crashes. None of the participants reported more than 4 crashes in the last 12 months.

Participants were also asked to rate the impact of their crashes, with 58.2% reporting no crashes, 32.5% reporting mild crashes, 7.2% reporting moderate crashes, and only 2.1% reporting serious crashes.

Near-crashes in the last 12 months were also assessed, with 26.4% of participants reporting no near-crashes, 50.7% reporting 1-2 near-crashes, 16.1% reporting 3-4 near-crashes, and 6.8% reporting more than 4 near-crashes. Regarding traffic offences, the majority of participants (65.8%) reported no offences, while 24% reported 1-2 offences, 3.1% reported 3-4 offences, and 7.2% reported more than 4 offences. Finally, participants' hometowns were assessed, with 148 (50.7%) reporting an urban hometown and 144 (49.3%) reporting a rural hometown. These demographic characteristics provide a comprehensive overview of the study sample and may aid in the interpretation of the study results.

Characteristic	Frequency	Percentage (%)
Gender		
Male	163	55.8
Female	129	44.2
License		
Yes	234	80.1
No	58	19.9
Driving experience		
Less than 2 years	51	17.5
From 2 to less than 5 years	181	62
Over 5 years	60	20.6 %
Crashes in the last 12 months		
0	188	64.4
1-2	93	31.8
3-4	11	3.8
>4	0	0
Crashes' impact		
No crashes	170	58.2
Mild	95	32.5
Moderate	21	7.2
Serious	6	2.1
Near-crashes in the last 12 months		
0	77	26.4
1-2	148	50.7
3-4	47	16.1
>4	20	6.8
Offences		
0	192	65.8
1-2	70	24
3-4	9	3.1
>4	21	7.2
Times being fined		
0	258	88.4
1-2	28	9.6
3-4	3	1
>4	3	1
Hometown		
Urban	148	50.7
Rural	144	49.3

Table 2 : Demographic characteristics of respondents

4.2. Measurement model evaluation

Three criteria must be evaluated to assess the quality of reflective measurement models: internal consistency reliability, convergent validity, and discriminant validity (Hair et al., 2014). The PLS-SEM approach measures internal consistency using composite reliability (CR). Table 3 displays that all five constructs had CR values above 0.7, ranging from 0.777 to 0.955, which aligns with the guideline recommended by Henseler, Ringle and Sinkovics (2009). The average variance extracted ranges from 0.414 to 0.781, 3 constructs have AVE below the recommended level of .5. However, Fornell and Larcker (1981) suggest that this estimate may be conservative and that the convergent validity of the construct can still be considered adequate based on the composite reliability value alone, even if over 50% of the variance is due to error. As the composite reliability values of the three constructs are well above the acceptable threshold, the internal reliability of the measurement items can be deemed acceptable (Lam, 2012).

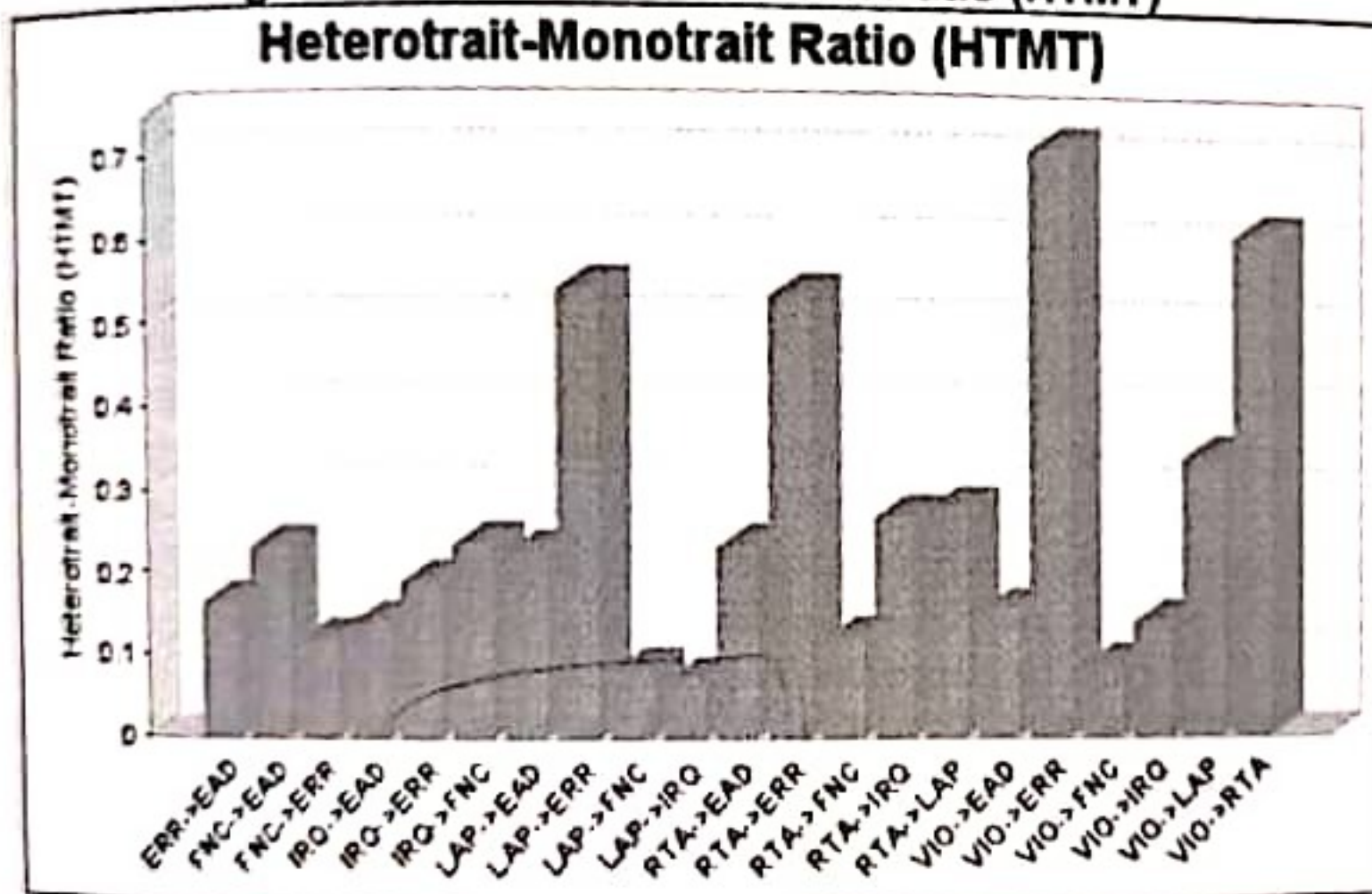
Dimension/Items	Outer loadings	Composite Reliability	AVE	VIF
LAP - LAPSES		0.798	0.445	
LAP1	0.540			1.188
LAP2	0.601			1.307
LAP3	0.673			1.555
LAP4	0.703			1.487
LAP5	0.792			1.290
VIO - VIOLATIONS		0.846	0.443	
VIO1	0.495			1.219
VIO2	0.625			1.459
VIO3	0.655			1.654
VIO4	0.757			1.807
VIO5	0.672			1.404
VIO6	0.743			1.547
VIO7	0.676			1.416
ERR - ERRORS		0.897	0.522	
ERR1	0.684			1.678
ERR2	0.751			1.850
ERR3	0.782			1.939
ERR4	0.750			2.006
ERR5	0.709			1.882
ERR6	0.732			1.929
ERR7	0.669			1.729
ERR8	0.695			1.629
RTA – RISK-TAKING ATTITUDE		0.777	0.414	
RTA1	0.526			0.526
RTA2	0.582			0.582
RTA3	0.754			0.754
RTA4	0.653			0.653
RTA5	0.676			0.676
EAD - EXTERNAL AFFECTIVE DEMANDS		0.929	0.620	
EAD1	0.738			2.101
EAD2	0.747			2.213
EAD3	0.817			2.791
EAD4	0.807			2.374
EAD5	0.808			2.865
EAD6	0.784			2.392
EAD7	0.782			2.172
EAD8	0.810			2.517
FNC - FUNCTIONALITY		0.941	0.763	

FNC1	0.720			
FNC2	0.898			1.739
FNC3	0.926			3.090
FNC4	0.911			4.399
FNC5	0.897			3.897
IRQ - INTERNAL REQUIREMENTS		0.955	0.781	4.069
IRQ1	0.835			
IRQ4	0.907			4.864
IRQ5	0.907			3.283
IRQ6	0.925			3.364
				3.743

Table 3 : Measurement model evaluation

The second criterion, convergent validity, is evaluated using two criteria: outer loadings and average variance extracted (AVE). An outer loading of 0.7 or higher is considered highly satisfactory (Götz, Liehr-Gobbers, & Krafft, 2009; Henseler et al., 2009). However, in exploratory research with new scales and dimensions, an outer loading above 0.5 is regarded as acceptable (Chin, 1998). Table 4 shows that the outer loadings for all measurement items, except for variable VIO1, which was eliminated due to its outer loading being less than 0.5, all items met Chin's (1998) threshold. The third criterion is discriminant validity. To evaluate discriminant validity, the HTMT criterion was utilised. As shown in Figure 1, the HTMT value for each construct was less than 0.9 with all constructs, indicating that all measurement instruments proposed in this study exhibited adequate discriminant validity (Hair Jr et al., 2021).

Figure 1 : Heterotrait-Monotrait Ratio (HTMT)



According to Hair et al (2006), multicollinearity can be assessed using the variance inflation factor (VIF). A VIF score of less than five is generally considered acceptable, indicating low multicollinearity among the measurement items. Based on our analysis, all items satisfied this criterion except IRQ2 and IRQ3, which were removed due to VIF scores greater than 5.

Overall, the assessment of the measurement model demonstrated that all six constructs possessed high internal reliability and validity for the evaluation of the structural model.

4.3. Structural model evaluation

To assess the significance of the path relationships between the constructs in the proposed model, a bootstrapping procedure was performed with 292 cases and 5000 resamples. The regression coefficient (β) and its significance were examined. The path coefficient was considered significant if the empirical t-value exceeded 1.96 at a significance level of 5%, per the recommended threshold by Hair et al. (2014). The findings in Table 4 demonstrate that all paths were significant except for Hypothesis 2. These results suggest that the proposed model robustly represents the relationships among the constructs under investigation.

	Direction	Path coefficient	Standard Deviation	t	P-Values	Conclusion
H1	EAD -> RTA	0.250	0.065	3.856	0.000	Supported
H2	FNC -> RTA	0.050	0.079	0.627	0.531	Rejected
H3	IRQ -> RTA	-0.246	0.073	3.371	0.001	Supported
H4	RTA -> ERR	0.431	0.060	7.138	0.000	Supported
H5	RTA -> LAP	0.226	0.060	3.760	0.000	Supported
H6	RTA -> VIO	0.459	0.056	8.211	0.000	Supported

Table 4 : Structural model evaluation

5. Discussions and conclusions

5.1. Discussions

The principal objective of this investigation was to scrutinise the interrelations among the different components of traffic climate, risk-taking attitudes, and the driving behaviour of motorcyclists in Vietnam. Except for the impact of functionality on risk-taking attitudes, the study's findings offer empirical evidence in support of five out of six proposed hypotheses.

The results of this study suggest that external affective demand positively impacts risk-taking attitudes among motorcyclists in Vietnam. This suggests that persons who view their traffic situation as extremely emotionally demanding from the outside tend to engage in higher amounts of risk-taking activities. This conclusion is consistent with earlier research that has related external stressors, such as traffic congestion and road rage, to greater risk-taking attitudes and behaviours (Emo, Matthews, & Funke, 2016; Galovski & Blanchard, 2004). Specifically, these stressors have been linked to increased risk-taking attitudes and behaviours in young adults.

In contrast, internal requirements had an adverse effect on risk-taking attitudes. This suggests that persons who view the traffic situation in which they are operating to be extremely mentally demanding tend to exhibit lower risk-taking behaviours. This result is consistent with the findings of prior studies that pinpointed the influence of internal influences on a person's driving behaviour (Măirean et al, 2017; Megias-Robles et al, 2022).

Functionality relates to both safety and mobility and the importance of a traffic system that operates effectively. This encompasses aspects such as the design, arrangement, and standard of the road infrastructure, which includes elements like road width, lane markings, signs, lighting, and traffic signals. While the findings of this study indicate that functionality may not have a direct impact on risk-taking attitudes, future research could explore potential indirect effects, for instance, through the influence of external affective demands and internal requirements, on risk-taking attitudes.

The findings of this study indicate that there may be a correlation between risk-taking attitudes and dangerous driving behaviours among motorcyclists in Vietnam. This correlation was shown to have a statistically significant level of significance. The study's findings indicated, more specifically, that an increase in risk-taking attitudes was connected with an increase in driving infractions and errors made while behind the wheel. This finding is in line with findings from earlier studies that have demonstrated a positive association between risk-taking attitudes and unsafe driving behaviours (Iversen, 2004; Ma et al., 2010; Sheykhfard et al., 2023).

The findings of this study have significant repercussions for the interventions on road safety. Specifically, treatments attempting to reduce dangerous driving behaviours among motorcyclists should consider the role of risk-taking attitudes in promoting such behaviours that are being reduced. This is because risk-taking attitudes are directly related to the behaviours, such as overconfidence or craving for excitement, to decrease risky-driving behaviours. This would be done to reduce the number of accidents caused by reckless drivers. In addition, interventions that emphasise improving road safety culture and promoting safer driving behaviours may reduce risky driving behaviours among motorcyclists.

In general, the findings of this study make a significant addition to the area of research pertaining to road safety in Vietnam. However, it is essential to note that the findings pertain solely to the circumstances of the Vietnam study and may not be applicable to the experiences of other groups or settings. These findings need to be validated by other research. It would also be beneficial to investigate other potential factors that may influence dangerous driving behaviors among motorcyclists in various circumstances. In spite of this, the findings of this study provide vital insights into the complicated interaction between traffic conditions, risk-taking attitudes, and driving behaviour among motorcyclists in Vietnam. Furthermore, they lay the groundwork for effectively designing road safety measures in the nation.

5.2. Conclusion

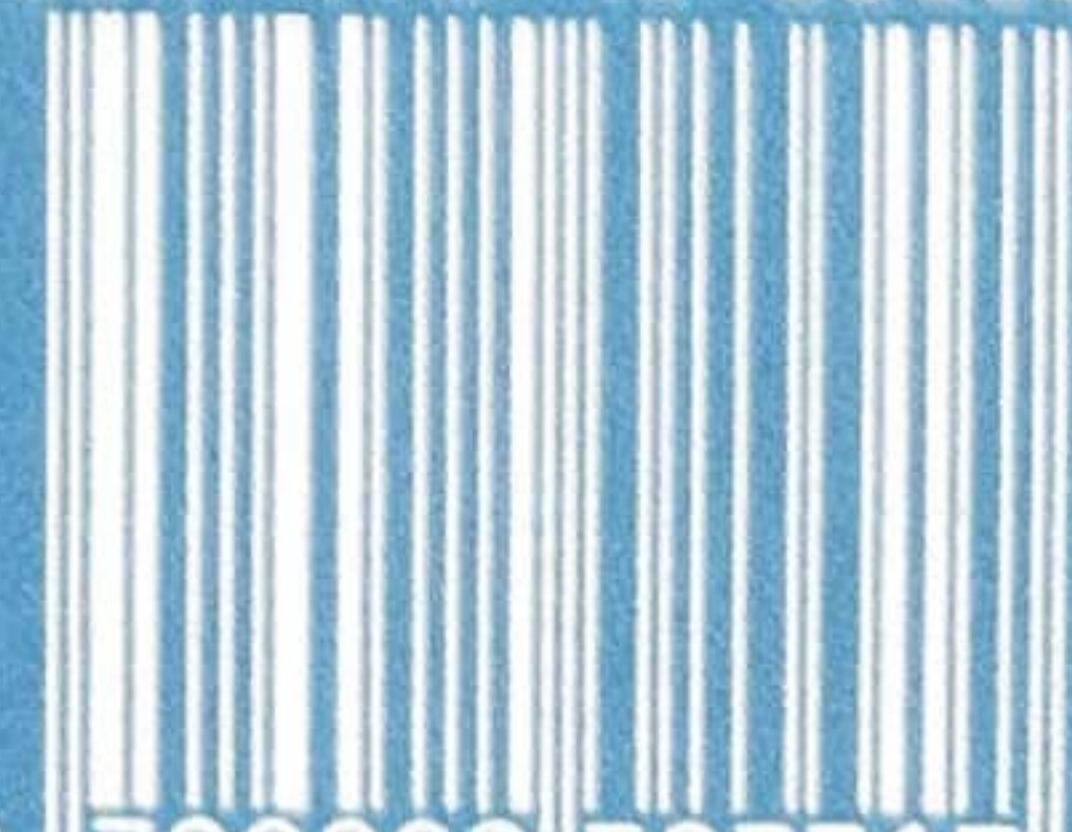
This study provides substantial and valuable insights into the multidimensional interaction between numerous components of traffic climate, risk-taking attitudes, and driving behaviour among motorcyclists in Vietnam. In summary, this study gives major and valuable insights into the relationship between these factors. This analysis was carried out in the specific setting of Vietnam, which has unique transportation constraints and cultural elements that influence driving behaviour. The findings of this study have substantial ramifications for policymakers and traffic management in Vietnam, who are attempting to implement targeted interventions to improve road safety and minimise dangerous driving behaviours among motorcyclists in the country.

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