The Motorcycle Rider Behavirour Questionnaire (MRBQ) in relation to on-road crash risks and traffic offences in Vietnam

1 Introduction

The motorcycle has become the essential mean to ensure the livelihood of the majority of people in motorcycling countries; however, the enormous number of bikes, plus the inherent threatening attributes of motorcycle traffic and the complexity of riding situations contribute to the significant hazards for the riders. (Jadaan et al., 2018; Vlahogianni et al., 2012; WHO, 2017). Statistics from the World Health Organization indicates that motorcyclists continue significantly overrepresented in all traffic deaths, with fatality rate befalling 28 times more often those of passenger vehicle occupants, based on per mile travelled; for example, in South-East Asia, motorcyclists accounts for 43% of all traffic deaths (WHO, 2018). Enhancing traffic safety for motorcyclists is consequently a pressing matter.

Driving behaviours have been found to be a decisive component behind 90-95% of the traffic accidents (Evans, 1970; Lin and Kraus, 2009) so that understanding motorcyclists' on-road behaviour is critical for not only the development but also the evaluation of the countermeasures specifically targeted for reducing both the number of crashes and the severity of riders' injury.

After the success of the **Driver Behavior Questionnaire** (Reason et al., 1990), one of the most widely used instruments for investigating four-wheeled vehicles driver behaviors, the **Motorcycle Rider Behavior Questionnaire (MRBQ)** was developed to measure behaviors relevance to motorcycling (Elliott et al., 2007). As long as the direct observation and official traffic records are not feasible due to limited resources, self-report can be a valuable method to collect data and advantageous for motorcycle safety research and practice. According to the original MRBQ, on-road riding behaviours could be distinguished into five factors, i.e. traffic errors (unintentional mistakes made by the rider), control errors (motorcycle handling lapses), speed violations, the performance of stunts (intended excitement seeking actions) and the use of safety equipments. Following its development, there have been several alternative explications on the initial factor structure of MRBQ (Table 1).

Table 1

The MRBQ factor structures across countries.

Country (Author, Public year)	**Sample size**	**% Male**	**Factors:** Items from original MRBQ *(and authors' additional items)*
The United Kingdom (Elliott et al., 2007)	8666	92	**Traffic errors:** 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13 **Speed violations:** 14, 15, 16, 17, 18, 19, 20, 21, 22 **Stunts:** 23, 24, 25, 26 **Control errors:** 35, 36, 37, 38 **Safety equipments:** 27, 28, 29, 30, 31, 32, 33, 34
Iran (Motevalian et al., 2011)	518	100	**Traffic errors:** 1, 2, 4, 5, 6, 7, 8, 9, 10, 11, 12, *and 01 additional item* **Speed violations:** 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, *and 01 additional item* **Safety violations:** 34, *and 06 additional items* **Traffic violations:** *05 additional items*

Country (Author, Public year)	**Sample size**	**% Male**	**Factors:** Items from original MRBQ *(and authors' additional items)*
			Stunts: 23, 24, 25, 26, 35, 36, *and 01 additional item* **Control errors:** 37, 38, 39, 40, *and 02 additional items*
Turkey (Özkan et al., 2012)	451	100	**Traffic errors:** 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 **Speed violations:** 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 22, 40 **Stunts:** 21, 23, 24, 25, 26, 42 **Safety equipments:** 27, 28, 29, 30, 31, 32, 33, 43 **Control errors:** 35, 36, 37, 38, 39
Autralia (Sakashita et al., 2014)	2375	79.2	**Traffic errors:** 1, 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 22, 35, 36, 37, 38 **Speed violations:** 14, 15, 16, 17, 18, 19, 21 **Stunts:** 23, 24, 25, 26 **Safety equipment:** 27, 28, 29, 30, 33
Malaysia (Ng et al., 2015)	204	84.8	**Traffic errors:** 1, 2, 5, 6, 7, 8, 9, 10, 11, 12, 13 **Speed violations:** 14, 15, 16, 17, 18, 19, 20 **Stunts:** 21, 22, 23, 24, 25, 26, 41 **Safety devices:** 27, 28, 29, 30, 32 **Control errors:** 35, 36, 37, 38
Australia (Stephens et al., 2017)	470	89	**Traffic errors:** 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 **Speed violations:** 14, 15, 16, 17, 18 **Stunts:** 21, 23, 24 **Control errors:** 12, 13, 35, 36, 37, 38 **Protective gear:** 27, 28, 29, 30, 32
Nigeria (Sunday, 2018)	500	100	**Control/Safety:** 23, 24, 26, 29, 31, 35, 38, 40, 41, *and 02 additional items* **Stunts**: 12, 13, 18, 22, 37, *and 02 additional items* **Errors**: 1, 3, 36, *and 01 additional item* **Speeding/Impatience:** 7, 10, 11, 15, 21, 25, *and 01 additional item*
Slovenia (Topolšek and Dragan, 2018)	205	86.3	**Traffic errors**: 1, 2, 3, 5, 6, 7, 11, 16 **Speed violations:** 18, 19, 20, 21 **Stunts:** 23, 25, 26, 27, 28 **Safety equipments:** 29, 30, 31, 32, 40 And 03 additional factors: **Helmet:** *03 additional items* **Clothing:** *03 additional items* **Alcohol:** *03 additional items*

Stunts = Performance of stunts; Safety equipment = Use of safety equipments

As can be seen from Table 1, there were not only differences in the factor structures of MRBQ across countries, but also the way items loaded under factors. For instance, items that were perceived as "Performance of stuns", intentional sensation seeking behaviors, among British riders were classified under "Control/Safety", acts in the context of losing control and safety, among Nigerian riders (Sunday, 2018). Or the "Use of safety equipments" factor is the opposite site of "Safety violations" subscale of Persian version (Motevalian et al., 2011). The previously observed distinction between Traffic errors and Control errors was not manifest among novice Australian motorists, and the forming items of those two subscales were found to load on a single Errors subscale (Sakashita et al., 2014). That evidence may reveal the variations in on-road traffic safety in cross-cultural studies.

One of the most valuable applications of the MRBQ is the prediction of the risk of riders' accident involvement. For instance, errors (traffic and control) and speed violations are some of the most significant behavioural factors that influence the on-road accident risks of motorcyclists (Elliott et al., 2007; Sakashita et al., 2014; Vlahogianni et al., 2012). Meanwhile, "Performance of

stuns" was the unique MRBQ factor correlated with crash involvement among Australian motorists (Stephens et al., 2017). Similarly, this factor was also the primary predictors of active accidents (i.e. you hit another road user or an obstacle) and offences (parking, overtaking, speeding or other) for Turkish riders (Özkan et al., 2012). A factor relating to "Using the safety equipment" emerged from data across all studies is not likely to be a determinant of a crash or a near crash.

While the majority of studies on validation and application of MRBQ was conducted in high-income countries like the United Kingdom (Elliott et al., 2007), Australia (Sakashita et al., 2014; Stephens et al., 2017), Slovenia (Topolšek and Dragan, 2018), or in some countries where most of the motorcyclists ride for pleasure like Iran (Motevalian et al., 2011), Turkey (Özkan et al., 2012), there remains a need for investigation on-road riding behaviours in the motorcycling, low/middle-income countries whose transportation systems centred around motorcycles. Therefore, MRBQ need to be validated in those countries to understand the possible causes of inconsistencies due to specific cultural, socio-economic and traffic systems.

The Vietnam Association of Motorbike Manufacturers (VAMM, 2019) reported the total number of motorbikes sold by 2018 is more than 3.38 million vehicles, an increase of 3.5% in comparison to 2017, and Vietnam currently has more than 50 million motorcycles. The advantages of motorcycles can be identified by the relatively small in size, giving maneuvering flexibility, the capability to weave through queues in congested areas, and the freedom to park practically anywhere (Hsu, 2003). Notably, the motorcycle with the capacity engine under 175cc is the major mode in traffic flow, and 79% of the population use motorcycle for regular commuting, which makes Vietnam one of the top motorcycling countries in the world (Anisa Holmes, 2017). The increase in motorcycle sales and popularity in recent years corresponds to a rising number of fatalities on Vietnamese roads. Particularly, the National Traffic Safety Committee of Vietnam announced that there are more than 8.500 people die each year from road traffic accidents, and about 90% of victims are motorcyclists and their passengers. Moreover, Vietnam economic losses more than $2 billion per year due to road traffic accidents, of which the number caused by motorcycles accounted for 75%.

It is unexpected that there is virtually a complete deficiency of systematic research on riding behavirors, one of the main factors threatening road safety, and its outcomes in Vietnam. This research was motivated by the urgent need to address the safety of motorcyclists on Vietnamese roads. The aims of the present study are: (1) to investigate the factor structure of the MRBQ, and (2) to examine the relationships between the factors of the MRBQ, background variables, and accident, traffic violation involvement in Vietnam.

2 Method

2.1 Participants and procedure

The questionnaire was administered in Vietnam, and consisted of three sections: demographic and driving experience background, information about self-reported traffic accidents and violation tickets received, and MRBQ. The data were collected using the snowball sampling technique. The trained students of the University of Danang delivered the paper-based questionnaire to the participants at parking lots and residential areas. Only people who rode a motorcycle were invited to participate in this survey, and they were assured of confidentiality and anonymity. Initially, the total number of motorcyclists recruited for this survey was **2823**. Following the removal of incomplete ones, **2254** useful samples were obtained. See **Table 2** for descriptive statistics of the participants.

Table 2

Sample characteristics.

Variable	Description of variable	N	Mean	SD
Age	Age of the motorcyclist	2254	24.3	5.9
Riding years	Total years of riding motorcycle	2254	6.1	5.2
Licencse years	Total years of holding the riding license	2254	4.9	4.7
Mileage	Average annual mileage (km)	2233	4863.8	4769.5
Near crashes	Number of near crashes (last 12 months)	2241	1.5	3.5
Crashes	Number of crashes (last 12 months)	2253	0.9	1.8
Offences	Number of penalized traffic violations (last 12 months)	2253	0.24	0.93

Variable name	N		Frequency	(%)
Gender	2250	Female	1650	73.3
		Male	600	26.7
Highest education level attained	2254	Elementary school	7	0.3
		Secondary school	23	1.0
		High school	82	3.6
		Bachelor / Engineer	2044	90.7
		Master / PhD	68	3.0
		Others	30	1.3
Marital status	2254	Single	1988	88.2
		Married	258	11.4
		Divorced	5	0.2
		Others	1	0.0
		Widowed	2	0.1
Holding a driving license	2254	No	156	6.9
		Yes	2098	93.1
Riding frequency	2254	Everyday	1953	86.6
		Several times per week	253	11.2

Variable name	N		Frequency	(%)
		Once a week	14	0.6
		Less than once a week	34	1.5
Main riding purposes	2246	Carry for free	18	0.8
		Carry for money	13	0.6
		Others	29	1.3
		Relax / Travel / Sport	27	1.2
		To working/studying places	2159	96.1
Have own motorcycle	2254	No	245	10.9
		Yes	2009	89.1
Engine capacity of own motorcycle	2006	<50cc	41	2.0
		>175cc	25	1.2
		50-175cc	1940	96.7
Self-reported near crash in the past 12 months	2254	No	996	44.2
		Yes	1258	55.8
Self-reported crash in the past 12 months	2254	No	1372	60.9
		Yes	882	39.1
Self-reported violation in the past 12 months	2254	No	1918	85.1
		Yes	336	14.9

2.2 Measures

2.2.1 Demographic questions

Questionnaire included items asking participants' sociodemographic background (e.g., age, gender, education level, marital status), and their riding information (e.g., license tenure, purpose of riding, riding frequency, average riding distance per year) and self-reported traffic accidents and traffic violations. To assess riding incidents, we asked participants "During the last 12 months, how many accidents (near-crash, crash) have you had?" and "During the last 12 months, how many traffic violations have you received?".

2.2.2 The Motorcycle Rider Behaviour Questionnaire (MRBQ)

The original MRBQ has 43 items, and for each item, the respondents are asked to rate the frequency of their behaviours during last year by choosing one of the 6 points scale (1=never, 2=hardly ever, 3=occasionally, 4=quite often, 5=frequently, and 6=nearly all the time). For all the scales, higher scores show the more frequent performance of the behaviour described. This measure has good reliability with Cronbach alpha coefficients for the five factors ranging from 0.70 to 0.84. Two researchers used the back-translation technique for translating MRBQ from English to Vietnamese. We conducted focus group discussions with 20 Vietnamese motorcyclists and 02 traffic police officers to find out what they understood from each question, and noted

unclear items. We achieved the final scales by taking their recommendation into account. Two experts with a comprehensive background in questionnaire design and transport and mobility from the University of Liège (Belgium) were also consulted to guarantee the quality of the questionnaire.

2.3 Statistical analyses

For cases missing of the MRBQ items, missing value were replaced with a 5% trimmer mean. Mean imputation was performed on 190 data points, which is 0.2% of the data.

The underlying structures of MRBQ have been established on prior empirical and theoretical grounds, so that before exploring the factor structure of the MRBQ in a representative sample of riders from Vietnam, the fit of the models previously found by all the authors in **Table 1** respectively with the present MRBQ data were examined via confirmation factor analysis (CFA) in Amos version 24. CFA was run using Maximum likelihood estimation and Asymptotically distribution-free estimation.

If the models produced poor fit to the data, the Principal Axis Factoring (PAF) and Direct oblimin method were run to examine the factor structure of the MRBQ in Vietnam. The internal consistency of the MRBQ scale scores was assessed by calculating Cronbach's alpha reliability coefficients.

Associations between demographic measures, riding information, MRBQ factors and self-reported yearly crash outcomes (near-crashes, crashes, traffic violations) were explored using **negative binomial regression**. In each of the analyses, age, gender, highest education level attained, years of motorcycle riding, years of holding the driving license, riding frequency, annual riding distances as well as MRBQ factors were used as predictors.

3 Results

3.1 Sample characteristics

The characteristics of the Vietnam sample are presented in Table 2. Most respondents of the final sample were female (73.2%), had a university degree or higher (93.7%), obtained a valid driving license (93.1%), and regularly rode motorcycles (86.6%) to the working/studying places (96.1 %). The ages of the participants were between 20 and 71, with a mean of 24.3 years (SD = 5.9). The mean level of riding experience was 6.1 years (SD = 5.2), the mean level of driving license ownership was 4.9 years (SD=4.7), and the mean of self-reported annual riding distance was 4863.8 kilometres. Typically, a motorcycle is used for short distance trip; thus, this results are within expectation.

Concerning to accident involvement over the last 12 months, 882 riders (39.1% of the sample) informed that they were involved in at least one crash (370 riders reported one crash, 264 riders reported two crashes, 108 riders report three crashes, and 140 riders reported more than three crashes), and 1258 riders (55.8 % of the sample) reported that they were involved in at least one

near-crash situation. 336 riders (14.9 %) had been get caught in one to twenty traffic violations in the last 12 months. In last year, average near crashes was 1.5 events (SD = 3.5) and average crashes was 0.9 (SD= 1.8) events.

3.2 MRBQ item scores

The most common actions reported by the participants were related to safe riding behaviours. For instance, out of an average score range of 1= never to 6=almost all the time, the two highest scoring items were: item 35 "Brake or throttle back (slow down) when going around a bend" (M= 4.56 ± 1.309); item 36 "Change gears when going around a corner or bend" (M= 4.50 ± 1.360). Apparently, in the case of motorcyclists, the relative lack of protection offered by motorcycles may cause riders to appreciate their supplemental vulnerability (Huth et al., 2014); therefore they adopt a generally defensive approach on the road, and to be less aggressive when they are riding (Rowden et al., 2016).

In constrast, the items related to use of safety equipments had relatively low scores. For example, item 43 "Wear bright/fluorescent clothing" (M= 1.43 ± 0.833), item 33 "Wear bright fluorescent strips/patches on your clothing" (M= 1.49 ± 0.947), item 42 "Wear a full leather-suit" (M= 1.50 ± 0.864), item 28 "Wear protective trousers – leather or non-leather" (M= 1.57±0.931). Noticeably, item 31 "Wear no protective clothing" had a high score (M= 3.94 ± 1.800), and it also demonstrates the behaviour relating to the use of reliable shielding equipments. Those behaviours are extremely rare among Vietnamese motorcyclists due to the lack of national road safety laws about protective gear while riding, except for the compulsory helmet legislation from August 2000 (Bao et al., 2017; Hill et al., 2009; Hung et al., 2008).

3.3 Factor analysis of MRBQ

A CFA was applied to test the internal structure of the MRBQ. The fit of the model was assessed by Chi-squared/degree of freedom ($\chi 2$/df) ratio, Goodness-of-fit index (GFI), Adjusted goodness-of-fit index (AGFI), Comparative fit index (CFI), the Root mean square residual (RMR), and the Root mean square error of approximation (RMSEA, RMSEA CL90) (Byrne, 2016; Zainudin, 2012). In general, a good fit of model should have 2:1 or 5:1 chi-squared/degree of freedom ratio, GFI >0.9 (Joreskog and Sorbom, 1984), AGFI>0.9 (Tanaka and Huba, 1985), CFI>0.9 (preferably >0.95) (Bentler, 1990), and RMSEA and RMR <0.08 or 0.01 (preferably <0.06) indexes (Browne et al., 1993).

Table 3.

Goodness of fit statistics for competing models of the MRBQ

Model	Method	$\chi 2$/df	GFI	AGFI	CFI	RMR	RMSEA	LO 90	HI 90	PCLOSE
The UK	ML	11.45	0.82	0.80	0.82	0.09	0.07	0.067	0.069	-

The UK	ADE	5.08	0.84	0.82	0.51	0.20	0.04	0.041	0.044	1.00
Turkey	ML	13.39	0.80	0.77	0.77	0.10	0.07	0.073	0.075	-
Turkey	ADE	5.65	0.82	0.80	0.44	0.20	0.05	0.044	0.047	1.00
Australia 2014	ML	15.95	0.79	0.76	0.78	0.10	0.08	0.080	0.083	-
Australia 2014	ADE	5.91	0.79	0.76	0.44	0.21	0.05	0.045	0.048	1.00
Malaysia	ML	11.28	0.85	0.83	0.85	0.09	0.07	0.066	0.069	-
Malaysia	ADE	5.13	0.83	0.80	0.53	0.19	0.04	0.041	0.044	1.00
Australia 2017	ML	11.47	0.88	0.86	0.85	0.09	0.07	0.066	0.070	-
Australia 2017	ADE	5.53	0.83	0.80	0.56	0.18	0.05	0.043	0.047	1.00
Nigeria	ML	21.394	0.814	0.77	0.73	0.126	0.10	0.095	0.093	0.097
Nigeria	ADE	7.219	0.874	0.845	0.42	0.205	0.05	0.053	0.05	0.055
Slovenia	ML	22.22	0.84	0.79	0.78	0.09	0.10	0.095	0.100	-
Slovenia	ADE	5.50	0.90	0.87	0.48	0.18	0.05	0.042	0.047	1.00

**ADE = Asymptotically distribution-free estimation; ML = Maximum likelihood estimation.*

As can be observed from **Table** 3, no model has given a good fit to the data. Given that the use of CFA presented poor fit, data were re-examined within an exploratory factor analysis (EFA) framework (Hu and Bentler, 1998; Thompson, 2004). The 43 items were subjected to PAF in order to determine the factor structure. Initially, eight factors had eigenvalues over 1.0 in Vietnam sample; nevertheless, both the Scree plot and parallel analysis recommended the 4-factor solution to be the most interpretable one. This 4-factor structure was found to be in the same line with the previous study conducted in Australia (Sakashita et al., 2014), and in Nigeria (Sunday, 2018). As there were some relatively high inter-correlations, the oblimin method of rotation was applied. The factor analysis was then rerun designating four factors.

The possibility that the factor analysis may be used without any concerns was checked by the application of the Bartlett's Test of Sphericity (BTS) and the Kaiser-Meyer-Olkin (KMO) test (Hair et al., 2018). While the BTS value was noticeably significant ($\chi 2$ (630)= 37916.7 and p <0.001), the KMO value=0.92 >0.5, and in conformity with the recommendations, the obtained BTS and KMO values suggest that the EFA can be reliably used in the further analysis (Field, 2018).

In interpreting the rotated factor pattern, six items (12 "Run wide when going around a corner", 13 "Ride so fast into a corner that you feel like you might lose control", 31 "Wear no protective clothing", 34 "Use daytime headlights on your bike", 39 "Have trouble with your visor or goggles fogging up", 40 "Another driver deliberately annoys you or puts you at risk") had low loadings for all the factors, and item 19 "Open up the throttle and just go for it on a country road" was cross-loading so that they were removed. The four factors, based on remaining 36 MRBQ items, explained 43.5% of the total variance. Questionnaire items and corresponding factor loading are presented (loading value of 0.3 were used as a cut off point) in **Table** 4.

Table 4.

Achieved results of the rotated factor pattern matrix

Item	Mean	SD	Control/ Safety	Traffic Errors	Safety Equipments	Speed/ Alcohol-related Violations
35 Brake or throttle back (slow down) when going around a bend	4.56	1.31	-0.47			
36 Change gears when going round a corner or bend	4.50	1.36	-0.46			
20 Ride between two lanes of fast moving traffic	1.52	0.83	0.47			
22 Ride so fast into a corner that you scare yourself	1.57	0.85	0.47			
26 Unintentionally do a wheel spin	1.32	0.74	0.56			
21 Got involved in racing other riders or drivers	1.39	0.78	0.58			
24 Pull away too quickly and your front wheel lifted off the road	1.29	0.71	0.65			
25 Intentionally do a wheel spin	1.26	0.72	0.65			
23 Attempt or done a wheelie	1.28	0.70	0.67			
37 Find that you have difficulty controlling the bike when riding at speed (e.g. steering wooble)	3.09	1.31		0.34		
10 When riding at the same speed as other traffic, you find it difficult to stop in time when a traffic light has turned against you	2.37	1.16		0.34		
38 Skid on a wet road or manhole cover, road making	2.63	1.11		0.38		
3 Not notice a pedestrian waiting at a crossing where the lights have just turned red	2.08	1.05		0.38		
1 Fail to notice that pedestrians are crossing when turning into a side street from a main road	2.64	0.99		0.43		
5 Miss ‘‘Give Way” signs and narrowly avoid colliding with traffic having right of way	2.11	1.05		0.51		
9 Attempt to overtake someone that you had not noticed to be signaling a right turn (in England; left turn in other countries)	2.24	0.97		0.51		
11 Ride so close to the vehicle in front that it would be difficult to stop in an emergency	2.65	1.02		0.57		
2 Not notice someone stepping out from behind a parked vehicle until it is nearly too late	2.75	1.02		0.57		
8 Distracted or pre-occupied, you suddenly realize that the vehicle in front has slowed, and you have to brake hard to avoid a collision	2.86	0.98		0.62		
7 Queuing to turn left (in England; turn right in other countries) on a main road, you pay such close attention to the mainstream of traffic that you nearly hit the car in front	2.58	1.00		0.62		
6 Fail to notice or anticipate another vehicle pulling out in front of you and had difficulty stopping	3.22	1.02		0.63		
4 Pull onto a main road in front of a vehicle you have not noticed or whose speed you misjudged	2.84	1.02		0.63		
33 Wear bright fluorescent strips/patches on your clothing	1.49	0.95			0.57	
43 Wear bright/fluorescent clothing	1.43	0.83			0.62	
32 Wear motorcycle gloves	1.84	1.16			0.66	
42 Wear a full leather-suit	1.50	0.86			0.67	
27 Wear motorcycle riding boots	1.70	1.00			0.71	

Item	Mean	SD	Control/ Safety	Traffic Errors	Safety Equipments	Speed/ Alcohol-related Violations
30 Wear body armour/impact protection for the elbows and shoulders	1.57	0.94			0.75	
28 Wear protective trousers – leather or non-leather	1.57	0.93			0.82	
29 Wear a protective jacket – leather or non-leather	1.54	0.87			0.91	
18 Race away from traffic lights with the intention of beating the driver next to you	1.88	0.97				0.36
41 Ride when you suspect you might be over the legal limit for alcohol	1.84	1.05				0.36
14 Exceed the speed limit on a country/rural road	2.12	1.07				0.60
17 Disregard the speed limit on a residential road	1.98	0.98				0.78
15 Disregard the speed limit late at night or in the early hours of the morning	2.25	1.11				0.86
16 Disregard the speed limit on a motorway	2.03	1.03				0.87
Cronbach's alpha			**0.852**	**0.819**	**0.893**	**0.828**

Nine items (20, 21, 22, 23, 24, 25, 26, 35, 36) loaded on factor 1. All items could be interpreted as dealing with issues of control errors and safety behaviours; therefore, the factor 1 was labelled "Control/Safety". This factor accounted for 25% of the total variance.

Factor 2 accounted for 10% of the total variance, and contained thirteen items (1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 37, 38). Thirteen items are related to unintentional mistakes made by the riders so that all of these items were taken to produce the factor 2, which could be labelled "Traffic errors".

Eight items (27, 28, 29, 30, 32, 33, 42, 43) loaded on factor 3, and all of them concerned using protective gears. Consequently, in consultation with prior studies (Table 1), this factor which explained a further 5% of the total variance was named "Using safety types of equipment" or "Safety equipments" for brevity.

Six items (14, 15, 16, 17, 18, 41) were found to load on the factor 4. There is agreement among the published research that all above items (with the exception of item 41) belong to an MRBQ factor relating to speed violations. Item 41 "Ride when you suspect you might be over the legal limit for alcohol" is the only one item of original MRBQ related to drink driving. Therefore, this factor was subsequently labelled "Speed & Alcohol-related violations", and it explained 3.5% of the total variance.

All factors had good reliability with Cronbach's alpha ranging between 0.82 and 0.89. This factor structure proved to be reasonably interpretable, and all items that load on each factor seem to be measuring a similar underlying construct. All factors shared weak to moderate correlations, suggesting that each factor seems to measure a conceptually distinct construct (Table 5).

Table 5.

The correlations among demographic variables, the number of traffic accidents, offences, and MRBQ factors

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Age	-										
2. Gender	-0.26	-									
3. Have license	0.01	-0.04*	-								
4. LicenseYears	0.58**	-0.24**	0.45**	-							
5. Annual mileage	0.19**	-0.17**	0.19**	0.26**	-						
6. Control/Safety	0.16**	-0.14**	-0.02	0.07**	0.00	-					
7. Traffic errors	-0.07**	0.08**	0.06**	-0.03	0.03	-0.01	-				
8. Safety equipments	0.04	-0.15**	0.00	0.00	-0.02	-0.04	0.10**	-			
9. Speed & Alcohol-related violations	0.002	-0.20**	0.07**	0.07**	0.11**	0.02	0.35**	0.26**	-		
10. Near crashes (12 months)	-0.07**	0.04	0.07**	-0.02	0.03	-0.01	0.24**	0.01	0.13**	-	
11. Crashes (12 months)	0.04	-0.07**	0.06**	0.07**	0.06**	0.07**	0.16**	0.10**	0.12**	0.38**	-
12. Offences (12 months)	0.12**	-0.18**	0.04	0.14**	0.07**	0.07**	0.07**	0.02	0.11**	0.18**	0.25**

**: p < 0.01; *: p < 0.05; Gender: 1= Male, 2 = Female; Have riding license: 1 = Yes, 0= No

3.4 Predictive validity in terms of traffic accident risks and offences

The sample data of traffic accidents and penalized violations did not follow the normal distribution, and initially violates the assumption of equidispersion; therefore, negative binomial regression analyses were performed to develop a predictive model for motorcycle fatal accidents and offence on Vietnamese roads (Denham, 2016). Table 6 displays the results of a negative binomial regression analysis.

Table 6.

Negative binomial regression analyses on yearly traffic accident risks and offences.

Variables	Incidence rate ratios Exp(B)	SD	Wald Chi-Square	95% CI	
DV: Number of crashs (12 months)					
[Gender = Male]	1.198	0.078	5.35*	1.028	1.396
[Have Riding License= No]	0.700	0.173	4.24*	0.498	0.983
Age	0.945	0.017	11.29***	0.914	0.977
Riding years	1.046	0.019	5.44*	1.007	1.087
Control / Safety	1.132	0.030	17.37***	1.068	1.201
Traffic errors	1.255	0.030	57.51***	1.184	1.331
Safety equipments	1.092	0.031	7.91**	1.027	1.161
DV: Number of near-crashes (12 months)					
[Gender = Male]	1.172	0.072	4.81*	1.017	1.350
[Have Riding License= No]	0.711	0.147	5.35*	0.532	0.949
Age	0.913	0.016	30.81***	0.884	0.943
Riding years	1.085	0.018	20.52****	1.047	1.123
Mileage	1.000	0.000	6.12*	1.000	1.000
Traffic errors	1.209	0.026	52.64***	1.148	1.272
Speed & Alcohol-related violations	1.153	0.028	25.49***	1.091	1.219

DV: Number of offences (12 months)					
[Gender = Male]	1.837	0.115	27.87***	1.466	2.302
Age	0.943	0.025	5.48*	0.898	0.991
Riding years	1.107	0.029	12.25***	1.046	1.172
Mileage	1.000	0.000	5.10*	1.000	1.000
Control / Safety	1.220	0.043	21.52***	1.122	1.328
Traffic errors	1.261	0.048	23.48***	1.148	1.385
Speed & Alcohol-related violations	1.141	0.053	6.16*	1.028	1.266

* p<.05; ** p<.01; *** p<0.001.

As shown in Table 6, gender, age, riding years and traffic errors of motorcyclist are the significant predictors of accident risk involvements and offences. According to the incidence rate ratios, males are expected to have higher rates for the yearly total number of crashes, near-crashes and offences (19.8%, 17.2% and 83.7% more, respectively) than females. The age of the motorcyclist is negatively related to the total amount of accident chances and offences, whereas riding years and traffic errors have positive relationships with them. More precisely, the rates of crash, near-crash and offence became 0.945, 0.913 and 0.943 (decreased by 5.5%, 8.7% and 5.7%, respectively) times lower with each extension of one unit in age. On the opposite, those rates became 1.046, 1.085 and 1.107 (increased by 4.6%, 8.5% and 10.7%, respectively) times higher with each increment of one unit in riding years. Likewise, those rates of Vietnamese samples riders increased by 25.5%, 20.9% and 26.1% with each increment of one unit in traffic error, respectively.

As in the analysis, individuals who did not have a riding license appeared to involve in crash and near-crash situations at lower rates than survey respondents who had riding license. Unexpectedly, for every extra unit in using safety gears while riding the motorcycle, 1.092 (increase by 9.2%) times more crashes were reported, a statistically significant result, p= .0049.

The Control/Safety factor is significantly positively associated to the overall number of crashes and near-crashes of motorcyclists, which increased the crash and near-crash rates by 13.2% and 22% respectively with each increment of one unit in Control/Safety.

The cumulative number of near-crashes and offences rose by 15.3% and 14.1% apiece with each addition of one unit in Speed & Alcohol-related violation factor.

4 Discussion

The primary objectives of our study were to validate the MRBQ and investigate the relationship between MRBQ factors, demographic variables, motorcycle riding information and accident risks, traffic offences among Vietnamese motorcyclists. Concerning the existing previous factor structures of MRBQ (Table 1), the initial CFA was used to test for the goodness-of-fit and provided unsatisfactory results (Table 3). Therefore, the EFA of MRBQ using Vietnamese data was performed and revealed a notable clear four-factor structure with 36 items (Table 4).

Our results are in compliance with most of the previous researches which have observed that the frequencies of the MRBQ responses were generally between “never” and “hardly ever”. The two most prevalent traffic errors of Vietnamese motorcyclists are “Fail to notice or anticipate

another vehicle pulling out in front of you and had difficulty stopping" (item 6) and "Find that you have difficulty controlling the bike when riding at speed" (item 37). The riders are more likely to engage in traffic errors than speed & alcohol-related violations or control errors/safety behaviours in Vietnam. Those behavioural traits of motorcyclists derive from the undisciplined traffic condition, as well as many of current road safety traffic legislation are either not comprehensive in their scope, or are unsuccessfully enforced in Vietnam (Chu et al., 2015; Mohamad et al., 2018).

Particularly, in Safety equipment factor, the riders reported almost never using protection stuff while riding. Those behaviours are extremely rare among Vietnamese motorcyclists because there are no obligations for using protective gears (except for the mandatory helmet wearing) when riding a motorcycle in Vietnam's current on-road safety law (Decree 46/2016/ND-CP issued on August 1, 2016). This factor is the most different from prior research in other countries, where the majority of the motorcyclists consider using protective items of clothing is a prerequisite for safe riding (Stephens et al., 2017).

While drunk driving seems to be one of the most severe traffic problems (Liu et al., 2015; Stewart et al., 2012), item 41 "Ride when you suspect you might be over the legal limit for alcohol" was dropped from MRBQ in earlier studies due to low loading scores, and many researchers claimed that vigorous enforcement and benefits of targeted drink driving campaigns had been operated effectively (Elliott et al., 2007; Özkan et al., 2012; Sakashita et al., 2014). Considering drink driving remains a comprehensive intricacy in Vietnam (Ngoc et al., 2012; Phuong et al., 2016) and item 41 had a moderate factor loading, we retained it in the Speed & Alcohol-related violations factor.

The current Control/Safety factor includes 09 items related to control errors and safety behaviours which were often perceived as stunts (item 21, 23, 24, 25, 26), errors (item 35, 36) or speed violations (item 20, 22) in previous studies (Table 1). A reasonable explanation for this is that most Vietnamese riders (96.1%) used motorcycles to get to the working/studying places on a daily basis and recognised 09 above items in the context of losing control or proactively keeping themselves safe instead of intentional performing of a stunt or violation on the road (Hsu, 2003; OECD/ITF, 2015). This factor exhibits not only the critical contrast in riding motives of motorcyclists but also the actual socioeconomics differences between countries (WHO, 2017).

The present study has some limitations. First, taking into consideration the shortage of questions measuring well-known behaviours in motorcycle-traffic systems, it might be essential to expand the MRBQ by attaching new rational items related to "helmet usage" (Özkan et al., 2012), "aggression driving", "riding on the wrong lane/sideways", "riding with an impaired motorcycle" (Motevalian et al., 2011) or "carry more than one passenger on the bike" (Sunday, 2018) in the focus of future studies in Vietnam.

Overall, this study gives some new understanding in the key components of a

5 Acknowledgements

6 Reference

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