IATSS Research 46 (2022) 258–268

Contents lists available at ScienceDirect

IATSS Research

Research article

Effectiveness evaluation on cross-sector collaborative education programs for traffic safety toward sustainable motorcycle culture in Vietnam

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ARTICLE INFO

Article history:
Received 18 October 2021
Received in revised form 27 December 2021
Accepted 13 January 2022
Available online 19 January 2022

Keywords:
Traffic safety
Motorcycle culture
Traffic education
Stakeholders
ASEAN

ABSTRACT

Motorcycle injuries have caused serious implications for public health and national economies in many ASEAN countries. Drivers' lack of road safety awareness and low level of voluntary compliance hinder the promotion of traffic safety. Against this background, the Vietnamese government cooperated with motorcycle manufacturers in a wide range of educational activities. This study evaluates the effectiveness of cross-sector collaborative education programs implemented in Vietnam through a series of statistical analyses. Utilizing a sample of 600 respondents, we focus on the educational effects on riders' attitudes, behaviors, accident prevention, and riders' psychological changes after participating in safety activities. The results show that the effectiveness of rider training differed depending on riders' experience. Motorcyclists' improvement in risk awareness mainly results from the enhancement of safety awareness. The structural model revealed that safety activities have positive effects on motorcyclists' riding confidence, safety awareness, joy and comfort while riding, independence and freedom in daily life, and perspective-taking abilities. Altruistic motivation is suggested as the key factor to encourage motorcyclists' safe riding, highlighting the importance of building up traffic moral and expanding traffic safety culture across the country. With an attempt to find out the insufficient and missing content from the present training programs, this study seeks to inform policy decisions on accident prevention as well as promote motorcyclists' well-being based on the sustainable motorcycle culture in ASEAN countries.

1. Introduction

Motorcyclists make up the largest group and represent 80% of the total number of road users in Southeast Asian countries [1]. Appropriately 90% of global road fatalities suffer to low- and middle-income countries even though these countries have about 60% of the world's vehicles [2]. Sharing the same vision with ASEAN, Vietnam has gone to great lengths to deal with traffic accidents. However, promoting traffic safety has become an intractable social challenge. Drivers' lack of road safety awareness, regulatory non-compliance, and limited enforcement of legislation are considered the key barriers to reduce road traffic fatalities [3]. Against this background, the Vietnamese government established the National Traffic Safety Committee (NTSC) as a unique organization to promote a range of activities with functions of coordination, legislation and monitoring, and evaluation of road safety strategies.

Strong management is considered the key to producing positive road safety outcomes. The government sought to solve traffic safety issues by the 3E approaches, including engineering, education, and enforcement. However, the growth rate of road infrastructure was too slow to meet the rapid rise in motorcycle transportation. The education and training for riders were not effective, and the law was missing and incomplete. Due to the ineffective strategies resulted from a lack of resources, equipment, and technology, the government turned to seek cooperation with social resources and enterprises to tackle the pressing issues in motorcycle safety. In the recent decade, cross-sector collaborations between the government and motorcycle manufacturers have been implemented in a wide range of educational activities in Vietnam that together have a role in solving traffic accidents to achieve mutually beneficial outcomes.

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Peer review under responsibility of International Association of Traffic and Safety Sciences.

https://doi.org/10.1016/j.iatssr.2022.01.001

1.1. Literature review

The provision of knowledge and riding practice has been considered the main solution to accident prevention. Lack of experience is mostly addressed formally through a range of rider licensing, training, and education programs. Educational activities for motorcyclists' safe riding have been established in many counties for decades. A review of the regional experience of motorcycle rider training and evaluation of interventions can be found from Haworth and Mulvihull [4] and Araujo et al. [5], respectively. The contents and effects varied between regions with different cultural backgrounds. Training programs generally target new riders, capturing not only young riders but also older ones seeking a license. For riders who already hold a license for riding permission, including moped riders obtaining only a car license, such rider training is usually undertaken voluntarily. On the other hand, motorcycle riders show a preference for informal learning processes, tending to accumulate skills and knowledge through experience over time [6]. This viewpoint is supported by the situation in motorcycle-dependent regions, especially in developing countries, that most motorcyclists start riding at a young age with limited supervision [7]. Immature and risky behavior was thus being considered the leading cause of the numerous riding injuries [8].

Motorcyclists' exposure to accident risk is not only for new riders but also for experienced motorcycle users. According to Global Road Safety Facility [9], 82% of road crash fatalities and injuries in Vietnam happened to the economically productive age groups (15–64 years), with the 15–49 age group being most vulnerable to fatalities. Regarding the relationship between riders' experience and risk-taking intentions, a pilot training program conducted in Australia revealed that riders with previous riding experience prior to training stated the issues contained in the course were common sense, yet still expressed riding styles that were contrary to some key instructions [10]. Effectiveness evaluation of motorcycle rider training has been focused on the improvement in skills and safer attitudes, including risk-taking and hazard perception, using the measures of reduction in accident injuries and fatalities [5]. However, it is hard to indicate the missing content existing in present courses with such an evaluation procedure. The extent to which rider training and education programs can compensate for lack of experience remains largely unknown [11].

Road traffic issue involves not only individuals but also all traffic participants, causing serious implications for national economies. Previous research has evaluated the impact of road safety interventions from a perspective of economic costs and benefits [12]. From vehicle manufacturers' viewpoints, securing the safety of mobility could not only sustain the development of local business but maintain the welfare of society and the environment. The provision of safe and efficient mobility improves access to opportunities and freedom in daily life, engaging residents and local communities to create value for safer mobility. Such organizational motives give high potentials for extensive cooperation, which accommodates different characteristics and needs, working together towards a more livable city.

Livability is about access to opportunities for people to improve their quality of life [13]. It is judged by citizens' health and well-being [14]. While no consensus around a single definition, well-being can be described as individual satisfaction with life, the experience of positive emotions (e.g., confidence, happiness), and effective functioning (e.g., development of one's potential, having control of own life) [15]. Social well-being lies more in the justice of inclusive systems for all residents. Individual freedom and opportunity are recognized as precursors to achieving social well-being [16]. Safe and inclusive transport and mobility supports equitable and inclusive social development by providing access to socioeconomic and life-enhancing opportunities. It provides safe and reliable access to a preferred destination considerate of individual needs [17]. This is indispensable for a balanced distribution of economic and social benefits, especially for Asian cities [17]. Although plenty of studies have focused on effectiveness evaluation of safety initiatives, limited research has addressed their social impact on participants' lives and well-being. How the motorcycle safety initiatives could contribute to a livable city and support equitable and inclusive development have not yet been clarified.

1.2. Study framework

This study was motivated by an urgent need for more cautious evaluations. We firstly examined the present safety initiatives implemented in Vietnam through a series of analyses focusing on motorcyclists' attitudes, behaviors, and accident prevention as well as riders' psychological changes after participating in safety activities, taking both participants and non-participants into account. Next, the analysis was carried out for understanding the social impacts of the cross-sector collaborative education programs and their effects on participants' well-being in life.

This study aims to figure out the insufficient and missing contents of the present motorcycle rider training programs, as well as reveal their social impact, thus seeking to inform policy decisions on accident prevention and encourage stakeholder engagement and collaboration.

2. Materials and methods

2.1. Study site and context

With the rapid growth of vehicle ownership, the registered vehicles in Vietnam reached 76.7 million while 93.9% were motorized two-wheelers [18]. Vietnam counted 422 motorized two- or three-wheelers per 1000 population, which was the highest status among ASEAN countries [19]. In particular, motorcycles dominate road traffic at a modal share of 74% in urban cities [20], leading to motorcyclists' exposure to accident risk. According to WHO [21], the rate of road traffic fatalities was 26.4 per 100,000 population in Vietnam, while the average rate for Southeast Asian countries was 20.7 in 2016. In the recent two decades, Vietnam showed a reduction in traffic accident fatalities. The average yearly fatality was 12,010 in the period 2001–2010, whereas 8741 in 2011–2020 [18]. Notably, there has been a progressive decrease every year in the period 2012–2020 [18].

Pursuing safety as an essential prerequisite to sustainability, the Vietnamese government has cooperated with motorcycle manufacturers in a wide range of traffic safety activities. Honda, a Japanese automobile manufacturer, established Honda Vietnam Co., Ltd. (HVN) as a local corporation in 1996. Accounting for a motorcycle market share of over 80% in Southeast Asian countries [22], HVN has dominated the Vietnamese market since 2003 until very recently [22,23]. Cooperating with the government, HVN has played a central role in traffic safety education in Vietnamese society. The collaborative education activities promoted by HVN are described as below.

Taking education as one of the pillars of road safety strategies, the Traffic Safety Education Center (TSEC) was established in 1999 to provide training to the general public as well as government officials. In particular, the training has been provided to traffic police officers and instructors of motorcycle dealers. The training programs have been implemented for over 2600 traffic police from 2013 to 2019 [24]. Additionally, the safety advice and instruction would give to all customers buying a motorcycle at Honda dealer stores.

The “I Love Vietnam” TV promotion was started in 2003, promoting traffic safety knowledge via social media. The traffic safety education for local children was started in 2008. In addition to holding seminars for children and teenagers (6–18 years old), teaching materials and instructor training were provided to school teachers. As of 2019, the accumulated number of trainees of HVN safety education in schools amounted to 10.2 million; About 4.7 million students attended the lessons in 2019.

In cooperation with the NTSC and the Ministry of Education and Training (MoET), the Helmet Donation Project has been carried out for pupils since 2018. Over 2 years, 4 million helmets were donated to all

first-grade students nationwide with a wish to promote compliance with regulations on wearing helmets. It is reported that the rate of helmet wearing among 6- to 15-year-old had increased from 35% in 2017 to 70% in 2019 [25].

2.2. Data collection

To evaluate the effectiveness and assess the social impact of safety activities, a self-administered questionnaire survey was conducted in Vietnam during the period from 29 July to 3 August in 2020. Since the HVN education program included a variety of elements and have been implemented across the country, the survey was entrusted to a market research agency to reach participants widely by online approaches. Participants, who were the registers of the research agency and its partner companies, were invited by personal emails. The valid responses were checked and adopted on a first-come-first-serve basis until fulfilling the target sample size.

A sample size of 600 valid responses were collected for this study. For further comparison and evaluation, the survey ensured a sample size of 100 non-motorcyclists, and another 100 respondents were motorcyclists that have not participated in HVN activities. Fig. 1 presents the distribution of collected samples across Vietnam.

2.3. Survey design and measures

The questionnaire was composed of three sections. The first section investigated demographic data (i.e., gender, age, motorcycle-riding experience), accident experience, and respondents' experience of education and training on motorcycles.

The second section consisting of two sets of items, was designed to assess rider's knowledge, attitudes towards road safety, and riding behaviors. Firstly, riding attitudes (12 items) were measured using a five-point Likert scale (5 = agree, 1 = disagree). It presented a series of statements to determine motorcyclists' attitudes towards pedestrian priority, speed limits, risk awareness, as well as risk-taking attitudes and frustration while riding on the roads. Secondly, behavioral factors (10 items) were investigated using a frequency scale (ranging from 4 = always/frequently to 1 = never). This part presented some potential risky behaviors in specific traffic conditions, and asked participants how often they performed these behaviors. It also accessed motorcyclists' hazard perception and prediction abilities. These behavioral items were divided into risk prediction, risk avoidance relevant to route choice, distracted driving related to mobile phone use, and violation of traffic rules.

The third section was used to appraise the social impact of safety initiatives. We focused on rider's psychological changes after taking part in safety activities such as their beliefs motiving to ride safely, expectation, and satisfaction in daily life. Respondents were asked multiple-choice questions about their subjective opinions on the effects of HVN activities. For example, we surveyed participants' changes in the way of thinking (item: Has your way of thinking changed after taking part in any HVN safety program? If so, in what way?). Consisting of 10 options, it concerned respondents' changes in the value of safety, perspective-taking abilities, confidence, freedom, and satisfaction in their daily lives. The motivation behind safe driving attitudes was also investigated (item: What is your reason for choosing to ride safely?).

2.4. Data and sampling processes

Table 1 lists the sample characteristics. Male and female respondents accounted for 34.0% and 66.0%, respectively. Most respondents were aged 20 to 29 (48.3%), followed by the group aged 30 to 39 (40.5%). A sample size of 500 (83.3%) respondents were motorcyclists riding a small type motorcycle (66.0%) or a medium – large one (17.3%). The other 100 respondents were not motorcyclists, while 38 (6.3%) of them were moped users. Riders with a riding experience of over 5 years accounted for 69.3%. For the traffic accident experience, the

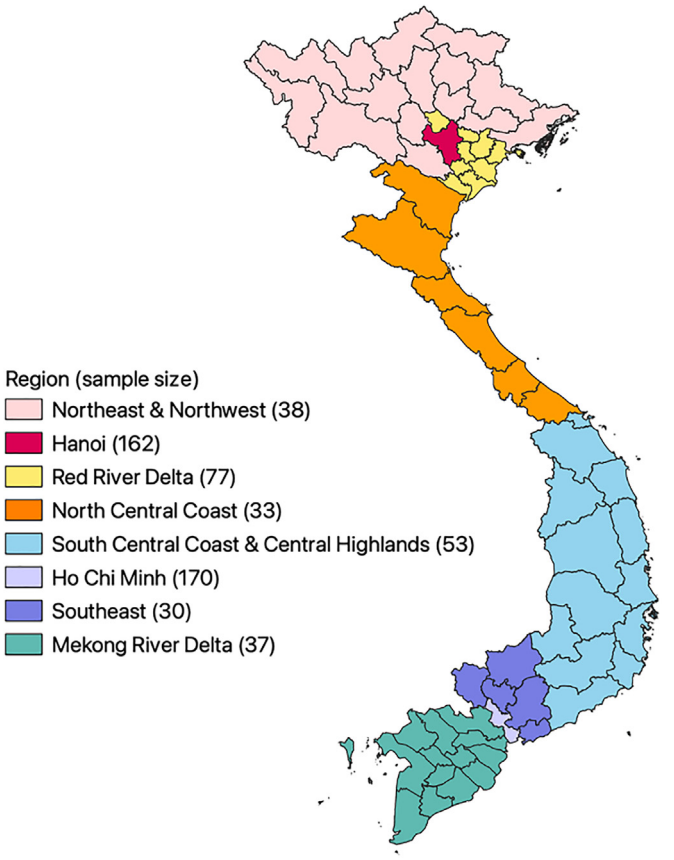

Fig. 1. Distribution of collected data across Vietnam.

Table 1
Sample profile.

Characteristics	Category	Sample size	Percentage (%)
Gender	Male	204	34.0
	Female	396	66.0
Age	<20	2	0.3
	20–29	290	48.3
	30–39	243	40.5
	40–49	43	7.2
	50–59	16	2.7
	≥60	6	1.0
Types of motorcycle	50 cc moped	38	6.3
	Small motorcycle (51–175 cc)	396	66.0
	Medium – large motorcycle (≥175 cc)	104	17.3
	I used to ride a motorcycle, but no longer do	22	3.7
	I have never ridden a motorcycle	40	6.7
Riding experience in years	Never	56	9.3
	Less than a year	17	2.8
	1 year – less than 3 years	57	9.5
	3 years – less than 5 years	54	9.0
	5 years or more	416	69.3
Experience of traffic accidents in the past year (n = 538)	An accident that caused human injury or death	36	6.7
	An accident that caused property damage	48	8.9
	A self-inflicted accident	95	17.7
	Never	395	73.4

sample size was 538, including motorcycle and moped users. 26.6% reported at least a traffic accident experience, while 6.7% had an accident that caused human injury or death in the past year.

Fig. 2 shows the participation in activities conducted by HVN. Except for the responses of I Love Vietnam TV program promoted by social media (52%), and safety classes for their children (15%), respondents that have taken part in one of the other activities were regarded as "HVN safety activities" participants. In addition to offering textbooks for school education (47%) and holding a helmet-donation campaign (31%), HVN focused on motorcyclists' safe riding skills and provided training courses in various ways. These training courses, which contained both skill training and classroom instruction, included the courses for the youth at a university or college (32%), courses conducted by dealers for customers and residents (22%), courses offered at the TSEC (64%), and other courses hosted by Honda dealers (14%). Respondents that have taken part in one of these four courses, which are shaded in blue in Fig. 2, were categorized as participants of the "HVN safe riding program" for the analysis in the following sections.

2.5. Data analysis

Firstly, descriptive statistics were performed to describe the basic features of the data. An independent sample *t*-test was used to compare the groups' performance. Prior to t-test, the Levene's test [26] was used to check the homogeneity of variances. The insignificant values of Levene's test confirm that the data are appropriate for conducting further analysis. The respondents were categorized based on their riding experience, participation in rider training, accident experience, and whether an altruistic motivation was shown behind safe riding. In addition, the effectiveness of the training for accident prevention was quantified by comparing the accident experience rate among groups. The analysis was conducted to investigate the difference in estimated results by riding experience.

Next, the Structural Equation Modeling (SEM) with the maximum likelihood estimates was applied to address a series of interrelated dependence relationships among latent variables and between latent constructs. This study explored the relationships among riders' attitudes and behaviors. Before proceeding with the analysis of model specification and causality, the scale validation was examined. This study analyzed the data following the two-stage approach. The first stage conducted a confirmatory factor analysis (CFA) to examine the scale validation for the measurement model. The hypothesized structural model was empirically tested using SEM in the second stage. After a test on hypothesized structure model, respondents' experience of motorcycle rider training and accident experience would be input into the structure model. Thus, the causality among education, accident, attitudes, and behavioral constructs would be confirmed.

For social impact assessment, the impact is defined as effects arising from the intervention, including immediate short-term outcomes to the individuals. This study examined the direct educational effects on the HVN participants, proposed a process for measuring and attributing the individual change to the organization's direct actions. We verified the proposed structural relationships, focusing on participants' changes in way of thinking after taking part in the safety activities. The causal relationships of riding confidence, safety awareness, joy and comfort while riding, independence and freedom in daily life, and perspective-taking abilities were empirically tested. All statistical analyses were performed by R version 4.0.3 (R Foundation, Vienna, Austria).

3. Results and discussion

3.1. Effect of motorcycle rider training on attitude, behaviors, and accident prevention

3.1.1. Descriptive statistics

The sample of motorcyclists ($n = 500$) was used in the analysis in this section. Fig. 3 presents the items relevant to riders' safety attitudes. The behavioral factors are shown in Fig. 4. The mean score of each item was computed based on Likert guidelines. Take risk-taking attitudes as an example, a high score indicated a high preference for risk-taking, and consequently, a negative attitude towards road safety. By contrast, a higher score in risk awareness indicated the better recognition of the potential for hazards, showing a positive attitude towards road safety.

3.1.2. Attributes to affect motorcyclists' attitudes and riding behaviors

Table 2 illustrates the effects of demographic characteristics and personal traits on measurement items. A *p*-value less than 0.05 determines

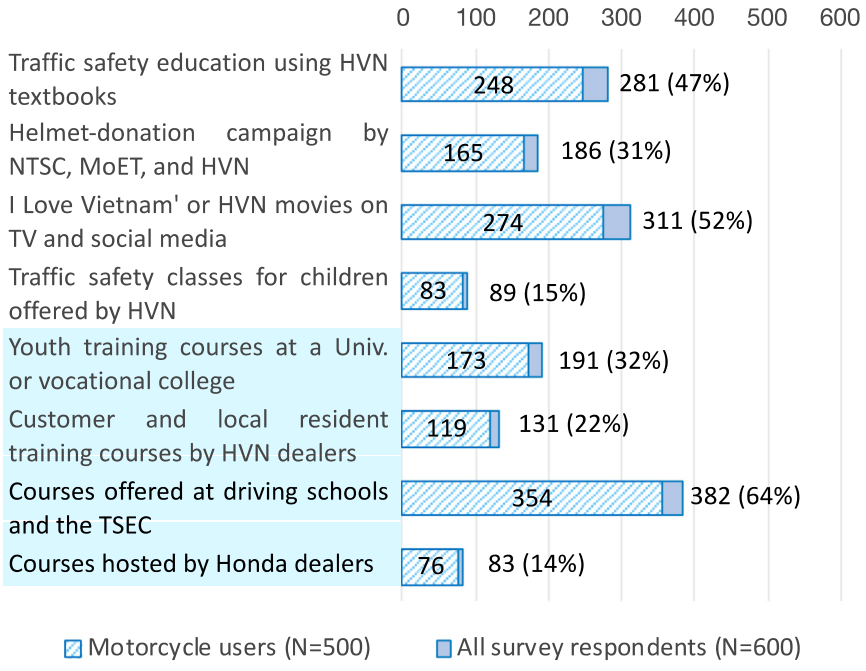

Fig. 2. Participation in the traffic safety activities conducted by HVN.

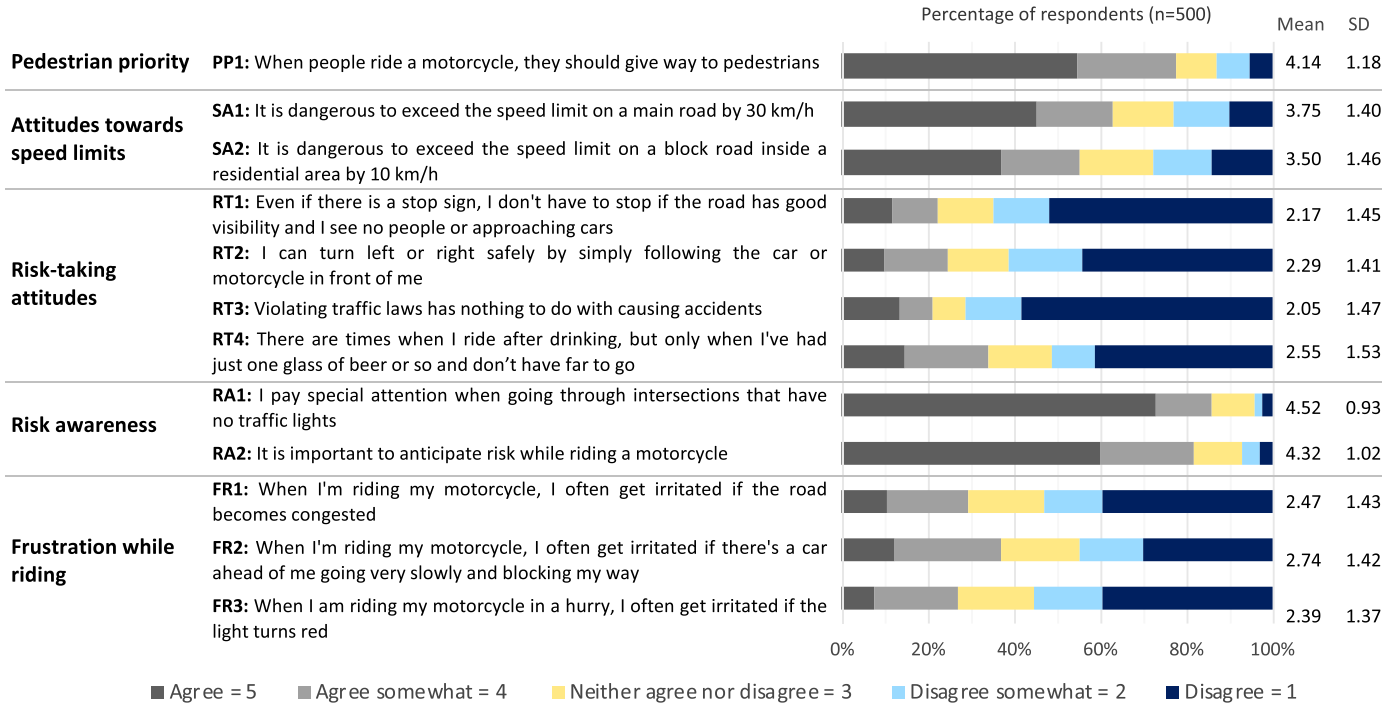

Fig. 3. Motorcycle rider safety attitudes and risk awareness.

whether a significant difference exists between the two groups. Riding experience, participation of HVN safe riding program, accident experience, and altruistic motivation were shown as significant factors.

Accident involvement can be taken as a decisive factor of risk-taking attitudes and behaviors, which is consistent with previous research conducted on Malaysian motorcyclists [27]. Experienced riders had better risk awareness and hazard perception abilities, while novice riders with less than 3-year experience had a higher tendency to exhibit risky behaviors. The average age of experienced riders was 32.1 years old while 27.9 years old for novice riders. Compared to non-participants, the participants performed positive attitudes towards road safety, showing lower preferences for risk-taking, violation, and distracted riding. However, significant effects were not obtained from riders' safer attitudes and behaviors (i.e., risk awareness and risk prediction).

Regardless of experienced riders performed better on almost all items, no significant differences showed in their compliance with drinking-driving (item RT4) and violation of riding on the sidewalk

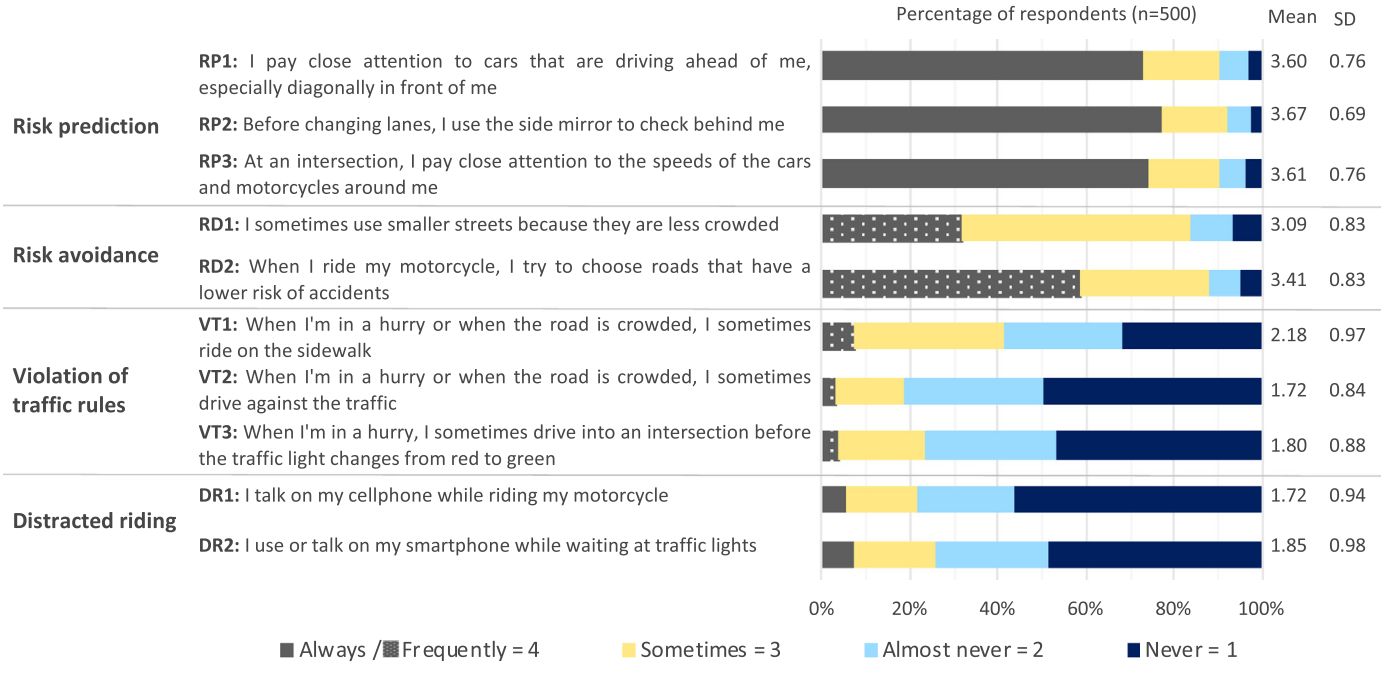

Fig. 4. Hazard perception, prediction, and violation while riding.

Table 2
t-test results to compare group means.

Construct	Item	Riding experience		Participate in HVN safe riding program		Accident experience		Altruistic motivation to ride safely	
		<3 yrs. ($n = 75$)	≥3 yrs. ($n = 425$)	Yes ($n = 401$)	No ($n = 99$)	Yes ($n = 131$)	No ($n = 369$)	Yes ($n = 371$)	No ($n = 129$)
Pedestrian priority	PP1	4.19	4.14	4.12	4.23	4.12	4.15	4.22*	3.92*
Attitudes towards speed limits	SA1	3.51	3.80	3.70	3.97	3.64	3.79	3.77	3.71
	SA2	3.52	3.49	3.44	3.73	3.47	3.51	3.45	3.64
Risk-taking attitudes	RT1	2.52*	2.11*	2.07*	2.58*	2.80*	1.95*	1.95*	2.82*
	RT2	2.88*	2.19*	2.17*	2.79*	2.81*	2.11*	2.04*	3.01*
	RT3	2.37*	1.99*	1.95*	2.43*	2.49*	1.89*	1.82*	2.71*
	RT4	2.68	2.53	2.45*	2.98*	2.89*	2.44*	2.37*	3.09*
Risk awareness	RA1	4.11*	4.59*	4.53	4.46	4.39	4.56	4.63*	4.21*
	RA2	3.96*	4.38*	4.30	4.39	4.15*	4.38*	4.43*	3.98*
Frustration while riding	FR1	2.99*	2.38*	2.36*	2.93*	2.93*	2.31*	2.27*	3.05*
	FR2	3.23*	2.66*	2.66*	3.07*	3.15*	2.60*	2.59*	3.17*
	FR3	2.92*	2.30*	2.26*	2.91*	2.90*	2.21*	2.20*	2.95*
Risk prediction	RP1	3.32*	3.65*	3.61	3.56	3.50	3.63	3.69*	3.33*
	RP2	3.36*	3.72*	3.69	3.60	3.54*	3.72*	3.76*	3.42*
	RP3	3.32*	3.66*	3.63	3.53	3.47*	3.66*	3.71*	3.33*
Risk avoidance	RD1	2.82*	3.13*	3.13*	2.93*	3.16	3.06	3.13	2.98
	RD2	3.09*	3.47*	3.45*	3.26*	3.34	3.43	3.51*	3.11*
Violation of traffic rules	VT1	2.35	2.15	2.15	2.30	2.38*	2.11*	2.05*	2.56*
	VT2	1.96*	1.68*	1.67*	1.94*	2.01*	1.62*	1.57*	2.17*
	VT3	2.01*	1.76*	1.76*	1.97*	2.15*	1.67*	1.65*	2.22*
Distracted riding	DR1	1.93*	1.68*	1.66*	1.97*	1.98*	1.63*	1.55*	2.21*
	DR2	2.13*	1.80*	1.81	2.00	2.17*	1.73*	1.70*	2.28*

* $p < 0.05$.

(item VT1), which were significant items for accident involvement. The previous study supported the results that avoidance of alcohol-related violations would significantly reduce the traffic risks for Vietnamese motorists [28]. The HVN safe riding program had a positive effect on reducing riders' risk-taking of drinking-driving, whereas there's no significant effect on violation of sidewalk riding. With the fact that driving down sidewalks has become common practice for motorcyclists in many motorcycle-dependent regions, especially in suburban cities, causing considerable damage to the walkways, these results provide evidence to inform road safety interventions.

Altruism was found a significant factor to determine the attitudes towards safety awareness and behavioral factors. Though the altruistic motivations behind safe riding were seldom investigated, relevant discussions can be found in previous studies [8,29]. Notably, altruism was the only attribute that a significant difference shown in pedestrian priority. No significant difference was shown in attitudes towards speed limits for all groups.

Because both the riding experience and participation of the HVN program were significant attributes, this study further categorized and reported riding experience for participants and non-participants. The average age of the participants was 31.7, and 13.7% of them were novice riders. For the non-participants, the average age was 30.5 while 20.2% of them were novice riders. Fig. 5 supports the results in Table 2 and eliminates the concerns that whether the effect of the training resulted from a higher percentage of experienced riders. Among the riders with similar riding experiences, HVN participants showed lower risky intentions.

3.1.3. Riding experience, accidents, and effect of motorcycle rider training

Experienced riders showed a better performance towards road safety. With the concern of a limitation of the self-administered survey that experienced riders got better scores due to their better knowledge, we further examined whether the better performance also reflected on accident prevention.

The estimated results showed that experienced riders had a lower accident rate than novice riders; however, the effectiveness on accident prevention differed depending on riders' experience. For novice riders that have never participated in the HVN safe riding program, 50% reported an accident experience in the past year. For those having a similar riding experience but participating in the training program, the accident experience rate was 38%, showing a 12% difference. In contrast,

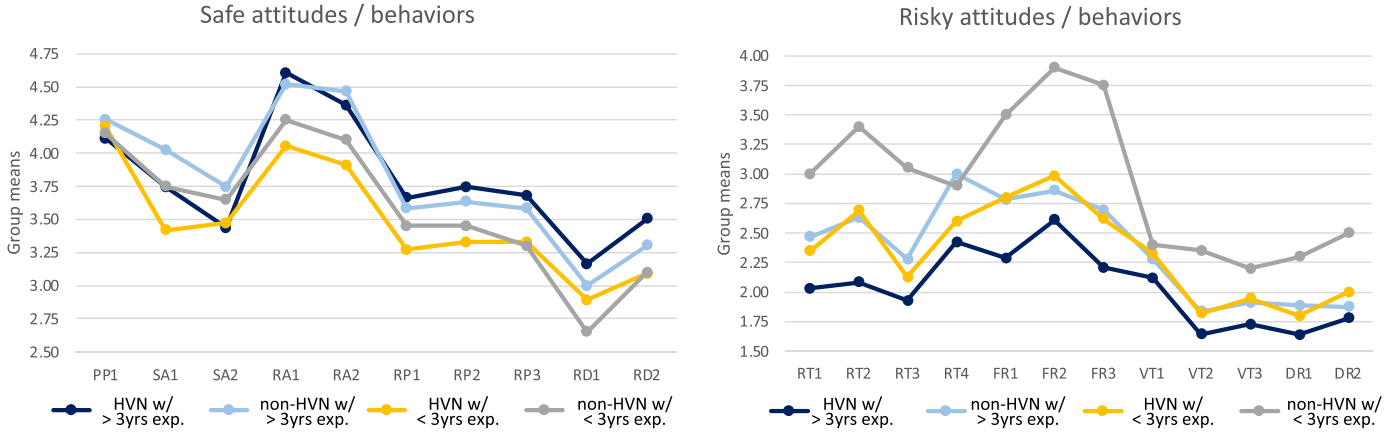

Fig. 5. Safe and risky intentions of motorcyclists with different riding experience for the HVN program participants and non-participants.

Table 3
CFA results of the measurement model.

Construct	Item	Cronbach's α	Standardized factor loading	Standard error	*p*-value	CR	AVE
Attitudes towards speed limits	SA1	0.762	0.775	0.101	0.000	0.762	0.616
	SA2		0.795	0.107	0.000		
Risk-taking attitudes	RT1	0.726	0.672	0.062	0.000	0.731	0.406
	RT2		0.727	0.059	0.000		
	RT3		0.598	0.065	0.000		
	RT4		0.555	0.069	0.000		
Risk awareness	RA1	0.796	0.871	0.040	0.000	0.797	0.662
	RA2		0.762	0.045	0.000		
Frustration while riding	FR1	0.826	0.790	0.057	0.000	0.824	0.610
	FR2		0.762	0.057	0.000		
	FR3		0.791	0.055	0.000		
Risk prediction	RP1	0.830	0.790	0.030	0.000	0.830	0.620
	RP2		0.861	0.027	0.000		
	RP3		0.719	0.031	0.000		
Risk avoidance	RD1	0.724	0.685	0.037	0.000	0.730	0.577
	RD2		0.828	0.037	0.000		
Violation of traffic rules	VT1	0.806	0.689	0.040	0.000	0.812	0.591
	VT2		0.864	0.033	0.000		
	VT3		0.767	0.036	0.000		
Distracted riding	DR1	0.826	0.885	0.037	0.000	0.827	0.705
	DR2		0.796	0.040	0.000		

there was almost no difference shown for experienced riders. The accident experience rate of HVN participants was accounted for 25%, while 23% non-participants reported an accident experience in the past year.

3.2. Causality analysis of attitudes, behaviors, and accidents

3.2.1. Measurement model

The descriptive statistics for the measurement items are presented in Fig. 3 and Fig. 4. In this section, confirmatory factor analysis was performed on latent constructs to conduct the scale validation. The estimated model showed a good fit (X2/df = 1.95, CFI = 0.965, TLI = 0.955, GFI = 0.943, AGFI = 0.919, RMSEA = 0.044). The convergent validity was examined by the strength and significance of the factor loadings (i.e., item reliability), Cronbach's α (i.e., internal consistency reliability), composite reliability (CR), and the average variance extracted (AVE). As shown in Table 3, the standardized factor loadings were ranged from 0.555 to 0.885, supporting the required level of 0.50. Both the Cronbach's α and CR estimates of all constructs achieved the recommended level of 0.70 [30]. Except for risk-taking attitudes (AVE = 0.406), the AVE values were higher than the suggested value of 0.50. Fornell and Larker [31] suggested that if AVE is less than 0.5 but higher than 0.4 and the composite reliability is higher than 0.6, the convergent validity of the construct is still adequate. The CR value of risk-taking attitudes was 0.731, implying an acceptable convergent validity.

3.2.2. Structural model and hypothesis test

Next, the hypothesized structural model was estimated to explore the causality among constructs. The goodness-of-fit indices (X2/df = 2.30, CFI = 0.942, TLI = 0.932, GFI = 0.920, AGFI = 0.898, RMSEA = 0.051) showed an acceptable fit on the sample data (n = 500 motorcyclists) [30]. To assess the effect of HVN activities, respondents' accident experience and improvement in safety awareness were input to the structural model (n = 400 motorcyclists participating in HVN activities). Fig. 6 shows the results with standardized path estimates and significance parameters. The re-estimated structural model also fit well (X2/df = 1.89, CFI = 0.945, TLI = 0.936, GFI = 0.908, AGFI = 0.883, RMSEA = 0.047).

The positive relationships between attitudes and behavioral constructs indicated that the higher preference for safe (risky) attitudes, the greater likelihood the riders would engage in safe (risky) behaviors. This finding is consistent with previous studies based on the theory of

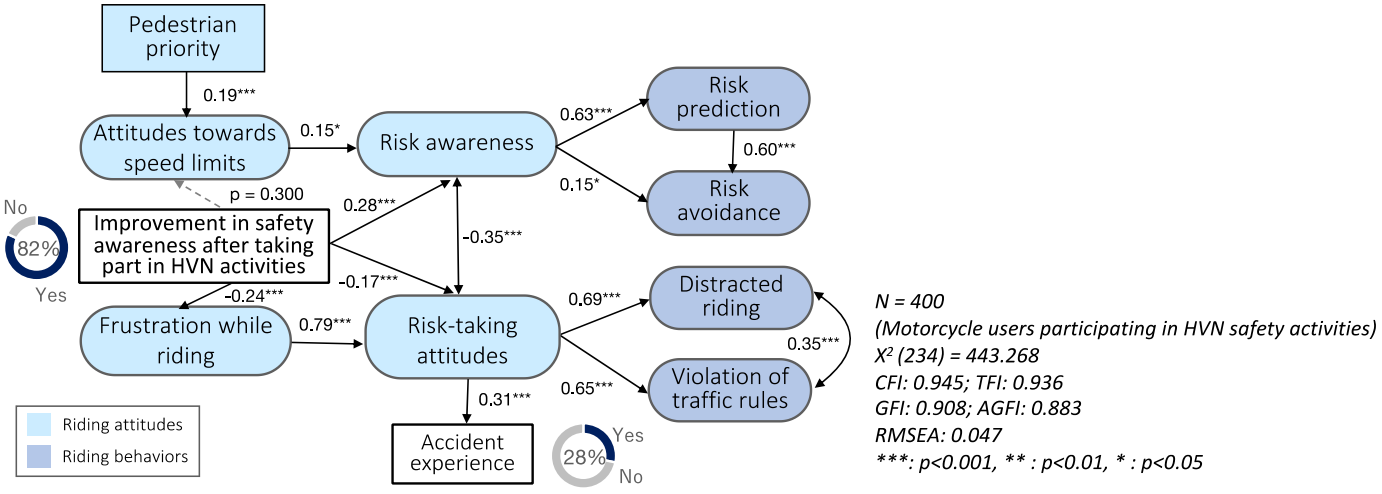

Fig. 6. Causality analysis among motorcyclists' attitudes, behaviors, educational effect, and accident experience.

planned behavior [29,32]. Attitudes towards speed limits positively affected risk awareness. Risk awareness had positive effects on risk prediction and risk avoidance. Remarkably, pedestrian priority positively affected attitudes towards speed limits. Risk-taking attitudes had positive effects on risky behaviors, including distracted riding and violation of traffic rules. As a negative emotion, riders' frustration while riding strongly affected risk-taking attitudes. It is noted that risk-taking attitudes were directly related to accident experience. Risk awareness and risk-taking attitudes were negatively related, showing the improvement in risk awareness related to less intention to participate in risky behaviors.

A relatively weak link appeared between risk awareness and risk avoidance. It is further notable that riders who showed a higher intention to behave risk prediction tended to avoid risk more while riding. Among 400 HVN participants, 82.0% reported a change in way of thinking of focusing more on safety while riding and/or being more aware of the need to protect own life. Despite no significant effect shown on attitudes towards speed limits, HVN participants' improvement in safety awareness could improve their risk awareness as well as reduce risk-taking intentions and frustration. Above all, motorcyclists' improvement in safety awareness encourages their safer riding attitudes and behaviors (i.e., risk awareness and risk prediction), which were pointed out as the missing contents of HVN safe riding program in Section 3.1.2 Table 2.

3.3. Social impacts of safety initiatives

This study surveyed motorcyclists' changes in their way of thinking after taking part in HVN activities. These items concerned respondents' value of safety, perspective-taking abilities, satisfaction, freedom, and confidence in their daily lives. Among 400 respondents, 49.8% expressed that being able to ride their motorcycles with confidence. Respondents focused more on safety (72.8%) and became more aware of the need to protect life (60.8%). In terms of independence and freedom, 23.5% expressed that they became able to move around independently, and 20.5% got more freedom in daily life. Some respondents found more joy (29.0%), and felt more comfortable (46.5%) when riding a motorcycle. Regarding the perspective-taking abilities, 30.3% became able to see things more from the car driver's viewpoint, while 25.8% expressed an improvement in taking pedestrians' perspectives.

Fig. 7 describes the structural relationship of the combination of items contributing to motorcyclist's well-being. The estimated model showed an acceptable fit (X2/df = 2.70, CFI = 0.917, TLI = 0.875, GFI = 0.950, AGFI = 0.901, RMSEA = 0.065). As shown in Fig. 7(A), riding with confidence positively affected safety and life protection awareness and riders' independence and freedom. Participants' safety and life protection awareness further affected their independence and freedom and perspective-taking activities. In addition, independence and

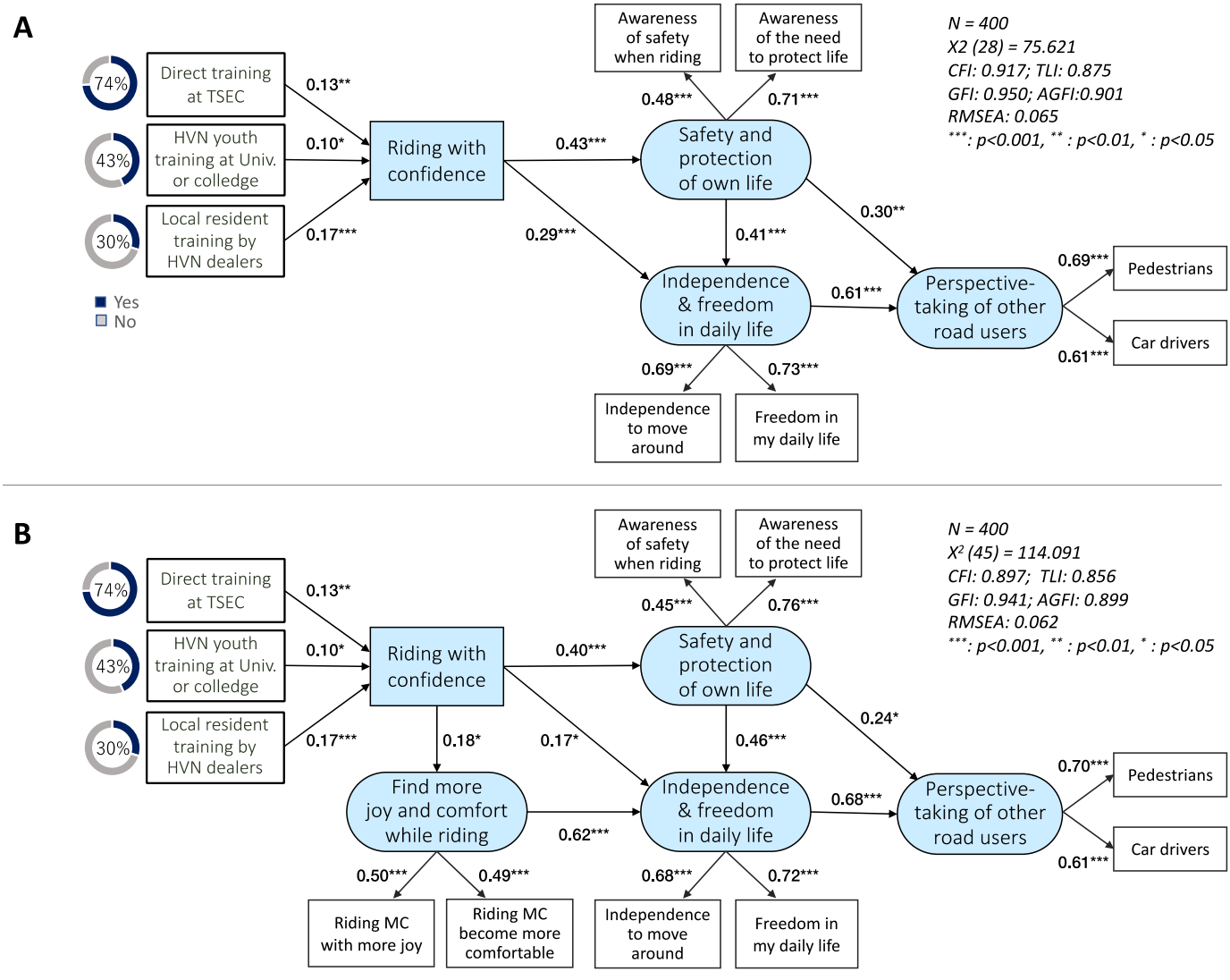

Fig. 7. Structural relationship to describe the combination of factors contributing to motorcyclist's well-being.

freedom in daily life positively affected the perspective-taking of other road users. HVN's rider training had a significantly positive effect on respondent's riding confidence, the effect resulted from direct training at TSEC, HVN youth training at university or college, and local resident training by dealers, respectively.

Fig. 7(B) has further verified that the impact of riders' confidence on the improvement of independence and freedom was mainly achieved by an increase in joy and comfort while riding. Motorcycle users' joy and comfort would positively affect their independence and freedom in daily life. These results provide empirical evidence on the social impact of initiatives raised from the Honda 2030 statement (Supplementary Material).

3.4. Potentials for cross-sector collaborative partnerships in traffic safety education

Fig. 8 illustrates the results of respondents' expectations towards parties that play major roles in providing safe driving instructions for motorcyclists currently and in the future. The figure is presented by the full sample of 600 responses which consists of 400 HVN participants, 100 non-participants, and 100 non-motorcycle riders. Among all relevant parties, families were considered to have the most prominent role in motorcycle safety education, following the local community and school education roles. The police were the only party that fulfills respondents' expectations. Notably, opinions differed between the HVN participants and non-participants that participants regarded the vehicle manufacturers played essential roles in safety promotion while non-participants didn't. In terms of functions of public sectors, local community, local municipalities, and the central government were expected by respondents to make more effort on safety issues in the future. Meanwhile, the local public sectors gathered more expectations than the central government.

4. Conclusions

Road traffic injuries have been among the leading causes of mortality in Vietnam. However, the data collection systems for traffic accidents remain inconsistent and incomplete. A survey was designed to study Vietnamese motorcyclists' experience of rider training, as well as the relationship among their road safety attitudes, behaviors, and accident experience. Comprising 600 valid responses, the samples consist of participants and non-participants of the safety promotion activities, incorporating motorcyclists and non-motorcycle riders. The research findings of this study corroborate a viewpoint from previous studies that the accumulation of on-road experience in conjunction with repeated or progressive exposure to training and education is the effective way to promote motorcycle safety [11].

First and foremost, the results suggest that experienced riders have better knowledge of road safety, whereas the limited effectiveness of rider training is shown on accident prevention for experienced riders. In terms of personal traits, altruism is the most significant factor affecting motorcyclists' safe riding.

Besides, riders' risk awareness and risk prediction abilities – that is, the positive attitudes to engage in safer behaviors – were pointed out as the missing contents of the HVN safe riding program. This was confirmed by the causality analysis that riders' risk prediction was directly led by their risk awareness. Remarkably, for those participants expressing an improvement in safety awareness after taking part in traffic safety activities, a significantly positive effect was shown in their risk awareness. This highlights that motorcyclists' improvement in risk awareness mainly results from their enhancing awareness of the need to protect life.

Last but not least, according to the social impact causality, riders become able to ride with confidence, find more joy and comfort, and enjoy the freedom of mobility after participating in rider training. It is notable that motorcyclists' awareness of safety and protection of life

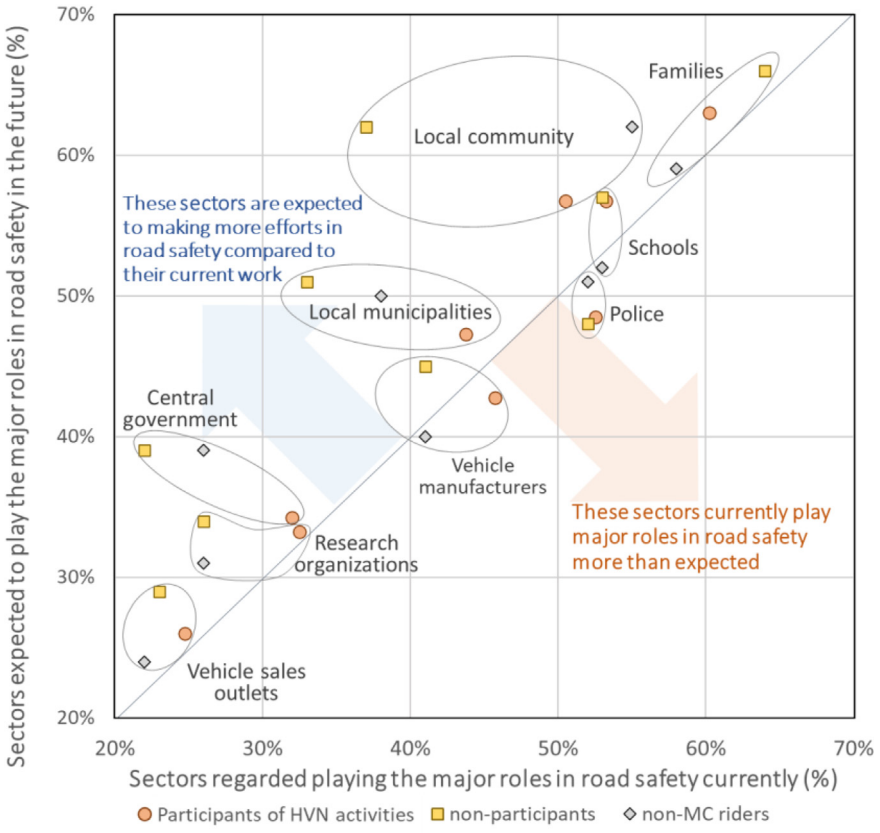

Fig. 8. Citizens' expectations of parties playing major roles in motorcycle safety education in the present and towards future.

contributes to their altruistic motivations of taking pedestrians' and car drivers' perspectives. These results reveal the importance of building up the moral for motorcyclists and providing implications for improving traffic safety education.

Traffic safety culture refers to the "shared patterns of behavior, shared norms prescribing certain road safety behaviors and thus, shared expectations regarding the behaviors of others" [33]. This kind of shared expectation could form a subtle social pressure to behave in accordance with "what is normal" in society. Despite that a shared value towards road safety can contribute to a safer society, it could also result in risky behaviors through the false consensus. This emphasizes the importance of education to facilitate road safety. In brief, the research findings emphasize the importance of risk prediction in order to prevent traffic accidents, while altruistic motivation is shown as the crucial factor for safe riding. To build up the traffic moral in Vietnamese society, it's important to make riders aware that auto accidents could not only affect one's life but a victim's entire family as well as the community. The outcomes of this study have been utilized for creating a traffic safety video with the purpose to promote proper traffic safety knowledge in the motorcycle-dependent society.

The rapid increase in motorcycle ownership has had a significant impact on urban form in many ASEAN countries. While motorcycle-dominated traffic makes it challenging to achieve livable cities, safety initiatives certainly help cities secure a safer and more pleasant traffic environment by reducing accident risks for all traffic participants as well as promoting motorcyclists' well-being. The findings of this study help to acquaint relevant parties with the social impact raised from the cross-sector collaborative education programs.

Cross-sector collaborative partnerships have played a central role in initiating practical societal activities in Vietnam. The institutional partnership adds complementary value among various stakeholders, improving social engagement for safer mobility. Material objects such as textbooks, helmets, and TV programs were directly provided to the new generation as a means to expand safety culture and build up moral across the country. The impact of safety initiatives is not only related to individuals' changes in awareness and behavior but also anticipated to have broader and longer-term effects on their communities and society. This is the process from individuals' embodiment of safe riding towards the socialization of sustainable motorcycle culture through the co-creation between citizens, communities, and society.

The results obtained in this study have confirmed the effectiveness of the cross-sector collaborative safety activities on the realization of a safe, free, and comfortable life. Despite environmental and safety concerns, two-wheelers provide irreplaceable freedom supporting the movement in daily life. In recent years, improved energy charging services are facilitating the introduction of new forms of electric vehicles. There is global emergence of electric personal mobility, including electric two-wheelers. The function of connections is regarded as the fundament of a liveable and efficient city [34]. Facilitating citizens' well-being by providing more efficient and safer mobility encourages cities to achieve liveability grounded in sustainable motorcycle culture.

The inadequate and unreliable traffic data system in Vietnam makes it challenging to analyze the cause of traffic accidents [3]. The underreporting remains a major issue among the official road traffic death data sources not only in Vietnam but also in the Southeast Asia region [35]. Despite the limitations of this study concern validity and probable inaccuracy of self-reported data, it is worth noticing that drivers' attitude is an important determinant of driving behavior. Moreover, the association between the self-reported tendency to commit violations and accident involvement has been investigated and recognized in previous research [36].

Supplementary notes

[1] Honda formulated its global vision with the 2030 statement, "Serve people worldwide with the 'joy of expanding their life's potential' – Lead the advancement of mobility and enable people everywhere in the world to improve their daily lives" [37]. They further set concrete actions for initiatives from three perspectives: (1) creating the joys by providing people safe, free, and comfortable life, (2) expanding the joys by fulfilling societies' various expectations and individual needs, and (3) ensuring the joys for the next generation by leading efforts toward a clean, safe, and secure society.

Conflicts of interest

The authors declare no conflicts of interest associated with this manuscript.

Acknowledgements

This study is part of the results of research carried out in Research Project 2041C of the International Association of Traffic and Safety Sciences. The authors would like to express our gratitude to Honda Vietnam Co., Ltd. for their kind cooperation in the interview and surveys.

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