Asian Transport Studies 11 (2025) 100159

Contents lists available at ScienceDirect

Asian Transport Studies

journal homepage: www.sciencedirect.com/journal/asian-transport-studies

Practical safety countermeasures for small-displacement motorcycle users in Vietnam: Findings from a focus group and in-depth interview study

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ARTICLE INFO

Keywords:
Risky behavior
Motorcycle riders
Focus group discussion
In-depth interview
Safety countermeasures
Vietnam

ABSTRACT

Along with the sharp increase in motorcycles over the past two decades, traffic crashes with small-displacement motorcycles have become a significant health concern in Vietnam. This study aimed to define practical safety countermeasures for enhancing road traffic safety for motorcycle users (both motorcycle riders and pillion passengers) in Vietnam. To that purpose, a qualitative study design was implemented, including a series of focus group discussions and in-depth interviews based on a semi-structured format with stakeholders involved in motorcyclist safety. The participants of the focus group discussions include motorcycle riders, automobile drivers, bicycle/e-bike riders, motorcycle trainers, and policymakers to define countermeasures to enhance traffic safety for motorcycle riders from the viewpoints of different road user groups and the local authorities. Besides, in-depth interviews were conducted with traffic police officers to define the essential and urgent solutions for reducing traffic crashes related to motorcyclists. The solutions for the leading risky behaviors of motorcyclists include tactical and operational strategies for motorcycle riders. Countermeasures for regulators and authorities to reduce the leading risky behaviors include engineering interventions, enforcement solutions, and education and training countermeasures. Strategies to avoid collisions when motorcyclists ride in pairs or groups include strategies for attitude change of motorcycle riders when riding, the behaviors motorcyclists should have when riding in pairs or in groups, and the appropriate riding skills for motorcyclists while riding in pairs or groups. Innovative strategies for enhancing motorcycle rider safety include strategies for motorcycle users and strategies for regulators and authorities. Providing hazard avoidance training for motorcyclists is the most significant and urgent solution that participants suggested for Vietnamese regulators and authorities in enhancing motorcycle users' safety. These findings imply that the riding training programs for motorcycle riders need to be adjusted and updated by traffic safety authorities, primarily focusing on hazard avoidance training to improve traffic safety for road users in general and motorcycle riders in particular.

1. Introduction

Over the past two decades, along with economic development, more reasonable vehicle prices, and increasing travel demand of Vietnamese people, the number of road motor vehicles has increased rapidly. Specifically, from 2008 to 2018, the average growth rate of road motor vehicles was about 8.03 %/year (TDSI, 2020). According to statistics on motor vehicles, by the end of 2019, the country had about 4.3 million cars and nearly 62 million motorbikes (TDSI, 2020). In parallel with the rapidly increasing number of motorcycles, and travel demand, traffic crashes with motorcyclists have evolved to become a significant challenge for local authorities. These days, road safety is considered a top priority in terms of public health in Vietnam, and ranks 6th (IHME, 2019). Every day in Vietnam, 25 people leave home and never return

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https://doi.org/10.1016/j.eastsj.2025.100159
Received 12 May 2024; Received in revised form 13 February 2025; Accepted 13 March 2025
Available online 24 March 2025

(NTSC, 2015). Vietnam is in the group of the 10 low- and middle-income countries responsible for almost half (48 %) of traffic deaths globally (WHO, 2010). According to a report of NTSC (2019), motorcycle-related traffic crashes account for about 80 % of total road traffic crashes in Vietnam.

Along with the changes in mechanisms, policies, and solutions that have been implemented in recent years, the number of traffic crashes involving motorcyclists is on a downward trend on all three indicators (i.e., the number of traffic crashes, the number of injured people and the number of deaths). However, this reduction rate is still relatively low and has not yet reached the target set by the government of reducing the number of deaths from traffic crashes by 5 ÷ 10 % annually by road Decision No. 1586/QD-TTg dated October 24, 2012). Specifically, the number of road traffic crashes with deaths has been reduced by about 4.5 %/year. In the face of this situation, there is a need for a direct and in-depth study on traffic safety with motorcycle riders, especially those who have been involved in traffic crashes. Furthermore, collecting opinions from experts, managers, authorities, automobile drivers and motorcycle riders are necessary to have a general understanding on road traffic crashes related to motorcyclists.

Although several studies on motorcyclist safety have already been conducted in Vietnam, and packages of safety solutions have been proposed (e.g., Bui et al., 2020; Nguyen et al., 2020; Nguyen et al., 2021; Nguyen-Phuoc et al., 2020; Nguyen-Phuoc et al., 2020; Truong et al., 2019), the majority of these studies used quantitative methods and concentrated on the prevalence of various risky behaviors, the relationship between risky behavior and crash risk, or the impact of risky behavior on riding performance. Aside from some cross-sectional survey work, much less is known about the psychological mechanisms that guide risky behavior among small-displacement motorcyclists in Vietnam. Therefore, the proposed safety solutions may not be appropriate or incomplete. Further research is required to determine the precise underlying motivations or contextual elements that lead to risk-taking behaviors. Moreover, previous studies mainly focused on observing or surveying the motorcyclists themselves. Different stakeholders involved in road safety have professional expertise that might contribute to a better understanding of risk-taking tendencies among small-displacement motorcyclists. Qualitative research techniques (e.g., focus groups and in-depth interviews) allow the development of such an in-depth approach. This study adopted the mentioned qualitative research approach. It included a multi-stakeholder perspective to improve the understanding of risky rider behavior and to re-shape the practical safety countermeasures for road users in general and motorcycle users in particular.

This paper focuses specifically on workable and effective countermeasures to reduce the risky behaviors of motorcycle riders in Vietnam. The combination of in-depth group discussions and expert interviews will reveal the underlying causes of motorcycle-related traffic crashes and thus capture the inadequacies related to traffic safety for motorcyclists from different angles. These results were used to identify the needs for further studies in road safety enhancement for motorcyclists in Vietnam.

According to Vietnamese traffic regulation, there are two types of motorcycle rider licenses: A1 and A2. The A1 license allows operating a small-displacement motorcycle (<175 cc), while a A2 license authorizes riding a large-displacement motorcycle (≥175 cc). Currently, motorcycles in Vietnam are mainly small-displacement types (50 cc–175 cc), with the most common being 100 cc–125 cc, accounting for 90 % (Chu et al., 2016). The rate of large-displacement motorcycles (≥175 cc) is very low, accounting for only about 0.05 % of the total motorcycle fleet in Vietnam (C67, 2016). Small-displacement motorcycles in Vietnam include underbone (i.e., a type of motorcycle that uses structural tube framing with an overlay of plastic or non-structural body panels) and scooter. Underbone motorcycles account for 59 % of the total national motorcycle fleet (Chu et al., 2016). This research will focus on small-displacement motorcycles. From here, the term "motorcycle" refers to a small-displacement type.

2. Objectives

This paper aims to study practical countermeasures for enhancing road safety for motorcycle users in Vietnam. More in detail, there are two objectives. The first objective is to identify the appropriate solutions for cutting down the leading risky behaviors (i.e., drink-riding, speeding, and inattentive riding: see Nguyen et al., 2020; Nguyen et al., 2021; Nguyen et al., 2022) of motorcycle riders. The second objective addressed the innovative and practical countermeasures for enhancing motorcycle rider safety. In the first objective, we present the tactical and operational strategies for avoiding the leading risky behaviors of motorcyclists and countermeasures that encourage the relevant stakeholders to cut down on these risky behaviors. For the second objective, we introduce safety countermeasures designed to promote safer riding behaviors among motorcyclists and provide recommendations for policymakers to implement enhanced measures.

We used focus group discussions and in-depth interviews to thoroughly understand the current inadequacies of the traffic law from the viewpoint of the participants (i.e., motorcycle riders, car drivers, bicycle riders, local authorities, motorcycle trainers, and road traffic police) in order to better define the appropriate countermeasures for reducing the risky behaviors of motorcyclists and identify innovative solutions for enhancing motorcycle users' safety. We applied a semi-structured format to flow beyond the given questions naturally and for emerging additional topics from participants (Huth, 2014; Massey, 2011).

3. Methods

3.1. Study locations

In terms of geographical context, this study was conducted in Ho Chi Minh City (HCMC) and Binh Duong province. They are the provinces with the highest rate of urban population in Vietnam. HCMC is a critical economic hub and financial centre located in the southern region of Vietnam. Binh Duong province neighbours HCMC and is a major industrial hub in southern Vietnam. These provinces have the highest personal motor vehicle use rates (over 94 % in each province). Moreover, the number of motorcycle crashes, people injured, and deaths annually in these provinces are among the highest in Vietnam (Vu et al., 2018; Vu and Nguyen, 2017).

The high crash rates in these areas reflect limitations in the current road safety policies, including insufficient enforcement of laws on mobile phone use while riding (MPUR), inadequate infrastructure for motorcycles, and a lack of public awareness programs. Due to weak enforcement mechanisms and high traffic volumes, existing policies, such as speed limits and designated motorcycle lanes, are often not strictly followed. This situation underscores the urgent need for more comprehensive and context-specific interventions to enhance road safety for motorcyclists.

Several demographic and socioeconomic factors in HCMC and Binh Duong contribute to motorcyclist behavior. Key demographic factors include a predominantly young population with a high demand for mobility. In contrast, socioeconomic factors such as low household income make motorcycles the most affordable and accessible mode of transportation. Many riders have limited formal training, and commuting pressures often lead to risky behaviors such as speeding and red-light violations. These regions' rapid urbanization and industrialization also contribute to high traffic density, making it challenging for motorcyclists to navigate safely in mixed-traffic conditions.

3.2. Research methodology

A qualitative study design was implemented, including a series of focus group discussions and in-depth interviews based on a semi-

structured format with different stakeholders involved in motorcyclist safety. Qualitative methods allow for an in-depth exploration of attitudes, perceptions, and motivations that quantitative surveys may fail to capture. They facilitate interactive discussions that help uncover hidden factors influencing risky behaviors and provide a richer contextual understanding of motorcycle safety challenges (Patton, 2014).

3.2.1. A qualitative study design: focus groups and in-depth interviews

Qualitative research is aimed at gathering detailed opinions and knowledge about a particular topic from selected participants (Bader and Rossi, 2002). In the field of road safety, this typically implies deeper situated knowledge or expertise that is difficult to extract from studies where other research methods are applied, such as crash epidemiology, crash in-depth investigation, or cross-sectional survey. Though highly relevant, epidemiological research or crash investigation is not always able to uncover inner motives driving road users' decisions and behaviors. Survey research is suitable to reveal such knowledge, but is often limited in further exploiting self-reported opinions, and might miss aspects experienced as relevant by different groups of stakeholders.

Focus groups are considered as an appropriate approach for the elicitation of more deeply situated insights. Usually, a moderator facilitates discussion with a selected group of participants, allowing the latter to elaborate freely on topics raised (e.g., Huth et al., 2014; Thomas et al., 1995). A focus group is not just gathering a group of people to talk. Rather, it is about assembling a special group in terms of purpose, size, composition, and procedures to discuss and gather information to understand how people feel or think about a certain issue (Krueger, 2002). The qualitative perspective of a focus group can provide the crucial importance and necessary data for the design of subsequent quantitative studies enabling further exploration of truly relevant issues within larger samples (Huth et al., 2014).

More in detail, there are four major reasons for conducting a focus group: (1) to identify a problem; (2) for planning to achieve a set of goals; (3) to fine-tune the implementation of a study; and (4) to assess and understand what happened during a study to guide future work (Morgan and Krueger, 1998). According to Krueger (2002), four distinct settings can be distinguished: (1) market research, (2) academic application, (3) use by non-profit organizations, and (4) participatory approaches. This study actually followed the "public/non-profit" approach, in a sense that the focus was on a societal challenge of primary importance (e.g., public road safety), but with an additional academic purpose in mind, i.e., exploration of risky ridership, its underlying motives, and its perceived link with motorcyclist crash risk. The core finality of the focus group discussions was to identify and explore some of the hidden dimensions behind risky ridership as a crash causative factor, in order to enable responsible practitioners and policy makers to more accurately set goals and select countermeasures. As will be mentioned later (see section 4.3), the majority of the data was collected by means of focus group discussions. These were however, further complemented by two in-depth interviews with members of the local traffic police department. Individual in-depth interviews instead of participation in a focus group session were organized for the members of the traffic police due to restrictions in terms of common availability. Both focus group sessions and in-depth interviews followed the same procedure and made use of the same tools and instruments (see sections 4.2, and 4.4 for more details).

3.2.2. A semi-structured discussion format

A semi-structured discussion format was adopted for the focus groups and the in-depth interviews. That decision was based on the fact that, for the topic under study here (i.e., risky ridership as a crash causative factor and appropriate countermeasures), data allowing to generate a preliminary list of relevant (but further to be explored) discussion items, is available. For instance, for several years already, the Traffic Police Departments of the three major cities of Vietnam (Hanoi, HCMC, and Binh Duong) collect data and produce statistics on the major causes of road traffic crashes resulting in serious or fatal injuries (SUD, 2018; Vu and Nguyen, 2017; Vu and Nguyen, 2018). Based on data from 2014 to 2016, crashes involving motorcyclists and resulting in serious or fatal injury could be (partially) contributed to one or a combination of the following thirteen factors: drink-riding, speeding, inattentiveness, not obeying to traffic signs (red-light running), wrong lane use or wrong roadway use, dangerous overtaking, dangerous change of direction, tailgating, not giving way at intersections, not giving way to approaching traffic, unsafe vehicle, pedestrian at fault, dangerous traffic environment). As can be seen, the majority of those factors relate to risky ridership. Such data are valuable as a first starting point in guiding discussions. Yet, as already mentioned, epidemiologic data uncovers only part of a crash causative chain with the underlying motives explaining why certain risky behaviors might prevail, remaining unclear. Moreover, it is well known that epidemiologic data is not without shortcomings, e.g., crash registration forms missing potentially relevant causative factors, inadequacies in terms of data collection and storage, et cetera. Besides available epidemiologic data, visual stimuli (e.g., photos or video footage of real-life traffic scenes) can be helpful to facilitate and guide discussion. It is indeed so that moderators are increasingly using projective techniques in qualitative research to help respondents achieve new levels of self-expression (e.g., Banks, 2018; Comi et al., 2014; Davison et al., 2012; Morgan et al., 2008; Nind and Vinha, 2016). Therefore, in this study, a combination of photos and videos showing real-life traffic scenes were used to elicit comments (i.e., projective use of visual stimuli) and guide discussion (i.e., facilitative use of visual stimuli).

3.2.3. A thematic analysis of stakeholder perspectives

Thematic analysis was chosen as the primary method for analyzing the qualitative data in this study due to its flexibility and effectiveness in identifying patterns and insights from diverse stakeholder perspectives (Braun, 2006). The study explored the underlying motivations and contextual factors contributing to risky behaviors among motorcycle users in Vietnam. Given motorcycle safety's complex and multi-faceted nature, thematic analysis provides a structured yet adaptable framework to analyze and interpret qualitative data systematically. The study required an in-depth understanding of road users' behaviors, perceptions, and the socio-cultural context influencing motorcycle safety. Thematic analysis was deemed appropriate for exploring diverse perspectives from various stakeholders, capturing rich, contextual insights, and developing practical safety recommendations grounded in the lived experiences of road users and enforcement authorities. The flexibility in data interpretation, systematic and replicable process, and compatibility with semi-structured interviews and focus groups made thematic analysis ideal for this research. While other qualitative analysis methods, such as grounded theory or content analysis, could have been considered, thematic analysis was preferred due to its focus on pattern recognition across datasets without needing theory generation (Heydarian, 2016; Neuendorf, 2018). Additionally, it allowed for flexibility in analyzing latent and manifest content within the data, ensuring a comprehensive understanding of motorcycle safety issues. In summary, thematic analysis was chosen for its suitability in exploring complex safety behaviors, capturing diverse perspectives, and providing actionable insights for policymakers, making it an invaluable tool for enhancing road safety initiatives in Vietnam.

3.3. Participants

The number of participants to be included in qualitative research depends on the purpose of the study, the number of issues to be discussed, and the time available (Hennink, 2007). Previous studies revealed that research based on qualitative techniques like focus groups or interviews often reaches saturation at a sample of 20–30 participants (e.g., Creswell and Poth, 2016; Morse, 2000; Patton, 1990). Morse (2000) for instance, proposed that a sample size of 30 participants is

probably a good working number for qualitative interviews. Stakeholders were selected using a purposive sampling method to ensure a diverse representation of perspectives. Criteria included experience level, occupation (e.g., riders, policymakers, police officers), and geographical representation. Invitations were extended to individuals with firsthand experience in motorcycle safety, and efforts were made to balance gender and age groups to capture a broad range of insights.

In total, 31 participants took part in this study. Twenty-nine participants assisted in a focus group discussion, while two participants were subjected to an in-depth interview because they could not make themselves available for the focus group sessions. In terms of sample composition, a multi-perspective approach was adopted with stakeholders from various backgrounds (i.e., both experienced and novice motorcyclists, car drivers, (e−)bicyclists, professional trainers, local road safety policy makers, and representatives of the traffic police department) participating in this study. The novice motorcycle riders included, had a motorcycle rider license and riding experience under two years. The bicyclist/e-bike riders were people who rode a bicycle/e-bike on a daily basis. The experienced motorcycle riders had a motorcycle rider license and riding experience of at least five years. The automobile drivers had a driver's license and driving experience of at least five years. Finally, the professional experts were selected mainly based on their professional profile and their level of experience with motorcyclist safety. Participants of the focus group discussions received a gift coupon of 250.000 VNĐ (~11 dollars) for their participation, while participants of the in-depth interview received a gift coupon of 500.000 VNĐ (~22 dollars).

The purpose was to contrast the opinions of lay-experts with those of professional experts. In terms of recruitment, the former (i.e., the lay-experts) were approached via a classic convenience sampling approach (i.e., public announcements), while for the latter (i.e., the professional experts), a selection was made of stakeholder representatives from organizations the Vietnamese-German University had collaborated with before in the context of road safety-related research projects. As for the public announcements targeting lay-experts: these were a combination of announcements held during classroom lectures at the Vietnamese-German University, and an announcement distributed via an e-mail list including staff members and students affiliated with the Vietnamese-German University. Before inclusion, it was verified whether indeed candidate-participants had sufficient practical experience with riding a small-displacement motorcycle, to make sure a sufficient level of (non-professional) expertise was present. As for the professional experts: this was a selection of representatives of relevant stakeholders in the area of road safety, with specialized 'professional' expertise in motorcyclist safety. Professionals included in the study were active for many years already in different sectors, ranging from professional training and education to police departments and policy making. The professional experts were invited by means of a personally addressed introduction letter with the official letterhead of the Vietnamese-German University.

Several challenges were faced during data collection, including participant scheduling conflicts, reluctance to discuss personal crash experiences, and maintaining engagement during lengthy discussions. These challenges were addressed by offering flexible scheduling options, ensuring strict confidentiality to build trust, and employing visual stimuli such as photos and videos to sustain interest and facilitate discussions. Additionally, trained moderators used active listening techniques and open-ended questioning to create a comfortable environment, encouraging participants to share their understandings more freely. Ground rules were established initially to foster an open and respectful environment. Table 1 provides more details on the background profile of the participants included.

Table 2 provides more details on participant numbers, background profile, and allocation to focus group sessions.

As can be seen, four focus groups were conducted to explore opinions of lay-people representing different road user perspectives (i.e., experienced and novice riders, bicyclists and riders of e-bikes, and car drivers). For each focus group session, a mixture of road user profiles was envisaged to be able to triangulate between different road user perspectives. For the two focus group sessions where experts were consulted, one group was composed by motorcycle trainers, the other by policy makers and representatives of local authorities. Focus group sessions included three to seven participants. As indicated already, two members of the traffic police department were contacted for a semi-structured in-depth interview.

3.4. Procedure

Ethical approval for this study was obtained from the Social and Societal Ethics Committee at the University of Hasselt (Ref.: REC/SMEC/VRAI/167/108). Participants were explicitly asked to give their informed consent before the start of the study. Confidentiality and anonymity were ensured by anonymizing transcripts, omitting personally identifiable information, and emphasizing voluntary participation. Participants were informed that they could withdraw from the study at any time and that their responses would be used solely for research purposes. The protocol that was implemented is shown in Fig. 1.

In the first step, the principal researcher (also the moderator of the focus group discussions and interviewer of the two representatives of the traffic police department) formally welcomed participants and explained the primary purpose of the study, i.e., to explore both layperson and expert opinions and experiences regarding the contribution of risky ridership to motorcyclist crashes. Participants were reminded there were no right or wrong statements and that any information was welcome, including opinions different from or opposed to the general way of thinking. Before entering step two of the protocol, participants were asked to individually provide demographic information (i.e., age, sex, riding experience, and occupation), and to self-report

Table 1
Participant characteristics.

Participant	Occupation	Gender	Age	MC rider/driver license (year)	Riding/driving distance per month (kilometers)
Novice motorcycle riders	university student	2 males, 3 females	19-22 (mean = 20.60; SD = 1.34)	1.40 (SD = 0.55)	37.00 (SD = 24.90)
Bicyclist/E-bike riders	university student	3 males, 2 females	19-22 (mean = 19.67; SD = 1.21)	–	58.33 (SD = 14.72)
Experienced motorcycle riders	traffic safety researchers	4 males, 1 female	26-29 (mean = 28.20; SD = 1.30)	8.00 (SD = 2.24)	1220 (SD = 960.20)
≥4-wheelers vehicle drivers	researchers & drivers	4 males, 1 female	27-49 (mean = 35.80; SD = 9.47)	16.80 (SD = 9.31)	1420 (SD = 605.81)
Motorcycle trainer, Policymaker/Authorities, Traffic police	–	8 males, 2 females	30-61 (mean = 40; SD = 12.62).	–	–

Table 2
Participants overview.

Focus groups			Number of group members	Group composition	Remark
Focus group discussion	**Motorcycle-related group**	Group 1: Experienced motorcyclist	5	*EM: 3, CD: 1, NMR: 1*	3 motorcyclists and 1 motorist had crashes in the last 36 months
		Group 2: Novice motorcyclist	7	*NM: 5, CD: 1, NMR: 1*	1 motorcyclist and 1 motorist had crashes in the last 36 months
		Group 3: Bicyclist/E-bike rider	5	*NMR: 4, EM: 1*	2 bicyclists and 1 motorcyclist had crashes in the last 36 months
		Group 4: ≥4-wheelers vehicle driver	4	*EM: 1, CD: 3*	1 motorcyclist had crashes in the last 36 months
	Expert group	Motorcycle trainer	3		Motorcycle, car and truck trainers
		Policymaker/Authorities	5		Binh Duong DOT
In-depth interviews		Traffic police	2		Lieutenant colonel, Leaders of traffic police department of Binh Duong province

Note: EM: Experienced motorcyclist, NM: Novice motorcyclist, NMR: Bicyclist/E-bike rider, CD: ≥4-wheelers vehicle driver.

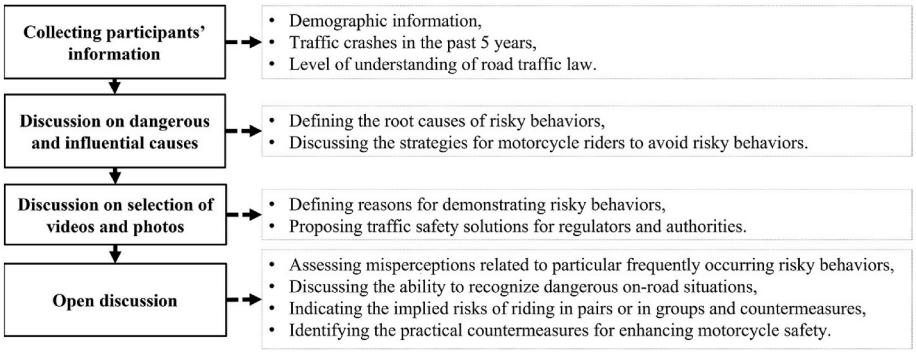

Fig. 1. Overview of study protocol for focus group discussions and in-depth interviews.

on their crash involvement over the last five years. The riding experience was verified through self-reported ride frequency, years of riding, and past crash involvement to ensure that participants had sufficient practical motorcycle experience. Moreover, the principal researcher briefly checked whether participants had a sufficient understanding of the Vietnamese road traffic law and regulations. Next, participants individually received a list with different factors identified by the Traffic Police Departments of the major cities of Vietnam as contributing to motorcycle crashes, which they were asked to rank order in terms of perceived risk. In addition, participants indicated how frequently they thought these different factors occurred.

The discussion items used in the focus groups were carefully developed based on prior epidemiological data collected from traffic police reports and national road safety studies. These data sources identified the most prevalent causes of motorcycle crashes in Ho Chi Minh City and Binh Duong Province. The focus group discussions were structured around these key risk factors, allowing participants to provide insights into the root causes and possible countermeasures. In addition, the epidemiological data helped in framing questions related to the frequency of specific risky behaviors, common crash locations, and the perceived effectiveness of existing safety measures. Including this data ensured that discussions were anchored in real-world statistics, providing participants with a factual basis to reflect upon their own experiences and perspectives. The results of this exercise were then presented and further discussed in groups.

Moderators were trained to establish a non-judgmental atmosphere and create a comfortable discussion environment. They used neutral language and open-ended questions to encourage participants to share their experiences without fear of criticism. Ground rules were set at the beginning of each session to ensure mutual respect and confidentiality among participants. These included maintaining anonymity, respecting differing viewpoints, and allowing participants to opt out of answering uncomfortable questions. These measures helped mitigate potential reluctance to discuss personally sensitive topics, such as past crashes or risky riding behaviors and ensured that participants felt comfortable sharing authentic insights.

In order to start up and guide the conversation, a list of opening questions was used to stimulate participants to reflect and discuss. This semi-structured pattern allowed the conversation to naturally flow beyond the given questions and left room for emerging additional topics (Huth et al., 2014). Once no new information was mentioned, the moderator proceeded with step 3 where visual stimuli (i.e., photographs and video footage of real traffic scenes) were offered to participants in groups. Visual stimuli like crash footage and street scenarios helped participants better relate to real-world situations, often triggering more profound reflections and specific recommendations. Visual stimuli enhanced the information gathered during the focus group discussions. These stimuli provided participants with a concrete reference point, making articulating their observations and opinions easier. The visual aids helped bridge gaps in technical understanding and encouraged participants to recall personal experiences related to similar traffic situations. Additionally, they facilitated more in-depth discussions by allowing participants to analyze and critique real-world behaviors rather than relying solely on abstract recollections.

Participants were asked to judge and comment on the behaviors shown, to explain how they would behave in a similar situation, to elaborate on potential reasons explaining why motorcyclists would behave as shown, and to express how they would personally cope with the risky behaviors shown, in case they would be confronted with these. A noticeable pattern emerged in participant responses before and after introducing the visual stimuli. Initially, participants provided general and subjective opinions based on their experiences and beliefs. However, after viewing the photos and videos, their responses became more specific, evidence-based, and solution-oriented. Many participants identified previously overlooked risk factors, such as poor road conditions, blind spots, and traffic rule violations by other road users.

Finally, in step four, participants could bring up thoughts and reflect freely on some popular misconceptions related to particular frequently occurring risky behaviors, countermeasures to cope with these issues, and the relevance of hazard avoidance skills. In order to be sure that the information provided by participants was sufficiently representative of their true opinions, the moderator closely observed when 'saturation' (i.e., the point at which new qualitative data no longer substantially changes the coding manual, meaning that new information only makes smaller contributions than the information already obtained) was reached. Besides, to mitigate social conformity pressures, moderators encouraged honest feedback by framing questions neutrally and reassuring participants that differing opinions were valuable. The discussion format ensured that participants could openly share insights without feeling compelled to conform to group expectations. The overall procedure took no longer than 1 h and 30 min in total.

3.5. Analysis protocol

The data collected was processed according to the protocol proposed by Braun (2006), which is shown in Fig. 2. Familiarization with data (i.e., step 1) included comparison of stenograph notes taken during the focus group sessions and interviews with the audio tapes to ensure similarity and verify whether no important information was missing.

The software package Atlas.ti 7.0 was used to generate initial codes from the transcriptions (i.e., step 2), whereafter more specific themes and sub-themes were identified (i.e., step 3). These were subsequently reviewed (i.e., step 4), resulting in more formal labels and definitions (i.e., step 5). These finally served as input for drafting the findings (i.e., step 6). This analysis protocol thus involved a constant moving back and forward between the entire data set, and the coded extracts of data, taking several iterative rounds before its completion. Triangulation with multiple coders ensured that themes accurately reflected participant perspectives.

4. Findings

The Atlas.ti software (Version 7.0) was used for coding, analyzing the data, and producing the study results. The countermeasures for the three leading risky behaviors were revealed from the FGD participants. The innovative strategies for enhancing motorcycle rider safety were proposed by the FGD participants and IDI participants.

4.1. Countermeasures for the three leading risky behaviors

Drink-riding, speeding, and inattentive riding are the three leading risky behaviors of motorcycle riders in Vietnam (Nguyen et al., 2021, Nguyen et al., 2022). The video discussions on these leading risky behaviors were conducted with 14 participants of 3 groups (i.e., experienced motorcycle rider, bicyclist/e-bike rider, and car driver) to define appropriate countermeasures. This part presents the countermeasures suggested by participants to avoid the leading risky behaviors and suggestions for regulators and authorities in cutting these down.

The countermeasures for motorcycle riders to avoid collisions with other road users engaging in drink-riding, speeding, and inattentive riding behaviors are categorized into two main themes (see Table 3). The first theme focuses on tactical strategies involving proactive measures motorcyclists can take to anticipate and avoid risks. The second theme addresses operational strategies, detailing specific actions motorcyclists can implement to prevent collisions with reckless riders or drivers (Fig. 3). Tactical strategies include "giving way", "paying full attention" and "keeping a safe distance", which help riders navigate hazardous situations more effectively.

> "*Always pay attention when riding, usually check the rearview mirrors to have enough time to define and give way for the vehicle behind riding at high speed and trying to overtaking. Reduce speed to give way for the* distracted *motorcycle riders overtaking. Ride into the roadside to give way for the drunk rider/driver.*" (P.16, Male, NMR, FGD)

Regarding the operational strategy, the focus group participants

Table 3
Conceptual dimensions and codes.

Theme	Conceptual dimensions	Code
Avoiding risky riders: Tactical strategy (Theme 1)	Drink-riding	Giving way Paying full attention Keeping a safe distance
	Speeding	Giving way Paying full attention
	Inattentive riding	Giving way Keeping a safe distance
Avoiding risky riders: Operational strategy (Theme 2)	Drink-riding	Increasing speed to overtaking Riding into the roadside Reducing speed
	Speeding	Riding into the roadside Reducing speed
	Inattentive riding	Riding into the roadside Reducing speed Sounding the horn to alert inattentive drivers/riders
Countermeasures for regulators and authorities: Engineering (Theme 3)	Drink-riding	Building more public parking lots
	Speeding	Installing surveillance cameras Installing speed humps Expanding the motorcycle lane
	Inattentive riding	Installing surveillance cameras Removing the countdown lamp systems
Countermeasures for regulators and authorities: Education and training (Theme 4)	Drink-riding	Encourage drinking non-alcoholic beverages Public campaign on the harms of drink-riding behavior
	Speeding	Use catastrophic images in public campaigns
	Inattentive riding	Training hazard avoidance skill for motorcycle riders
Countermeasures for regulators and authorities: Enforcement (Theme 5)	Drink-riding	Banning pubs without parking lots Increasing patrolling and saction activities Increasing punishment level Strengthening of enforcement measures
	Speeding	Increasing punishment level
	Inattentive riding	Indirect penalization Increasing punishment level Allowing hands-free mode

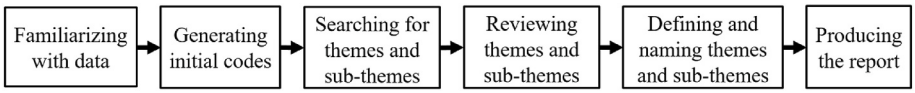

Fig. 2. Stepwise data analysis protocol. Source: adopted from Braun (2006).

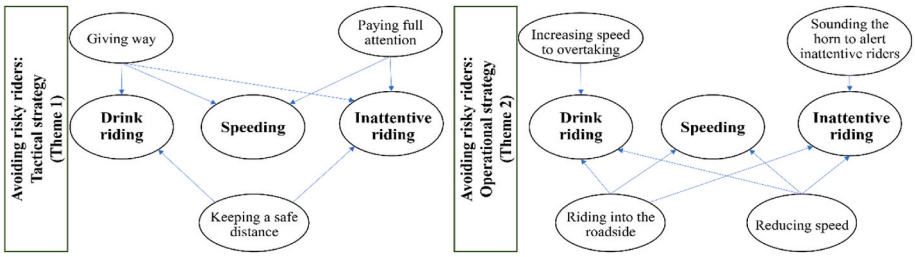

Fig. 3. Countermeasures for motorcycle riders to avoid crash with other risky riders/drivers.

reveal countermeasures to avoid crashes with the three leading risky behaviors. According to them, the countermeasures to avoid collisions with other riders/drivers behaving dangerously, include "reducing speed", "increasing speed", "riding into the roadside" and "sounding the horn to alert".

Regarding the operational strategy, focus group participants identified specific countermeasures to help avoid crashes caused by the three leading risky behaviors. According to them, effective countermeasures include "reducing speed", "increasing speed", "riding into the roadside", and "sounding the horn to alert".

> "*Reduce speed and give way for the vehicle behind riding at high speed and trying to overtaking. Sound the horn to alert a rider who riding inattentive and reduce the speed. Increase speed to overtake or reduce speed to give way for the drunk rider.*" (P.19, Male, CD, FGD)

The countermeasures for regulators and authorities to reduce "drink-riding", "speeding", and "inattentive riding" behaviors among road users are categorized into three main themes (Fig. 4). The first theme focuses on engineering countermeasures while the second theme addresses education and training countermeasures. Finally, the third theme includes participants' suggestions for modifying and updating current traffic laws in Vietnam to reduce the most prevalent risky behaviors among motorcycle users effectively.

According to the participants, "speeding" behavior occurs for two main reasons. The first reason is that motorcycle lanes are too narrow compared to overall traffic volume. As a result, motorcycle riders often encroach on car lanes to arrive on time for work. When riding in car lanes, motorcyclists must maintain a speed similar to that of cars, leading to higher speeds. The proposed solution to this issue is to expand motorcycle lanes to accommodate the increasing number of motorcycles in Vietnam. The second reason for "speeding" is some riders' general passion for speed. To mitigate this behavior, participants suggested implementing countermeasures such as "installing surveillance cameras" and "installing speed humps" on roads to enforce speed limits more effectively.

> "*Need to build more public parking. Install the speed humps and surveillance camera systems at the road segments that motorcycle riders usually exceed the speed limit.*" (P5, Female, NMR, FGD)

The education and training countermeasures discussed by participants include public campaign methods and programs aimed at providing 'hazard avoidance skills' for motorcycle riders. Additionally, to reduce 'inattentive riding' behavior, participants proposed 'training hazard avoidance skills' for motorcycle riders. This training would equip riders with essential knowledge about potential hazards, helping them recognize and understand the dangers associated with 'inattentive riding' on the road.

> "*Provide knowledge on motorcycle riders' hazards to help motorcycle users understand the on-road hazard and have practical riding skills for avoiding the different types of hazards, such as mobile phone use while riding.*" (P17, Male, EM, FGD).

4.2. Strategies to avoid collisions when riding in pairs or in groups

The discussion on strategies to avoid collisions when riding in pairs or groups revealed three main themes, each with several sub-themes (see Fig. 5). The first theme focuses on attitude adjustments that motorcycle riders should adopt to enhance safety while riding in groups. The second theme highlights appropriate riding behaviors that motorcyclists should follow when riding in pairs or groups. The third theme outlines essential riding skills that motorcyclists must develop to prevent collisions with other riders in group riding situations (see Table 4).

In all circumstances, motorcyclists must remain calm while in traffic

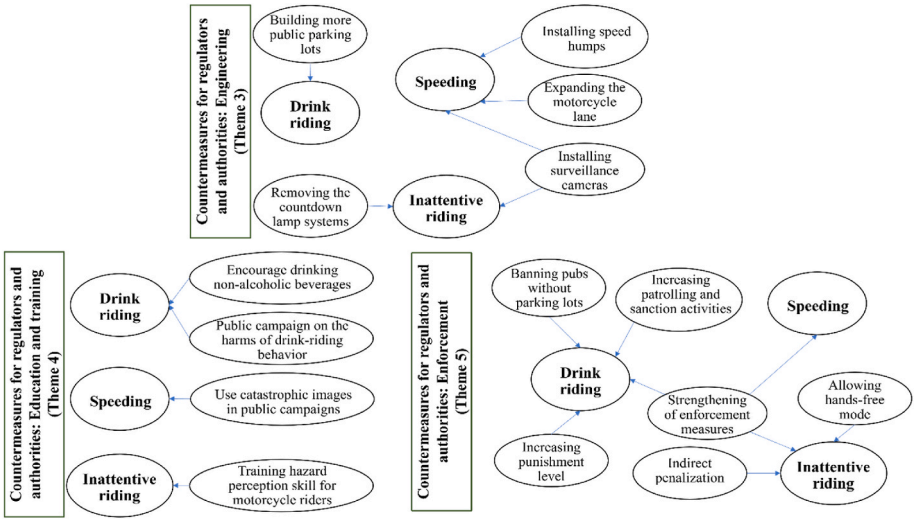

Fig. 4. Countermeasures for road safety authorities to cut down risky behaviors.

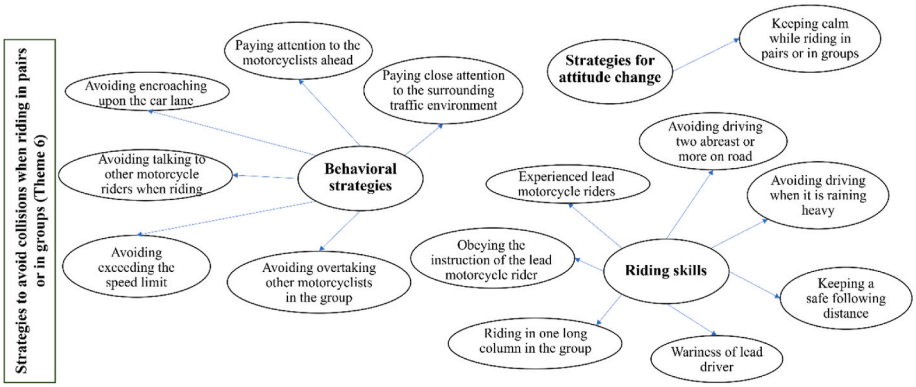

Fig. 5. Strategies to avoid collisions when riding in pairs or in groups.

Table 4
Conceptual dimensions and codes.

Theme	Conceptual dimensions	Code
Strategies to avoid collisions when riding in pairs or in groups (Theme 6)	Strategies for attitude change	Keeping calm while riding in pairs or in groups
	Behavioral strategies	Avoiding encroaching upon the car lane
		Avoiding talking to other motorcycle riders when riding
		Avoiding exceeding the speed limit
		Avoiding overtaking other motorcyclists in the group
		Paying close attention to the surrounding traffic environment
		Paying attention to the motorcyclists ahead
	Riding skills	Avoiding riding two abreast or more on road
		Experienced lead motorcycle riders
		Avoiding riding when it is heavily raining
		Keeping a safe following distance
		Wariness of lead motorcycle rider
		Riding in one long column in the group
		Obeying the instruction of the lead motorcycle rider

to handle unexpected incidents on the road effectively. This becomes even more important when riding in groups, as proximity between riders increases the risk of horizontal collisions. Additionally, unpredictable or reckless behavior by some MC riders in the group can lead to chain-reaction crashes. Therefore, the most important strategy for riding in pairs or groups is for each rider to stay calm and composed, letting them respond properly to any sudden or hazardous situations caused by other group members.

> *"The strategies that could apply to avoid the traffic crash when riding in a group include: Keeping calm, always paying attention, and not talking to each other when riding in a group. Do not travel over the speed limit. Motorcyclists who ride behind other riders must pay close attention to the traffic condition and obey the direction of the group leader, not encroach upon the car lane, and not overtake other people in the group. The team leader must alert team members soon when the hazards are discovered."* (P.2, Male, EM, FGD)

Certain behaviors are critical to ensuring safety when riding in pairs or groups. These include "avoiding talking to other riders while riding", "avoiding exceeding the speed limit", "avoiding overtaking riders in the group", "paying close attention", and "paying attention to the riders ahead". Among these, participants emphasized that "avoiding exceeding the speed limit" is particularly important in preventing collisions when riding in groups.

Participants also identified key riding skills that motorcyclists should develop to enhance group riding safety. These include "avoiding riding two abreast or more on the road", "having experienced lead riders", "avoiding riding in heavy rain", "keeping a safe following distance", "maintaining wariness of the lead rider", "riding in a single-file formation", and "obeying the lead rider's direction". The two most highly recommended skills for group riding safety were "keeping a safe following distance" and "obeying the lead rider's direction".

> "*Riding in one long column. The group's leader must have many experiences, to consider dangerous situations and warn other riders in his group. Always pay close attention to traffic conditions around and keep a safe following distance. Do not ride over the speed limit. Motorcyclists who ride behind other riders have to pay close attention to the traffic condition and obey the direction of the group leader, do not encroach upon the car lane, not overtake other people in the group. Do not ride two abreast or more on the road when riding in pairs or in groups. Do not ride in a group when it's raining because riders in the group will be hard to observe each other, and may crash into each other due to limited visibility and slippery road.*" (P.3, Male, CD, FGD).

4.3. Practical countermeasures for enhancing motorcyclist safety

The discussions on innovative strategies for enhancing motorcycle rider safety were conducted through focus group sessions with twenty-nine participants from six groups and in-depth interviews with two road traffic policymakers. This section presents the innovative strategies suggested by participants to improve safety for both motorcycle riders and pillion passengers.

The discussion is categorized into two main themes (see Table 5). The first theme focuses on safety measures that motorcycle users can adopt, including providing them and themselves with appropriate safety features. The second theme investigates strategies for regulators and authorities to enhance motorcycle safety (Fig. 6).

The innovative safety strategies for motorcyclists are also divided into two key categories. The first category addresses 'preventive devices' that should be installed on motorcycles to enhance safety. The second category covers 'protective devices' that motorcycle users should wear while riding to minimize injury risks in the event of a crash.

Preventive devices that motorcycles should be equipped with include ''reflective materials,'' "qualified rearview mirrors", "hazard lights", "daytime running lamps ", and "LED headlights". Many riders modify their motorcycles for aesthetic purposes, often removing or replacing the

Table 5
Conceptual dimensions and codes.

Theme	Conceptual dimensions	Code
Innovative safety strategies for motorcyclists (Theme 7)	Preventive devices	Reflective materials for motorcycle
		Qualified rearview mirrors
		Hazard lights for motorcycle
		Daytime running lamp for motorcycle
		LED turn signals for motorcycle
	Protective devices	Qualified full-face helmet
		Protective shoes
		Protective gloves
		Elbow guard
		Protective clothing
Innovative strategies for regulators and authorities (Theme 8)	Engineering	Periodic maintenance of road surfaces
		Expanding motorcycle lane
		Separating lanes of motorcycle and automobile
	Education and training	Training hazard avoidance skills
		Periodic training for shipper and MC taxi rider
		Using infographics in public campaigns
	Enforcement	Applying IT in monitoring and sanctioning

original rearview mirrors with more stylish alternatives. However, these aftermarket mirrors are often untested, unlicensed, and of low quality, which can compromise safety. Additionally, some motorcycles, such as early-morning shopping or evening delivery services, are frequently used in low-light conditions. To improve visibility, some MC riders in Vietnam replace the right-hand side rearview mirror with an LED light to enhance brightness.

Motorcycle headlights improve rider vision and visibility, particularly in dark or adverse weather, such as heavy rain or fog. These lights also enhance a motorcycle's lighting signature, helping other road users detect the vehicle more easily. Additionally, modern motorcycles' LED turn signal systems are recommended to improve conspicuity, especially in poor weather conditions. A lack of conspicuity in being seen and correctly perceived has been identified as a significant factor contributing to motorcycle-related crashes. To address this issue, participants strongly recommended daytime running lamps for new motorcycle models, as they can significantly enhance visibility and help reduce crash risks.

"*Motorcycles need to be equipped the qualified rear-view mirrors to ensure the rear visions for motorcycle riders.*" (P.3, Male, CD, FGD)

"*Install the reflective materials for motorcycles. Besides, motorcycles should be equipped with the daytime running lamp to increase their visibility to other vehicles and be fitted with the LED turn signals to increase the forward brightness for the motorcycle rider.*" (P.26, Male, PA, FGD)

Several protective devices are recommended for motorcycle users to reduce the risk of severe injuries in traffic crashes. According to participants, these protective devices fall into three main categories: head protection, body protection, and hand and leg protection.

Head injuries are challenging to recover from compared to other types of injuries. Therefore, participants strongly recommend that both motorcycle riders and pillion passengers wear "qualified full-face helmets" to minimize head injuries. In Vietnam, the helmet market is flooded with low-quality products that authorities struggle to regulate. These substandard helmets fail to provide adequate protection and can even pose additional risks. For example, a poorly made helmet may break apart in a crash and cause severe facial injuries. To address this concern, participants emphasized that motorcycle riders should use ''qualified helmets'' rather than low-quality alternatives worn merely to comply with police regulations.

Additionally, body protection in the form of protective clothing, hand and leg protection, such as "elbow guards", "protective gloves", and "protective shoes", are recommended for motorcyclists, particularly when riding at high speeds on national highways or provincial roads. These protective measures help minimize the severity of injuries in the event of a crash.

"*Motorcycle riders and pillion passengers must use the full-face helmet types with quality assurance. When riding, motorcycle riders should wear boots, leather shoes to protect their feet. While riding on the national highways and provincial roads, motorcycle riders should wear protective clothing, protective gloves and specialized shoes.*" (P31, Male, TP, IDI).

Participants identified three key categories of innovative solutions for regulators and authorities to improve road safety for motorcycle users: engineering, education and training, and enforcement (Fig. 7).

The innovative engineering solutions proposed for local authorities focus on enhancing road infrastructure to improve safety for motorcyclists. These solutions include "periodic maintenance of road surfaces", "expanding motorcycle lanes", and "separating lanes of motorcycle and automobile".

"*The two most innovative solutions should be considered in applying to enhance motorcycle rider safety, include: improving the motorcycle training programs to enhance the riding skills for motorcycle riders, especially the on-road hazard avoidance skills, and also, teach appropriate riding behaviors for motorcyclists; applying information technology in monitoring and sanctioning risky behaviors or violations of motorcycle riders, such as the traffic surveillance camera or red light camera.*" (P31, Male, TP, IDI)

Participants most frequently proposed solutions for education, training, and enforcement. For education and training, the recommended countermeasures include "training hazard avoidance skills", "periodic training for shippers and motorcycle taxi riders", and "using infographics in public campaigns". Participants suggested an innovative solution for enforcement: "applying IT in monitoring and sanctioning"

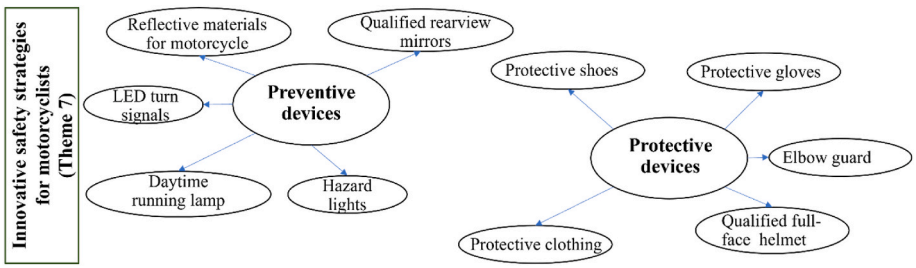

Fig. 6. Innovative safety solutions for motorcycle users.

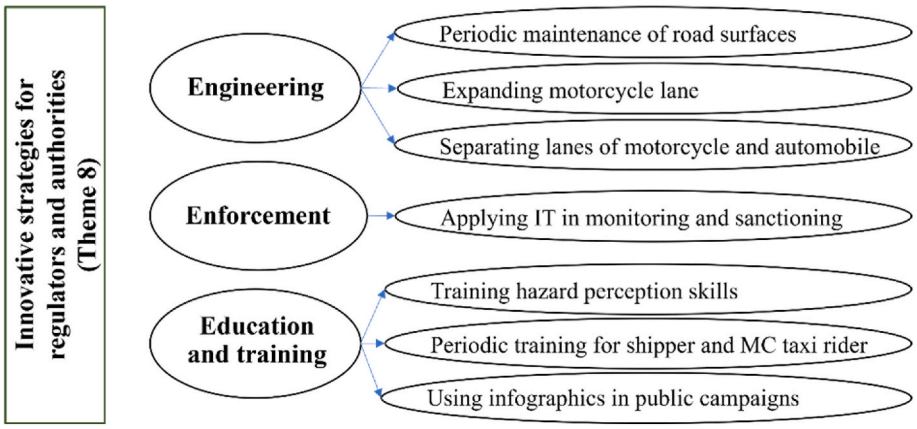

Fig. 7. Innovative solutions for regulators and authorities.

to improve compliance with traffic laws.

Participants noted that the current training program for motorcyclists in Vietnam is inadequate, as it fails to equip riders with the fundamental skills needed to respond to and handle dangerous situations effectively. Additionally, while public campaigns have been widely implemented, their effectiveness remains low. As a result, participants emphasized the need to revise public awareness campaigns using more innovative approaches to improve their impact.

> "*There is a need to review the current training program and the licensing process for motorcycle riders. The motorcycle rider's licensing in Vietnam is theoretical. This lacks training the handling skills to deal with the dangers on the road to the motorcycle rider. When teaching the theory test questions, many places teach the trainees how to cheat, how to know what the right and wrong answers are based on the specific signalment of the questions' characteristic, so the trainees need not read the question carefully before choosing the correct answers. In some motorcycle rider licensing centers, the examinee need not do anything for the theoretical test; the examiner will help them. At the practical test, the examinee is allowed to have mistakes up to four times.*" (P30, Male, TP, IDI)

"*Using fake motorcycle rider licenses is widespread, the sale of counterfeit riding license is rampant on social networks. Many people have over one motorcycle rider license (i.e., an official license and many fake licenses). Therefore, it is necessary to coordinate between the traffic police and the local authorities to control and reduce the fake rider licenses. The motorcycle training and testing process are currently not well controlled. It is necessary to strengthen supervision from many units to ensure the quality of the motorbike license. The public campaign has been carried out so much. However, the effect is not high. The cause is because the person carrying out the public campaign has not brought inspiration for learners, and the trainees often follow the crowd to study or be forced to study. The trainer should use infographics of dangerous motorcycle-related crashes in public awareness campaigns to attract participants' attention. In Vietnam, the motorcycle rider license for motorbikes mainly focuses on theoretical contents. With the rapid increase in the number of the motorcycle, the training riding skills program for motorcycle riders, are necessary to: (1) be able to well-control their vehicles; (2) to recognize the dangers while riding on national highways and provincial roads; (3) to deal with dangerous situations may occur while riding.*" (P31, Male, TP, IDI).

5. Discussion

The focus group discussions and in-depth interviews in this qualitative study revealed the stories behind participants' experiences and viewpoints that are not detectable with quantitative studies, observational studies, experimental studies, or secondary data from traffic police.

5.1. Countermeasures for the leading risky behaviors

Drink-riding, speeding, and inattentive riding are the three leading causes of motorcycle-related road traffic crashes in Vietnam. To effectively avoid risky behaviors from other road users, especially these three major risks, motorcycle riders should develop hazard avoidance skills that enable them to quickly recognize dangerous behaviors and take appropriate actions to prevent crashes.

Motorcyclists can employ various tactical strategies after identifying potential hazards, such as "giving way to risky riders", "paying full attention to risky riders", or "maintaining a safe distance". Among these, ''giving way'' appears to be the most effective strategy for avoiding collisions, particularly when encountering drink-riding, speeding, or inattentive riders.

In addition to tactical strategies, motorcyclists should adopt effective operational strategies to navigate hazardous situations safely. One of the most recommended operational strategies is "reducing speed". Lowering speed allows riders to observe dangerous behaviors more effectively, select the most appropriate preventive actions, and minimize the severity of injuries in the event of a collision.

For regulators and authorities, participants identified "installing speed bumps and humps" as the most effective countermeasure to reduce speeding among motorcyclists. Placing these traffic calming devices in high-risk areas where speeding is prevalent can significantly reduce the likelihood of crashes. Lowering vehicle speeds is one of the most effective ways to improve road safety. However, simply imposing lower speed limits is ineffective without proper law enforcement. Thus, implementing physical measures such as speed bumps and rumble strips remains one of the most widely used strategies for curbing excessive speeding (Afukaar, 2003).

To address inattentive riding, participants recommended training in hazard avoidance skills as a key countermeasure for regulators and authorities. In such training programs, policymakers should provide motorcyclists with essential knowledge about potential hazards, including external event hazards (caused by road conditions and other road users) and internal hazards (caused by the riders).

A long-term strategy to enhance motorcycle safety involves comprehensive education programs to improve riders' awareness and correct common traffic safety misconceptions. Building a well-informed generation of 'safe' motorcyclists through targeted training and public awareness campaigns is crucial for achieving sustainable improvements in road safety.

5.2. Strategies to avoid collisions when riding in pairs or in groups

Riding in pairs or groups is common among motorcyclists in Vietnam, particularly among young riders who often go on backpacking trips

during holidays. The motorcycles typically used for such trips are medium-displacement motorcycles (135cc–150 cc), such as Exciter, Winner, and Raider, or large-displacement motorcycles (≥175 cc). Due to their higher engine capacity, these motorcycles encourage riders to travel at high speeds, sometimes leading to racing behaviors within the group.

The most important rule when riding in pairs or groups is to adhere to the speed limits designated for each road and region. Group riders should maintain a single-file formation, avoiding staggered riding or overtaking other members within the group (Huth et al., 2014). Riders often match their speeds with others in the group, as perceived normative behavior influences their riding style (Huth et al., 2014).

When riding near or in parallel formation, riders may engage in casual conversations, which increases the risk of lateral collisions, especially at high speeds, due to potential handlebar or mirror contact. Additionally, riding too closely can obstruct the visibility of those behind, making it difficult for trailing riders to anticipate and react to sudden road hazards.

To ensure group safety, the lead rider should be the most experienced motorcyclist, as they are responsible for navigating the route and identifying potentially dangerous areas. Team members must follow the lead rider's guidance while remaining cautious about mimicking behaviors such as speed selection (Huth et al., 2014). Riding discipline within the group is essential to minimizing risks and ensuring safe group travel.

5.3. *Practical countermeasures for enhancing motorcycle users' safety*

Motorcycles must be fully equipped with the manufacturer's safety equipment to reduce the likelihood of traffic crashes. Riders should not alter or remove essential motorcycle components, including the frame, fuel tank, shock absorber, braking, wheels, lighting, and rear-view mirrors. Manufacturers carefully designed and synchronized these original parts to ensure optimal performance and safety. Any modifications or additions may compromise the overall structure and functionality of the motorcycle. A defensive rider scans ahead to anticipate obstacles, checks surroundings and observes vehicles behind (Schewe, 2010). In Vietnam, many riders remove the right-hand rear-view mirror or replace the original mirrors with low-quality alternatives to avoid police penalties. However, many young or novice riders fail to recognize the safety benefits of rear-view mirrors, particularly for making turns and lane changes. Using poor-quality mirrors can impair a rider's ability to accurately judge the distance and speed of approaching vehicles, increasing the risk of collisions.

Motorcycle riders are more vulnerable to traffic crashes than automobile drivers due to their exposure and reduced vehicle size (Vlahogianni et al., 2012). A critical issue is that automobile drivers often fail to detect motorcycles promptly in situations such as wrong-way riding, following at close distances, navigating obscured intersections, or negotiating tight curves with limited visibility. These crash scenarios are more common than those caused by bad weather (Rößger and Lenné, 2017). Because motorcycles are smaller than four-wheeled vehicles, they are harder to detect, even in broad daylight. As a result, road users' reaction times to motorcycles tend to be slower than their responses to larger vehicles (Rößger et al., 2012). Additionally, large vehicle drivers, such as those operating trucks or containers, struggle to detect motorcycles in their blind spots, which increases crash risks. Predicting a motorcycle's movement is challenging due to its dynamic and often unpredictable riding patterns (Ragot-Court et al., 2012). The "looking but not seeing" phenomenon is often cited as a cause of motorcycle-related crashes, highlighting the difficulty in detecting smaller vehicles (Dahlstedt, 1986). Improving motorcycle conspicuity is critical for reducing these crashes, especially during daylight hours (Winkelbauer et al., 2012). Conspicuity can be categorized into two perspectives: sensory conspicuity and cognitive conspicuity (Rößger and Lenné, 2017). Sensory conspicuity refers to an object's ability to stand out due to physical characteristics like brightness, color contrast, and angular size (Jean and Gunter, 1989). Cognitive conspicuity, on the other hand, depends on an observer's experience and expectations. To enhance motorcycle visibility, several solutions have been recommended, including brightly colored motorcycle designs, reflective protective clothing, and the use of daytime running lights (DRL) to improve conspicuity (Rößger and Lenné, 2017). Studies from the US, Australia, Japan, and the UK confirm that DRLs and Automatic Headlight On (AHO) systems effectively reduce motorcycle-related crashes by increasing visibility (Elliott et al., 2003).

Most motorcycles in Vietnam use halogen lighting technology, emitting less light than modern Xenon and LED alternatives. Halogen lamps generate significant heat, deleting plastic lamp covers and reducing emitted light over time. On the other hand, LED lights are more energy-efficient, reach maximum brightness instantly, and provide directional illumination, improving rider visibility. Studies show that LED turn signals can enhance a rider's reaction time by up to 30 % when signaling turns (Vu and Nguyen, 2020). Motorcycle-related crashes frequently result in severe head injuries, which can be fatal or cause permanent disabilities (e.g., neurological damage). Many Vietnamese riders neglect to wear helmets, particularly for short-distance trips, nighttime rides, or special occasions (Brijs et al., 2014). Many riders wear low-quality or counterfeit helmets to comply with traffic regulations, but these helmets provide little protection (Hung et al., 2008). Research shows that over 80 % of traumatic brain injuries in Vietnamese motorcycle crashes involve riders using fake or inadequate helmets (Duc et al., 2013). To improve head protection, quality-assured helmets are essential for reducing injury severity. Studies confirm that helmet use significantly decreases the risk of head and brain trauma (DeMarco et al., 2010; Keng, 2005; Khor et al., 2017; McDermott et al., 1993; Rowland et al., 1996). Three types of helmets are used in Vietnam: half-face, three-quarter, and full-face. While all three types provide fundamental protection for urban riding, full-face and three-quarter helmets offer superior safety for high-speed environments such as highways and provincial roads. Helmets should also include a windshield to protect riders' eyes from dust and insects, which could otherwise impair vision and increase crash risks.

Research on protective clothing for motorcyclists remains limited. However, the protective benefits of materials such as leather have long been recognized (Feldkamp et al., 1977; Hurt et al., 1981). Protective clothing is crucial in minimizing injuries during crashes, shielding riders from environmental conditions (wind, rain, cold, and heat), and improving conspicuity (de Rome, 2006). Wearing reinforced protective gear is particularly important for high-speed travel to mitigate injury severity.

Two key strategies for improving motorcycle safety involve enforcement measures and education programs. One innovative enforcement solution is the application of IT-based monitoring, such as red-light cameras, to detect and penalize traffic violations. Studies confirm that red-light cameras effectively modify motorists' risky behaviors and improve road safety (Mccartt and Eichelberger, 2012; Retting et al., 1999, 2008). Additionally, increasing fines for recurrent traffic violations can be a stronger deterrent, provided enforcement mechanisms are in place (Moolenaar, 2014). Motorcycle safety education should focus on hazard avoidance training to equip riders with essential skills for recognizing and responding to on-road dangers. In Vietnam, pre-license training programs emphasize traffic laws but neglect advanced riding techniques. High-income countries have reformed training models into higher-order skills like hazard perception, defensive riding, and nighttime riding strategies. Studies suggest that supervised training and structured licensing systems significantly reduce crash risks (Haworth and Mulvihull, 2005; Kardamanidis et al., 2010).

To enhance motorcycle safety, Vietnam should revise its pre-license training programs to incorporate advanced riding skills, improve public awareness campaigns, and introduce stricter enforcement policies targeting high-risk behaviors. Tailored safety education for rural and

mountainous regions, where limited access to training resources should also be prioritized. Solutions such as mobile loudspeaker announcements and community-led safety programs could improve safety awareness in remote areas. By adopting a comprehensive approach integrating engineering, enforcement, and education, policymakers can significantly reduce motorcycle-related crashes and enhance overall road safety.

5.4. Implementation of countermeasures

Based on insights from focus group discussions and in-depth interviews, several practical strategies have been proposed to implement motorcycle safety countermeasures in Ho Chi Minh City and Binh Duong province, necessitating a multi-faceted approach that integrates engineering, enforcement, and education measures. Engineering interventions include expanding motorcycle lanes on key arterial roads, installing speed-calming devices at traffic crash-prone locations, and enhancing road lighting and visibility. Enforcement measures recommend increased deployment of automated enforcement systems, randomized sobriety checkpoints, and implementation of progressive fines and stricter penalties for repeat offenders. Education and training programs involve developing mandatory hazard recognition and avoidance training modules in pre-license motorcycle training centers, launching city-wide public awareness campaigns, and partnering with ride-hailing and delivery service platforms to mandate safety training for their riders. Additionally, pilot programs and policy recommendations suggest a phased implementation approach to assess the effectiveness of countermeasures, stakeholder collaboration to monitor and refine the measures, and advocating for policy revisions to include evidence-based countermeasures. The successful implementation of these strategies requires coordinated efforts among policymakers, enforcement agencies, and the public to reduce motorcycle-related crashes and enhance overall traffic safety, contributing to Ho Chi Minh City's and Binh Duong province's long-term vision of sustainable and safe urban mobility.

6. Conclusion and recommendations

Every study has its limitations. This study was based on a qualitative research design, and the convenience-sampling approach for the recruitment of lay-experts in this study might have biased the sample in terms of the level of education as compared to the overall population. In terms of risk incidence, it needs to be further validated whether the behaviors mentioned by the participants in the focus groups and in-depth interviews indeed predominate among small-displacement motorcyclists in Vietnam. Even though there is empirical work from Vietnam available on several of the risky rider behaviors mentioned in this study (e.g., mobile phone use distraction, tailgating, wrong lane use, illegal u-turns, turn signal neglect, riding in pairs, and drink-riding), most of these studies are exploratory in nature, limited in number, and primarily focused on how such behaviors result in safety risks and how they degrade rider performance. Motorcyclists were also categorized based on self-reported riding experience in this study. In more detail, novice motorcyclists were defined as those with less than two years of riding experience, while experienced riders had over five years of riding. However, no distinction was made regarding how their perspectives differed during focus group discussions, as it was the belief that both novice and experienced motorcyclists faced similar challenges in the traffic environment and exhibited comparable attitudes towards risky behaviors and safety countermeasures. It is a valuable suggestion for future research to explore in more detail the extent to which past rider experience might affect the topics discussed during the focus groups. Further examination should also be conducted on other risky behaviors of motorcycle riders beyond the three leading ones explored in this study to develop suitable solutions.

The study results provide a concrete picture of the necessary and appropriate solutions to improve road safety for motorcyclists with the typical characteristics of transport infrastructure and traffic user behavior in Vietnam. The most essential and urgent countermeasure is adjusting and updating the pre-license training program for motorcycle riders, focusing on training riding skills and hazard avoidance skills. Further detailed studies need to provide comprehensive information for policymakers to promulgate suitable adjustments in enforcement to address the three leading risky behaviors of motorcycle riders.

This study makes several significant contributions to the understanding and improvement of motorcycle safety in Vietnam. First, it adopts a multi-stakeholder approach, integrating diverse perspectives to identify practical safety countermeasures comprehensively. Second, the study introduces an innovative framework for addressing risky behaviors through tactical, operational, and regulatory strategies, emphasizing hazard avoidance training as a critical intervention. Additionally, the findings contribute valuable insights for policymakers by providing evidence-based recommendations to enhance road safety policies and educational programs. Ultimately, this research bridges the gap between theoretical safety measures and their practical implementation, offering a strategic roadmap for improving motorcycle safety in Vietnam's complex traffic environment.

CRediT authorship contribution statement

Dinh Vinh Man Nguyen: Writing – review & editing, Writing – original draft, Visualization, Software, Resources, Methodology, Investigation, Formal analysis, Conceptualization. **Anh Tuan Vu:** Supervision. **Veerle Ross:** Supervision. **Tom Brijs:** Conceptualization. **Geert Wets:** Supervision. **Kris Brijs:** Writing – review & editing, Validation, Supervision, Software, Methodology, Formal analysis, Conceptualization.

Acknowledgments

The research reported in this paper was supported by the Special Research Fund (BOF) of Hasselt University and the Research Fund of Vietnamese-German University. The corresponding author would like to thank and acknowledge the support of Binh Duong Department of Transport, and Binh Duong Traffic Police Department for introducing participants for the focus group discussion and the in-depth interview.

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