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Final report from a workshop
held on 9–23 June, 2021

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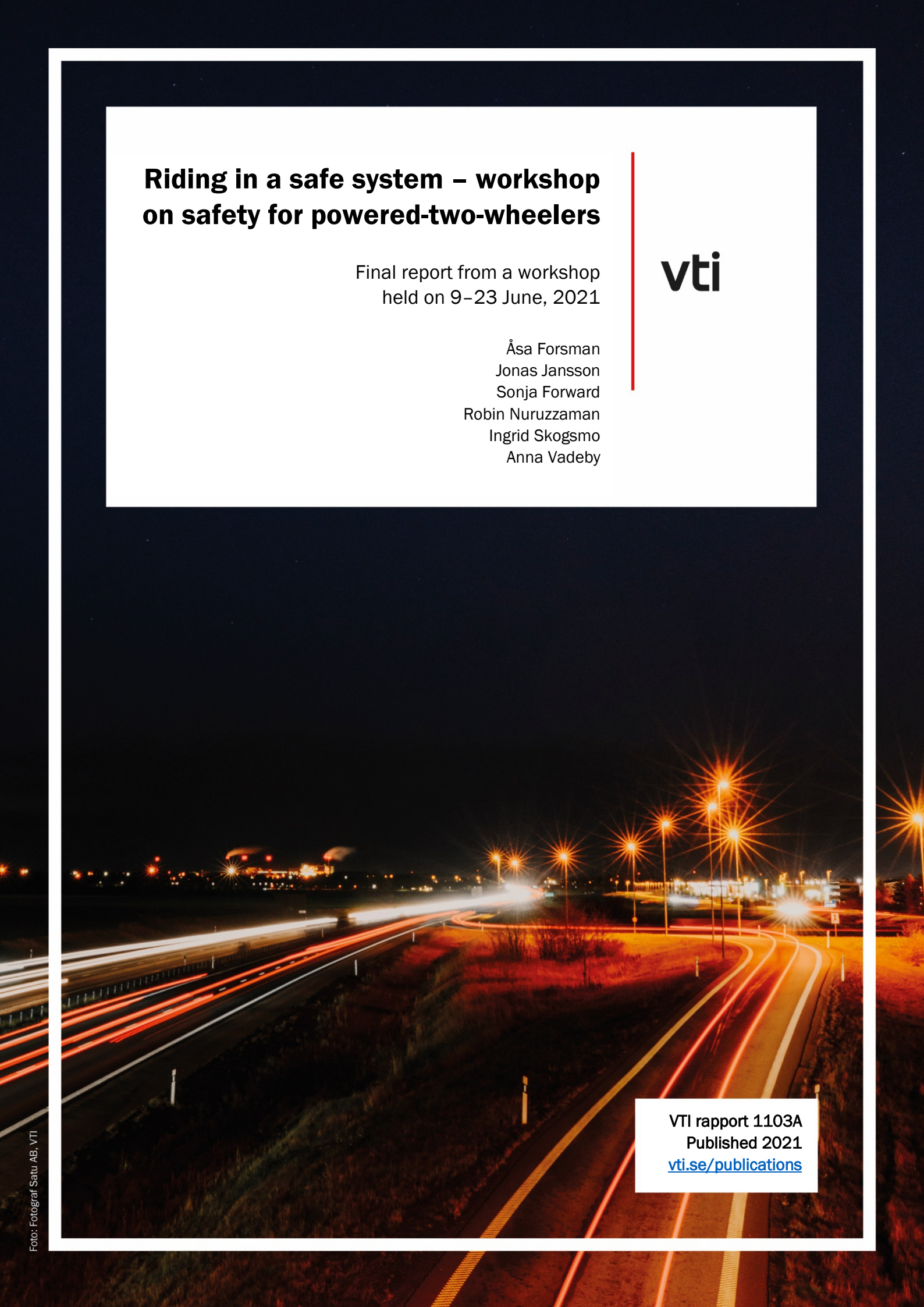

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vti

Authors: Åsa Forsman, VTI, Jonas Jansson, VTI, Sonja Forward, VTI, Robin Nuruzzaman, VTI, Ingrid Skogsmo, VTI, Anna Vadeby, VTI
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Författare/Author

Åsa Forsman (VTI, orcid.org/0000-0003-4680-4795)

Jonas Jansson (VTI)

Sonja Forward (VTI, orcid.org/0000-0001-7383-2412)

Robin Nuruzzaman (VTI)

Ingrid Skogsmo (VTI)

Anna Vadeby (VTI, orcid.org/0000-0002-9164-9221)

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Foreword by the workshop steering committee

Riding a powered-two-wheeler (PTW) is one of the most common modes of transport in the world, but PTW riders are also some of the most vulnerable road users. Improving the safety of riders will have a dramatic impact on road safety globally.

In June 2021, the International Transport Forum (ITF), the Swedish Transport Administration, the Swedish National Road and Transport Research Institute (VTI), the International Motorcycling Federation (FIM), and the motorcycle manufacturers associations (IMMA and ACEM) organised a workshop on PTW Safety, as a follow-up to the Third Global Ministerial Conference on Road Safety, held in Stockholm in February 2020. The workshop was held over several virtual sessions in June 2021 and involved more than 200 experts from all regions in the world.

This report, prepared by VTI on behalf of the steering committee, describes the process before, during and after the workshop and presents its conclusions and recommendations. It also summarises the discussions from the different sessions.

The goal of this workshop was to develop and propose directions and priority actions for policy makers to effectively include and improve safety of PTW riders in their regional, national, or local road safety policy activities. It was also to ensure that riders are integrated in the objectives of the Stockholm Declaration which represents the recent evolution of road safety from Vision Zero and the Safe Systems Approach.

The term PTW includes light mopeds with maximum design speeds of 50 km/h, as well as motorcycles with higher engine and power capacities covered by many different segments, vehicle types, and users. This includes a wide diversity of vehicles in the world. There are also significant variations in their use due to differences in climate, geography, and economic development. The workshop recognized the existence of these unique regional aspects to motorcycling while seeking to define a short list of effective mechanisms that are valid for all regions.

The priority actions are the result of careful consideration and fruitful discussions among leading global experts on the diverse associated fields of expertise. In the selection of the priority actions, the steering committee has given priority to the recommendations that are feasible and can have true impact on road safety within the decade 2021–2030. Therefore, this report can be seen as a starting point for organised discussions in the regions to concretely contribute to the Global Plan for the Decade of Action for Road Safety 2021–2030 as presented by the World Health Organization (WHO). To complement the priority actions, the research recommendations presented in chapter 12 of this report should not be forgotten.

The steering committee is grateful for the contributions of all participants in this workshop and hopes the content of this report will be an inspiration towards effective policy by all involved stakeholders worldwide, thus saving millions of lives.

Summary and priority actions

An international workshop on safety for powered-two-wheelers (PTWs), Riding in a safe system, was held as a series of virtual meetings 9–23 June 2021. The workshop was co-organised by the International Transport Forum (ITF), the Swedish Transport Administration, the International Motorcycling Federation (FIM), the motorcycle manufacturers associations (IMMA and ACEM), and the Swedish National Road and Transport Research Institute (VTI). The workshop was a follow-up of the Third Global Ministerial Conference on Road Safety, held in Stockholm in February 2020, but it also built on a previous workshop in 2008 in Lillehammer and the 2015 ITF research report "Improving Safety for Motorcycle, Scooter and Moped Riders" (OECD/ITF, 2015).

The workshop, which included six expert sessions, focused on seven different areas: (i) Sustainable practices, work-related issues and procurement, (ii) Modal shift and urban needs, (iii) Training, education, and licensing, (iv) Vehicle safety, protective safety, and Intelligent Transport Systems, (v) Road infrastructure and road environment, (vi) Speed management, adapting speeds and behaviour to different environments, (vii) Youth and child safety.

Eight priority actions were recognized by the workshop to achieve the integration of PTWs in the safe system by 2030. These actions build on the Stockholm declaration and its 9 recommendations. The actions are generalized results from the outcome of the expert sessions. The 8 priority actions from the workshop are listed below with a further description of each action, and more detailed actionable items can be found in the rapporteur's recommendations per session as described in the report.

- **Move to sustainable practice**
- **Support modal shift**
- **Adopt safe vehicles and equipment**
- **Educate safe riders**
- **Redesign infrastructure**
- **Ensure safe speed**
- **Protect children**
- **Increase knowledge**

Move to sustainable practice

Public and private organisations should, in the context of Shared Responsibility, apply best practice in PTW safety and report, separately for PTWs, on their organisation's safety footprint across the entire value chain, in order to improve road safety for professional users, customers, employees and other road users.

Public and private organisations, such as fleet owners and local governments, should assess where and how PTWs are used in their operations, their jurisdictions, and associated businesses.

Public and private organisations should subsequently set and drive safety policies to improve PTW safety across their activities and throughout their value chains, and report on the situation and policies implemented (PTW safety footprint) in periodic sustainability reporting.

Fleet owners, government policy makers and researchers should develop and promote self-regulation and legislation for professional PTW taxi and delivery fleet-operating companies.

Governments and researchers should perform PTW risk assessments, and develop strategic solutions for local sustainable transport plans

Support modal shift

Rethink, redesign, and reallocate infrastructure and urban planning. Cities and road authorities should develop new solutions that include PTW mobility in urban settings for sustainable and safe use of PTWs for efficient mobility. This includes adapting speed in urban areas, where pedestrians and cyclists interact with motorized vehicles, in accordance with the Stockholm Declaration[1].

Manufacturers and researchers should improve and demonstrate the sustainability (safety and environmental footprint) of PTWs as a space-efficient mobility tool, and city planners should enable better connection of PTWs with public transport.

Local governments should improve the management of PTW parking capacity in general, and especially at public transport hubs to enable modal shift from and to PTWs, allocating sufficient space and preventing impairment of pedestrian access through the design of parking infrastructures and enforcement of parking rules.

Local and national governments should increase safe transport choices everywhere to reduce forced reliance on PTWs, and especially for small children (e.g. school buses) and in low- and middle-income countries.

Adopt safe vehicles and equipment

To accelerate the adoption of PTW safety technologies such as ABS[2] and AHO[3], safe vehicles and products should be promoted by regulation, procurement, and incentives by governments, fleet operators, and insurance companies respectively. Industry should also continue to drive safety performance on all markets. Scientific safety ratings programs should stimulate consumers to choose safe vehicles, helmets and other personal protective equipment (PPE).

In line with UN Resolution A/RES/74/299, national and regional regulatory bodies should implement UNECE WP.29 minimum requirements.

ABS and CBS are priority technologies for accelerated global fitment in the new Decade of Action 2021-2030. Government policy makers in all regions of the world should develop a progressive roadmap to equip new motorcycles with ABS, adapted to the local context. Corporate fleet owners should set voluntary policies and procurement guidelines incorporating fitment of these technologies on new vehicles.

Automatic Headlamp On (AHO) requires further promotion as a safety solution for PTWs. It benefits from the status of minimum requirement under UNECE WP.29 and the 1968 Vienna Convention on road traffic but requires more awareness.

All stakeholders should promote the use and standardization of PPE and helmets and promote development of UNECE WP.29 minimum requirements.

Independent scientific safety rating results from independent consumer safety rating programs for PTWs, helmets, and other PPE should be considered.

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[1] A critical prerequisite to support modal shift is a safe environment for walking, bicycling and low speed powered two- or three-wheelers. The Stockholm Declaration recommends a maximum speed limit of 30 km/h in urban areas unless strong evidence exists that higher speeds are safe.

[2] Anti-lock Braking system.

[3] Automatic Headlamp On.

Government and diverse vehicle industries should assure safe integration of PTWs in connected and automated mobility, addressing both efficient connectivity systems and the detection of PTWs by other vehicles.

Educate safe riders

Promote state-of-the-art rider education and licensing systems. Governments, authorities, rider associations, and industry should accelerate the availability of effective, affordable, and accessible education, training, and licensing programs in all regions, especially in low- and middle-income countries.

All stakeholders, especially governments, fleet operators, and industry should accelerate the availability of effective, affordable, and accessible PTW training and education programs.

Governments to adopt and promote state-of-the-art PTW rider licensing systems.

Training and education for riding PTWs should include recommendations and awareness on the risks of riding with a child on a PTW, and how to do it with the least risk.

All stakeholders should, under the lead of the public and/or private organisations, develop and promote a new traffic safety culture, promoting amongst others: risk-awareness, awareness on VRUs, use of helmets and other PPE.

Redesign infrastructure

Improve infrastructure safety for PTWs. Governments and road authorities should comply to latest standards and update their road manuals and design and maintenance guidelines to include best practice and safe system principles for PTWs.

Infrastructure managers, researchers, and institutions should update and promote road design standards, manuals, and guides to reflect latest best practice knowledge on PTW safety.

All stakeholders should develop new (and radical) ideas by rethinking the traffic system, reorganising infrastructure space allocation and design, to consider the relatively higher proportions of PTWs in traffic in some regions.

Researchers, manufacturers, and governments should share knowledge and experiences on safe and efficient infrastructure solutions which support the mix of PTWs, other vehicles, and other Vulnerable Road Users (VRUs) in road traffic.

Ensure safe speed

Road authorities should set appropriate speed limits that are in line with safe system principles. All stakeholders should promote technology, infrastructure design, enforcement, procurement, information, training, and education to ensure speed compliance.

All stakeholders should promote the new speed policy recommendations, resulting from the Global Ministerial conference, and develop infrastructure design solutions for traffic calming.

Industry, insurance companies, and authorities should develop and promote new solutions for supporting riders in choosing appropriate speed.

Protect children

All levels of governments should improve safety by offering suitable transportation alternatives, where possible, to carrying small children on PTWs. If child passengers are carried on a PTW the child should use appropriate safety equipment, and PTWs should have relevant child occupant

protection system. Children should be protected in school zones, for example, by infrastructure measures and technology solutions.

Efforts should be made to reduce the risk of children and youth on PTWs in urban safety and urban mobility plans. These provisions should include identifying when and where children are passengers on PTWs—including moto-taxis—and strategies for reducing their risk through such measures as reducing speed, using protective equipment, avoiding highways, etc.

The safety of children should be improved by offering suitable transportation alternatives, such as public transport and school buses, especially in low- and middle-income countries.

Children should use appropriate safety equipment, and PTWs should have relevant child occupant protection system.

Researchers, manufacturers, and governments should develop and promote solutions to support riders who have to carry children.

Training and education for riding PTWs should include recommendations and awareness on the risks of riding with a child on a PTW, and how to do it with the least risk.

The power of corporate and government procurement should be utilized to improve the safety of children on motorcycles. This includes requirements that all firms providing services to the corporation have strong policies preventing child or youth passengers on any motorcycles owned by that firm.

Increase knowledge

Governments, industry, and the research community shall fill the gaps in knowledge and develop innovative solutions for the safety of PTW users. Substantial funding is to be quickly devoted to in-depth, epidemiological, and biomechanical research into the mechanisms of PTW crashes and their consequences, as well as the measures to remedy them.

Research needs and knowledge gaps are further described in Chapter 12.

Preface

The content of this report builds on the work conducted before, during, and after the virtual workshop *Riding in a safe system*, 9–23 June 2021. It is based on the discussions during the expert sessions, reports from the rapporteurs, and priority actions consolidated by the steering committee.

We would like to thank everyone involved; the steering committee, moderators, rapporteurs, all experts that participated in the sessions, and presenters at the two introductory sessions. Because of everyone's excellent contributions, the workshop was a great success and lead to relevant and meaningful priority actions. The workshop gathered experts from around the world and from a variety of stakeholders ensuring a broad consensus on the actions.

The community of PTW users comprises a large variety of riders with different prerequisites and needs. It is our strong belief that the priority actions evolving from the workshop will be an excellent basis to improve safety for all riders and move towards a safe system.

Linköping, December 2021

Jonas Jansson
Head of department Traffic and road user, VTI

Examiner

This report was reviewed by members of the steering committee, moderators, and rapporteurs, who contributed to the report by providing comments and suggestions.

The recommendations and priority actions in the report are those of the workshop and steering committee and do not necessarily reflect the views of VTI as a government agency.

Table of contents

1. Introduction

An international workshop on safety for powered-two-wheelers (PTWs), Riding in a safe system, was held as a series of virtual meetings 9–23 June 2021. The workshop was co-organised by the International Transport Forum (ITF), the Swedish Transport Administration, the International Motorcycling Federation (FIM), the motorcycle manufacturers associations (IMMA and ACEM), and the Swedish National Road and Transport Research Institute (VTI).

The workshop was a follow-up of the Third Global Ministerial Conference on Road Safety, held in Stockholm in February 2020, but it also built on the 2008 Lillehammer workshop (ITF/OECD/JTRC/TS6, 2008) and the 2015 ITF research report "Improving Safety for Motorcycle, Scooter and Moped Riders" (OECD/ITF, 2015).

The event in Lillehammer 2008 gathered nearly 100 experts from 21 countries, representing the main stakeholders involved in motorcycle safety (ITF/OECD/JTRC/TS6, 2008). The workshop resulted in 3 general principles and 13 practical countermeasures. It also identified the need to support continuing dialogue and co-operation between the various actors involved in motorcycle safety. Two years later, in 2010, ITF set up a working group on the safety of PTWs to review trends in PTW crashes and examine crash-contributing factors. Their work resulted in a report which included a set of safety countermeasures (OECD/ITF, 2015). The report also discussed motorcycle safety in the context of a safe system approach and emphasized that it is a shared responsibility.

The Third Global Ministerial Conference on Road Safety in 2020 marked the end of the Decade of Action for Road Safety 2011–2020. However, in September 2019, the Sustainable Development Goals Summit reaffirmed commitment to implementing the 2030 Agenda on Sustainable Development (AEG, 2019; UN, 2019). Therefore, the ministerial conference was also a starting point for the future direction of global road safety strategies and the conclusion of the conference was summarized in the Stockholm Declaration[4]. An Academic Expert Group (AEG) was formed to create a set of recommendations for the coming decade. The outcome was nine recommendations that are presented in the next section.

The aim of the present workshop was to gather experts on PTW safety from all important stakeholders to discuss the nine recommendations of the Academic Expert Group and their application to motorcyclists' safety. The main goal was to develop a set of priority actions to improve motorcycling safety for the decade 2021–2030, taking regional aspects into account.

The workshop started with two public events: an opening session and a session giving an overview of the situation for PTWs in the world. Then followed six expert sessions with invited participants, which covered seven different areas:

1. Sustainable practices, work-related issues, and procurement.
2. Modal shift and urban needs.
3. Training, education, and licensing.
4. Vehicle safety, protective safety, and Intelligent Transport Systems.
5. Road infrastructure and road environment.
6. Speed management, adapting speeds and behaviour to different environments.
7. Youth and child safety. This issue did not have a dedicated session but was addressed in all sessions.

[4] https://www.roadsafetysweden.com/contentassets/b37f0951c837443eb9661668d5be439e/stockholm-declaration-english.pdf

Each expert session provided a set of recommendations and, finally, eight priority actions were recognized by the workshop to achieve the integration of PTWs in the safe system by 2030. These were presented at a public closing session on 29 September 2021. An overview of the process is presented in Figure 1.

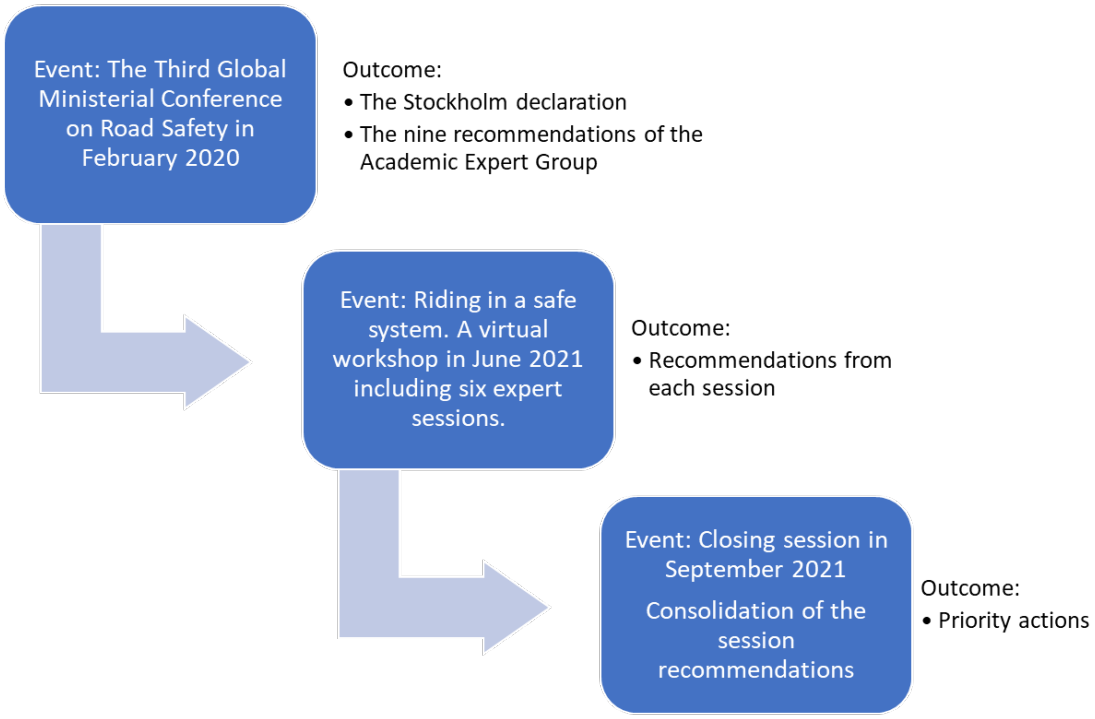

Figure 1: An overview of the events and their outcomes leading to the priority actions presented in this report.

The invited participants in the expert sessions were selected to represent different parts of the world and included policy makers, researchers, and representatives of motorcyclists' organisations, industry, road authorities, and international organisations.

1.1. The nine recommendations of the Third Global Ministerial Conference on Road Safety in Stockholm 2020

The recommendations of the Academic Expert Group are based on Agenda 2030 and the Sustainability Goals (SDGs), where road safety was for the first time included as a part of the global development agenda. The inclusion of road safety among the SDGs means that road safety is a shared responsibility of a wide range of stakeholders, both public and private, and stresses the need for further engagement among all stakeholders.

The Academic Expert Group´s vision for road safety describes how existing initiatives can be combined with progressive techniques that lead to road safety integration in a range of other social developments in a comprehensive way. The goal is that road safety will be an integral part of a broad range of social endeavours, from commercial enterprises to humanitarian initiatives.

The nine recommendations, with brief descriptions from AEG (2019), are included below. For a more detailed description, see the AEG report.

Recommendation #1: Sustainable Practices and Reporting

To ensure sustainability of businesses and enterprises of all sizes, organisations are recommended to provide annual public sustainability reports, including road safety disclosures. They are also recommended to require the highest level of road safety according to safe system principles in their

internal practices, in policies concerning the health and safety of their employees, and in the processes and policies of the full range of suppliers, distributors, and partners throughout their value chain or production and distribution system.

Recommendation #2: Procurement

To achieve the Sustainable Development Goals addressing road safety, health, climate, equity, and education, all tiers of government and the private sector are recommended to prioritize road safety following a safe system approach in all decisions. This includes the specification of safety in their procurement of fleet vehicles and transport services, in requirements for safety in road infrastructure investments, and in policies that incentivize safe operation of public transit and commercial vehicles.

Recommendation #3: Modal Shift

To achieve sustainability in global safety, health, and environment, nations and cities are recommended to use urban and transport planning along with mobility policies to shift travel toward cleaner, safer, and affordable modes incorporating higher levels of physical activity such as walking, cycling, and the use of public transit.

Recommendation #4: Child and Youth Health

To protect the lives, security, and well-being of children and youth, and ensure education and sustainability of future generations, it is recommended that cities, road authorities, and citizens examine the routes frequently travelled by children to attend school and for other purposes, identify needs, including changes that encourage active modes such as walking and cycling, and incorporate safe system principles to eliminate risks along these routes.

Recommendation #5: Infrastructure

To realize the benefits that roads designed according to the safe system approach will bring to a broad range of SDGs as quickly and thoroughly as possible, governments and all road authorities are recommended to allocate sufficient resources to upgrade existing road infrastructure to incorporate safe system principles as soon as feasible.

Recommendation #6: Safe Vehicles Across the Globe

To achieve higher and more equitable levels of road safety across the globe, vehicle manufacturers, governments, and fleet purchasers are recommended to ensure that all vehicles produced for every market will be equipped with recommended levels of safety performance. It is further recommended that incentives for use of vehicles with enhanced safety performance are provided where possible, and that the highest possible levels of vehicle safety performance are required for vehicles used in private and public vehicle fleets.

Recommendation #7: Zero Speeding

To achieve widespread benefits to safety, health, equity, climate, and quality of life, it is recommended that businesses, governments, and other fleet owners practice a zero-tolerance approach to speeding. They should further collaborate with supporters of a range of SDGs on policies and practices to reduce speeds to levels that are consistent with safe system principles using the full range of vehicle, infrastructure, and enforcement interventions.

Recommendation #8: 30 km/h

To protect vulnerable road users and achieve sustainability goals addressing liveable cities, health, and security, a maximum road travel speed limit of 30 km/h is recommended to be mandated in urban areas unless strong evidence exists that higher speeds are safe.

Recommendation #9: Technology

In order to quickly and equitably realize the potential benefits of emerging technologies to road safety—including, but not limited to, sensory devices, connectivity methods, and artificial intelligence—it is recommended that corporations and governments incentivize the development, application, and deployment of existing and future technologies to improve all aspects of road safety, from crash prevention to emergency response and trauma care. Special attention should be given to the safety needs and social, economic, and environmental conditions of low- and middle-income nations.

1.2. The aim of the report

The aim of this report is to describe the process before, during, and after the workshop that led to the priority actions. Since the priority actions are a synthesis of the views of the invited experts as expressed and discussed in the different sessions, reporting from these sessions is an essential part of the report. Each expert session is described in a separate chapter that comprises a summary of the discussions, recommendations, and selected references.

The summary of the discussions captures the issues raised during the session and reflects the views of the attending experts. Therefore, it may not in all cases represent the latest research, facts, or figures. References are only included if referred to during the discussion, in the chat, or in emails after the session. The intention has been to reproduce the essence of the discussions of each topic, as a background to the recommendations. The recommendations from each session are taken from the rapporteurs' reports, and not formulated by the authors of the present report. Only a few corrections of linguistic errors and layout changes have been made. Each chapter ends with a section called 'Comments and scientific references'. The aim of this section is to provide the reader with relevant references that are related to the topics discussed during the sessions. The selection is made by the author of that chapter and depends both on what was discussed and what was found in the literature. It does not cover all areas discussed during the session and it is not a systematic literature review. The literature search was performed by VTI's library based on the content of the expert sessions as described by the steering committee.

2. Preparation and implementation of the workshop

The workshop was organised by a steering committee with the following participants:

- Chair: Maria Krafft, Swedish Transport Administration
- Edwin Bastiaensen, International Motorcycle Manufacturers Association (IMMA)
- Jesper Christensen, Swedish Motorcyclists Association
- Rex Deighton-Smith, International Transport Forum
- Veronique Feypell, International Transport Forum
- Rikard Fredriksson, Swedish Transport Administration
- Hilda Gomez, Consultant, Colombia
- Christopher Hodder, International Motorcycling Federation (FIM)
- Elin Karlsson, Swedish Motorcyclists Association
- Jonas Jansson, VTI, Sweden
- Dimitris Margaritis, Centre for Research & Technology, Hellas – CERTH, Greece
- Rajesh Menon, Society of Indian Automobile Manufacturers (SIAM)
- Edward Moreland, Harley Davidson
- Antonio Perlot, Motorcycle Industry in Europe (ACEM)
- Jörgen Persson, Swedish Transport Administration
- Matteo Rizzi, Swedish Transport Administration
- Pierre Van Elslande, University Gustave Eiffel, France
- Veneta Vassileva, Motorcycle Industry in Europe (ACEM)
- Dolf Willigers - Federation of European Motorcyclists Associations (FEMA)

Initially, the workshop was planned to take place in Stockholm in June 2020 but was postponed due to the Covid-19 pandemic and changed into a virtual meeting. The practical arrangements of the meetings (invitations, virtual meeting rooms, recordings, etc.) were managed by ITF.

The steering committee agreed on six expert sessions with different topics as the basis of the workshop. The chosen topics were linked to the nine recommendations of the Academic Expert Group, see Table 1. It was also decided that recommendation #4 on child and youth health should be discussed in all sessions. The recommendations to be considered in each expert session was included in the information sent to participants before the session and also presented at the beginning of each session.

Table 1 Connection between the topics of the expert sessions and recommendations of the Academic Expert Group, as presented at the sessions.

Topics of the expert sessions	Recommendations from the Academic Expert Group								
	#1: Sustainable Practices and Reporting	#2: Procurement	#3: Modal shift	#4: Child and youth health	#5: Infrastructure	#6: Safe vehicles across the globe	#7: Zero speeding	#8: 30 km/h	#9: Technology
Sustainable practices, work-related issues, and procurement	X	X		X					
Modal shift and urban needs			X	X					
Training, education, and licensing		X		X			X	X	
Vehicle safety, protective safety, and Intelligent Transport Systems		X		X		X			X
Road infrastructure and road environment				X	X				X
Speed management, adapting speeds and behaviour to different environments				X			X	X	X

The next step was to select experts for all sessions. The aim was to find a good balance between different types of stakeholders and different regions. The stakeholders were divided into policy makers, international organisations, motorcycle industry representatives, motorcyclist organisations, NGOs, and researchers from universities, research institutes, or independent consultancies. The steering committee used their, and their organisations', networks to find the experts.

Each session was chaired by a moderator and a rapporteur. The moderator and rapporteur planned the session together with support from the steering committee, and decided on which topics to discuss and specific questions to address. This information was sent to the participants beforehand so they could be better prepared. It was also possible to share comments and background information with the group before the session.

During the sessions, the discussions were led by the moderator while the rapporteur took notes and summarized the discussions at the end. Two extra rapporteurs were appointed to cover the area of child and youth health. They attended three sessions each.

The authors of this report participated in the sessions as observers. Their role was only to listen and take notes for the report, they did not take part in the discussions.

The experts participated in the sessions under the premise of the Chatham House Rule[5]:

> "When a meeting, or part thereof, is held under the Chatham House Rule, participants are free to use the information received, but neither the identity nor the affiliation of the speaker(s), nor that of any other participant, may be revealed."

To facilitate the work of both the rapporteurs and observers, the sessions were recorded. The recordings were only used as a support when writing the reports. It is important to emphasize that the report only provides a general description of the discussions and its recommendations. It does not

[5] https://www.chathamhouse.org/about-us/chatham-house-rule

include quotes that can be associated with a specific participant or organisation. The only exception to this is the two public sessions that opened the workshop.

2.1. Consolidation of priority actions

After each expert session, the rapporteur drafted a report with the most important observations from the session and a list of recommendations. The rapporteurs covering the area of child and youth health wrote a joint report from all sessions. In all, there were seven reports from the six expert sessions.

The reports were circulated after the meeting and all participants had the opportunity to make comments. A first consolidation meeting was held on 23 June were the rapporteurs presented the preliminary recommendations. After that, the reports were adjusted and then circulated among the session participants one more time.

Based on the final recommendations from each session, the steering committee drafted a set of priority actions. The moderators and rapporteurs were given the opportunity to give comments before completion. These priority actions are the main outcome of the workshop and were presented at the closing plenary on 29 September 2021.

2.2. Limitations and definitions

The scope of the workshop and this report is limited to two-wheeled mopeds and motorcycles, or more precisely, vehicles of the categories L1 and L3[6]. In the present report, they are referred to by the term powered-two-wheelers (PTWs). The workshop was also limited to the use of PTWs in the transport system. Off-road riding or racing as well as power-assisted bicycles and electric kick-scooters were beyond the scope of discussion.

2.2.1. List of definitions and abbreviations

Safe system – A safe system can be described as a holistic approach to road safety including the road transport system and the interactions between roads, travel speeds, vehicles, and road users. The road transport system should be adapted to the limitations of the road users, by anticipating and allowing for human error. The responsibility for preventing fatalities and serious injuries is shared by road users and those who design, maintain, and operate all parts of the road transport system. If road users fail to follow the rules of the transport system due to lack of knowledge, acceptance, or ability, it is still the system designers' responsibility to prevent fatalities and serious injuries.

With the safe system approach, health losses in the road transport system are no longer tolerated as the inevitable price that society needs to pay in order to have mobility it is simply not acceptable that road users, regardless of means of transportation, risk their lives when travelling.

An example of a safe system that was first adopted by the Swedish parliament in October 1997, is Vision Zero. This is a vision of a safe road transport system where nobody is killed or seriously injured.

The Stockholm Declaration – *"*Building on the Moscow Declaration of 2009 and the Brasilia Declaration of 2015, UN General Assembly and World Health Assembly resolutions, the Stockholm Declaration is ambitious and forward-looking and connects road safety to the implementation of the 2030 Agenda for Sustainable Development. The Stockholm Declaration also reflects the recommendations of the conference's Academic Expert Group and its independent and scientific assessments of progress made during the Decade of Action for Road Safety 2011–2020 and its

[6] https://unece.org/fileadmin/DAM/trans/main/wp29/wp29resolutions/ECE-TRANS-WP.29-78r6e.pdf

proposals for a way forward."[7] Among other things the recommendations emphasize supporting modal shift by creating a safe environment for walking, bicycling and low speed powered two- or three-wheelers. The Stockholm Declaration recommend a maximum speed limit of 30 km/h in urban areas unless strong evidence exists that higher speeds are safe.

Moped/L1[8] – a two-wheeled vehicle with maximum design speed not exceeding 50 km/h and with an engine cylinder capacity not exceeding 50 cm3.

Motorcycle/L3[9] – A two-wheeled vehicle with maximum design speed exceeding 50 km/h, and with an engine cylinder capacity exceeding 50 cm3.

ABS – Anti-lock Braking System

ADAS – Advanced Driver Assist System

AHO – Automatic Headlight On

ARAS – Advanced Rider Assist System

ISA – Intelligent Speed Adaptation

HICs – High-Income Countries

LMICs – Low- and Middle-Income Countries

PPE – Personal Protective Equipment

PTW – Powered-Two-Wheeler, here limited to mopeds and motorcycles

VRU – Vulnerable Road Users

[7] https://www.government.se/information-material/2020/02/stockholm-declaration

[8] https://unece.org/fileadmin/DAM/trans/main/wp29/wp29resolutions/ECE-TRANS-WP.29-78r6e.pdf

[9] Ibid.

3. Opening session

Mr Stephen Perkins, Head of Research and Policy Analysis at the International Transport Forum (ITF), welcomed the listeners to the virtual workshop. He stated that motorcycling possibly poses the greatest challenge to achieve the safe system goal with zero deaths and serious injuries on our roads. Because of this, the countermeasures taken for motorcyclists can help in pushing boundaries to achieve a safe system for all road users. He then presented the program of this opening session and the rest of the workshop, and presented the speakers of the opening remarks.

3.1. Opening remarks

The first opening remark was made by Mr Tomas Eneroth, the Swedish Minister for Infrastructure. He mentioned that the Stockholm Declaration has been endorsed by the United Nations and that the next decade 2021–2030 of action now starts. He emphasised the need for an integrated approach, and that it is a shared responsibility involving both the private and the public sector: "it is our responsibility to improve road safety".

The second presentation was by Ms Ángela Maria Orozco Gómez, the Colombian Minister of Transport. She stressed the importance of motorcycles and that their use is part of wellbeing, offering accessibility and work opportunities for large groups of people. She then described a range of different actions taken to improve motorcycling safety in the short and long term in her own country. Actions that are inspired by the safe system approach and including all road users focusing on safer vehicles and safer road users. Ms Ángela Maria Orozco Gómez argued that Colombia needs better informed road users and better prepared drivers, and to achieve this it needs to be a shared responsibility. She finished the presentation by stating the importance of collaboration with international organisations.

The third opening remark was by Mr Young Tae Kim, Secretary General of the International Transport Forum (ITF). Mr Young Tae Kim was very pleased with the progress made after the Global Ministerial Conference on Road Safety in Stockholm. He mentioned that Colombia joined the ITF this year which meant that it now has 63 member countries.

3.2. Keynote presentations

The first keynote presentation was made jointly by Dr Maria Krafft, Traffic Safety Director at the Swedish Transport Administration and Prof. Claes Tingvall, chairman of the Academic Expert Group. The title of their presentation was "Recommendations of the recent Global Ministerial Conference on Road Safety. What do they mean for motorcyclists?"

In their presentation they emphasised the shift from putting the responsibility mainly on the individual road user to a shared responsibility of all stakeholders. The former was described as going 'downstream', meaning that the road user should adapt their behaviour to the traffic system. However, in order to achieve a safe system, the approach taken should be 'upstream' instead of 'downstream'. This means that it is the infrastructure and technical solutions which should be adapted to the road user. Traffic safety was also put into context of the United Nations Sustainable Development Goals. The most relevant goals for traffic safety are number 3: Ensure healthy lives and promote well-being for all at all ages; number 11: Make cities and human settlements inclusive, safe, resilient, and sustainable; and number 12: Ensure sustainable consumption and production patterns. They also argued that businesses need to become a partner in the development of sustainability, especially multinational companies and other large corporations who, according to them, could have a massive impact.

The second keynote was by Dr Nhan Tran, Head of Safety and Mobility at the World Health Organization, with the title "The challenge of motorcyclist safety". Dr Nhan Tran stressed the excess

risk of motorcycle crashes in comparison with other road users and he reflected on three different issues:

1. Evolving modal shifts and changing demographic

   Many have a biased picture of a motorcyclist, either as a young extreme rider or using the motorcycle as a family vehicle. But this is changing, since motorcycles are becoming increasingly used for commuting and delivery services in different parts of the world. The question he raised was how we can evolve our systems to accommodate this modal mix.

2. Applying a safe systems response for motorcyclists

   Behaviour does not exist in isolation but is a function of the system and environment. Motorcyclists exists and we need to be responsive to them and their needs.

3. Equity and sustainable development

   Many do not have a choice but to ride a motorcycle, it is a necessity for them. The question is how we can address their needs.

The third keynote speaker was Mr Jorge Viegas, President of the Fédération Internationale de Motocyclisme (FIM), and his title was “The point of view of motorcyclists”. He started the presentation arguing that motorcyclists often are the victims. He then stressed the importance of understanding the cause of crashes. Within motorcycle sports there is high level of safety awareness, which can be used for the transport system. Some motorcyclists violate the rules and want to show off, but they are also victims of the road environment and other drivers. From a sustainability perspective, motorcycles are much less polluting than cars and today some motorcycles are electric. He finished his presentation by pointing out the need to take into consideration the experiences of the riders: “Please listen to us”.

The fourth and final keynote was by Mr Rakesh Sharma, President, International Motorcycle Manufacturers Association (IMMA) with the title: “The point of view of the motorcycle industry”. He started his presentation by urging to look at how PTWs are being used. In some countries they are used for deliveries, ambulance services, the police, but also for leisure. For many it is a way to get an income. The solution, according to Mr Sharma, needs to be customized. He stated that there must be a diversity of safety measures since there is a diversity of riders, motorcycles, and needs. This would include training and better infrastructure. He added that the latter was not designed for motorcyclists.

The opening session finished by Ms Véronique Feypell, ITF, who presented the outline of the rest of the virtual workshops.

4. Motorcycling in the Regions

The second opening session “motorcycling in the regions” included regional reports from around the world, and was moderated by Mr Edwin Bastiaensen, Secretary General of IMMA. The introduction of the session presented an overview of benefits and specifics of PTWs, highlighting issues such as social factors, economical aspects, and congestions.

The regional reports mentioned both differences and similarities in PTW usage and some of the fundamental factors that were discussed included the following:

- **Different types of vehicles** – The scope of vehicles that is being discussed in the workshop comprises a wide variety of vehicles. The focus is on mopeds (UNECE category L1) and motorcycles (UNECE category L3). These vehicles may be designed for on- or off-road capabilities, vary significantly in engine capacity, weight, and technical equipment.
- **Purpose of use** – The reason for traveling by PTWs varies greatly across the world. Several regions describe the importance of PTWs for personal transport, economic growth and being an enabler for many families to have an income and means of transport (e.g., India, China, Africa, Latin America, Southeast Asia). For some people a PTW is their only alternative. They cannot afford buying more sophisticated and expensive vehicles. Other regions describe PTWs as being mainly a vehicle for leisure and recreational activities (e.g., North America and Europe). However, the use also varies within a region. For example, in southern Europe, a PTW is often used as an efficient mode of transport in dense urban areas, whereas in northern Europe motorcycling is more used for recreational purposes. The following 5 motivating factors for motorcycle use were identified and discussed:
    - Primary Mobility
    - Alternative (Urban) Mobility
    - First Responder Services
    - Business
    - Leisure
- **Technical regulation and standards** – The minimum requirements addressing vehicles and protective equipment, as well as the use of helmets and other personal equipment varies significantly between countries. Different regions have different requirements for technical specification and performance of PTW and homologation for vehicle and/or equipment is absent in some regions. Some countries adopt other standards but there are also examples where minimum requirements are lacking. A UN regulation (No. 22) exists for helmets and is currently being revised. For other personal protective equipment (PPE) worldwide standards also need further development.
- **Climate and weather** – Different climate and seasonal changes have a large impact on the kind of vehicles that are used and the length of the riding season This also influences how vehicles are equipped and what personal protective gear is used. In some countries icy conditions and cold weather pose a serious challenge to riding a two-wheeler in the wintertime. In other countries, humidity and high temperatures affect the choice of PPE and the use of helmets.
- **Infrastructure** – When it comes to road infrastructure countries face different challenges. While some countries maintain an old infrastructure, others are in need of building a new. Many roads have been built mainly with cars in mind, although there are some countries that build PTW-friendly facilities and examples of dedicated PTW infrastructure have been introduced.

- **Market** – The markets for PTWs differs from very rapid growth in Latin America to a relatively stable market in Southeast Asia. PTWs are viewed as a space-efficient and effective mode of transport, and sometimes being part of a "Mobility-as-a-Service" (MaaS) offer or playing an important part in switching to more sustainable urban transport solutions. This trend is also pronounced with other types of micro-mobility vehicles, such as electric kick-bikes, and seems to be accelerated during the Covid-19 pandemic.

Detailed descriptions of the specificities of seven different regions were presented at the workshop. Below is a brief outline of each region, with an addition of Australia and the Middle East (these where not represented during the workshop but are added to cover additional regions). The regions described below do not follow a strict geographical, or other, order. The purpose was to give an overall picture of differences and similarities between different parts of the world. The presenters, regions and moderator are presented in Figure 2.

Figure 2 Outline of the session Motorcycles in the regions.

4.1. Regional reports

4.1.1. China

- 23 provinces and 5 autonomous regions
- 1.40 billion people (2020)
- GDP: US$ 14.7 trillion (2020), GDP per capita: US$ 10.5 thousand[10]

China is one of the largest markets in the world for PTWs. In dense cities battery electric PTWs are dominant (about 300 million electric PTWs in the country), because of issues with air quality and pollution. Combustion engine-powered PTWs are still often used for long distance trips (about 90 million vehicles in the country). Nearly every household owns a PTW, and car ownership is also increasing. PTW fatalities are 2.86 per 100 000 people, 63 per cent of which occur in rural areas. The fatality rate is higher in China than in similar countries. Of all fatal and severely injured, 79 per cent sustain a head injury. Only 20 per cent of the riders use a helmet despite helmet requirement in

[10] Population and GDP for all regions are based on data provided by the World Bank (https://data.worldbank.org/indicator/). The year 2020 is used throughout when available, for a few countries a previous year is used instead.

legislation, and riders are often speeding. There is also a problem with PTW riders using space intended for bicycles and pedestrians. There is an E-level license requirement for motorcycles and F-level for mopeds. Acquiring a license includes two written tests and two driving tests, but they are easy to pass.

4.1.2. India

- 28 states and 8 union territories
- 1.38 billion people (2020)
- GDP US$ 2.6 trillion (2020), GDP per capita: US$ 1.9 thousand

India is one of the largest PTW manufacturers in the world, and the 5th largest car manufacturer. Indians own 143 PTWs per 1000 people. A large increase in PTW ownership is expected and a desire to reach levels such as in China, were nearly every household owns a PTW, was mentioned. The Covid-19 pandemic has created a great demand for PTWs. About 60 per cent of rural households own a PTW and 33 per cent of the PTW owners use their vehicle for their daily work commute. Mobility challenges in India are related to traffic conditions (e.g., congestion, traffic mix, pedestrian safety), regulatory concerns (e.g., non-compliance with traffic rules), infrastructural concerns (e.g., potholes, lighting), and air pollution. Road crashes are the primary cause of death among those aged 15-29 years and PTWs have the highest fatality rate of all vehicles. As a part of the Indian road safety policy, it is mandatory to sell helmets along with new PTWs.

4.1.3. Southeast Asia

- Indonesia, Malaysia, Thailand, Taiwan, Japan, the Philippines, and Vietnam
- 0.71 billion people (2020)
- GDP US$ 7.6 trillion (2020), GDP per capita: US$ 10.7 thousand

In this region, over 10 million new PTWs are sold per year. The market has been rather stable the last years, except during the Covid-19 pandemic when sales went down. PTWs are often the main mode of transport. According to WHO, the PTW (incl. 3-wheelers) share of all road fatalities is about 43 per cent. In-depth crash investigations from Thailand indicated lack of organised rider training. The vast majority of crashes involved drivers who were self-taught or taught by family or friends. Initiatives taken by countries are: Policy on traffic control (Indonesia), traffic safety promotion events (Japan), measures taken by employers to prevent traffic-related deaths and injuries of workers (Malaysia), new land transportation office and establishment of stricter rules before issuing driver's license (Philippines), workshop on corporate measures for sustainable road safety (Thailand), subsidised training courses (Taiwan), and traffic safety research (Vietnam).

4.1.4. Latin America

- 19 countries
- 0.65 billion people (2020)
- GDP US$ 4,8 trillion (2020), GDP per capita: US$ 7.4 thousand

The PTW fleet in Latin America was very small before the year 2000, but since the fleet has grown rapidly. In 2016, the region had 46 million PTWs. Several countries have a PTW share of 35 per cent or more. Uruguay, Colombia, and Dominican Republic have over 50 per cent PTWs in their vehicle fleet. Some reasons for the growth in the use of PTWs are poor access to public transport, high congestion, low cost of PTWs, door-to-door flexibility, and that PTWs are an enabler for many families to have an income. Lack of driving skills and of knowledge of risks is a problem. Between

2010 and 2020, the total number of road fatalities has increased as well as the share of motorcycle fatalities, which is above 50 per cent in some countries. The challenges include road sharing, training, and licensing. In Colombia, more than 50 per cent of injury crashes occur during the 2 first years of driving. Another challenge is that youth and children of all ages die in PTW crashes. The road infrastructure is not safe for PTWs. Examples of proposed countermeasures are mandatory ABS/CBS brakes, blind spot mirrors on trucks, and increased use of helmets and PPE.

4.1.5. Africa

- 55 states
- 1.34 billion people (2020)
- GDP US$ 2.4 trillion (2020), GDP per capita: US$ 1.8 thousand

In general, there is little research on PTWs and road safety in Africa, therefore the actual number of vehicles and crashes is unknown. As an example, the actual number of PTWs in Burkina Faso is twice the registered number. The proportion of powered-two- and three-wheelers of the motorized vehicle fleet is estimated to be about 23 per cent, which corresponds to over 7 million vehicles on the continent. PTWs are filling a gap in transport that was created by a decline in public transport. Their appeal are their flexibility and low cost. PTWs are usually used for commercial purposes, especially in rural areas. For example, it is estimated that 5 jobs are created per PTW in Kenya. PTWs are also part of the health service structure. The causes of crashes which have been identified range from poor infrastructure and unlicensed, untrained riders, to lack of knowledge and respect of traffic laws, speeding, use of alcohol and drugs, and poor post-crash care. The latter is many times due to a lack of insurance. Also, 30 per cent of motorcyclists use their phone while riding and almost 50 per cent do not use helmets. A way forward for Africa is to learn from other regions, to review and revise legislation, improve infrastructure and training, and enforce the use of helmets.

4.1.6. Europe

- 27 EU member states
- 0.45 billion people (2020)
- GDP EU US$ 15.2 trillion (2020), GDP per capita: US$ 33.9 thousand

The PTW fleet in Europe increased almost 40 per cent over the last 20 years. There is a great diversity of vehicles, users, patterns, and purposes. The traditional stereotype is that PTWs are used as mobility tool in southern Europe and leisure tool in northern Europe, which can be linked to cultural differences but also weather conditions. However, it appears that the differences are diminishing over time. There has also been an increased interest in PTWs during the Covid-19 pandemic. The number of killed PTW riders has decreased by about 55 per cent in the last 20 years and the number of killed riders per vehicle is also decreasing. Only five countries have PTW-specific safety strategies and motorcycles are often neglected in transport and infrastructure plans. Examples of recent safety improvements are a new system for training and licensing, the European Motorcycle Training Quality Label, adoption of new PPE regulations, and mandatory ABS/CBS and AHO. Furthermore, the EU Road Infrastructure Management Directive will be revised, focusing specifically on vulnerable road users including motorcyclists. In the future, further advanced technological safety features, including advanced rider assistance systems, will be available.

4.1.7. North America

- United states of America, Canada
- 0.37 billion people (2020)
- GDP US$ 22.6 trillion (2020), GDP per capita: US$ 61.4 thousand

In the US, PTWs are mainly used for leisure. Median age of a rider is 50 years and 81 per cent are male. There is a preference for cruisers (43% of registered motorcycles). 12.2 million motorcycles are in use in the US and 8 per cent of households own at least one motorcycle. About 700 000 motorcycles are registered in Canada. The number of motorcycle fatalities has increased substantially in the US since the mid 1990s. The proportion of fatal crashes linked to speeding is about 33 per cent for motorcycle riders. This is a much higher share than for passenger car drivers (below 20%). Investigations in the US have shown that local mandatory helmet laws lead to a local reduction in ridership. When it comes to sustainable practices, ridesharing services show a slow uptake on motorcycles. There is a small, but growing, market of shared e-mopeds. Law enforcement agencies have a long tradition of using motorcycles for traffic law enforcement and as escort. The states have authority for operator licensing and most states have age and training requirements. Some challenges for motorcyclists are lack of visual recognition, potholes, crash barriers, and exposure to road furniture. More than 40 per cent of public roads are in mediocre or in a poor condition and roadway design features are a contributing factor in about one third of the traffic fatalities. Potential for ITS solutions is recognised and benefits and gaps are described in a government report.

4.1.8. Australia (added by authors)

- Six states and three territories
- 0.026 billion people (2020)
- GDP US$ 1,3 trillion (2020), GDP per capita: US$ 51.8 thousand

PTW sales are stable with around 100 000 vehicles sold per year. In total, there are about 35 PTWs per 1000 persons, which corresponds to 4.5 per cent of all motor vehicle registrations[11]. In 2020, 188 PTW riders were killed in road traffic crashes, which is 17 percent of all road deaths[12].

4.1.9. Middle East (added by authors)

- 16 UN member states
- 0.36 billion people (2020)
- GDP US$ 2.8 trillion (2020), GDP per capita: US$ 7.8 thousand

The Middle East motorcycles market has been growing significantly owing to the lack of reliable public transportation systems along with rising urbanization. Motorcycle taxis are being used for carrying goods and passengers to distant places in many countries. Sales are expected to increase over the coming years[13]. The sales are around 10 million vehicles per year, and 18 per cent of the population in the United Arab Emirates claims to own a motorcycle.

[11] https://www.abs.gov.au/statistics/industry/tourism-and-transport/survey-motor-vehicle-use-australia/latest-release

[12] https://www.roadsafety.gov.au/performance/road-deaths-road-user

[13] https://www.6wresearch.com/industry-report/middle-east-motorcycles-market-2020-2026

4.2. Road traffic deaths in different regions

Traffic safety in general differs greatly between regions. There is a three-fold difference between Europe, which has the lowest road traffic death rate per capita, and Africa, which has the highest (Figure 3). The proportion of riders/passengers of motorized two- and three-wheelers among all fatalities is almost 30 percent, considering all regions together. It ranges from around 10 percent in Africa and Europe, to over 40 percent in Southeast Asia. Please note that the differences in proportion of PTW user fatalities between the regions do not reflect differences in PTW safety. For such comparison, PTW exposure such as fleet size or traffic volume need to be considered.

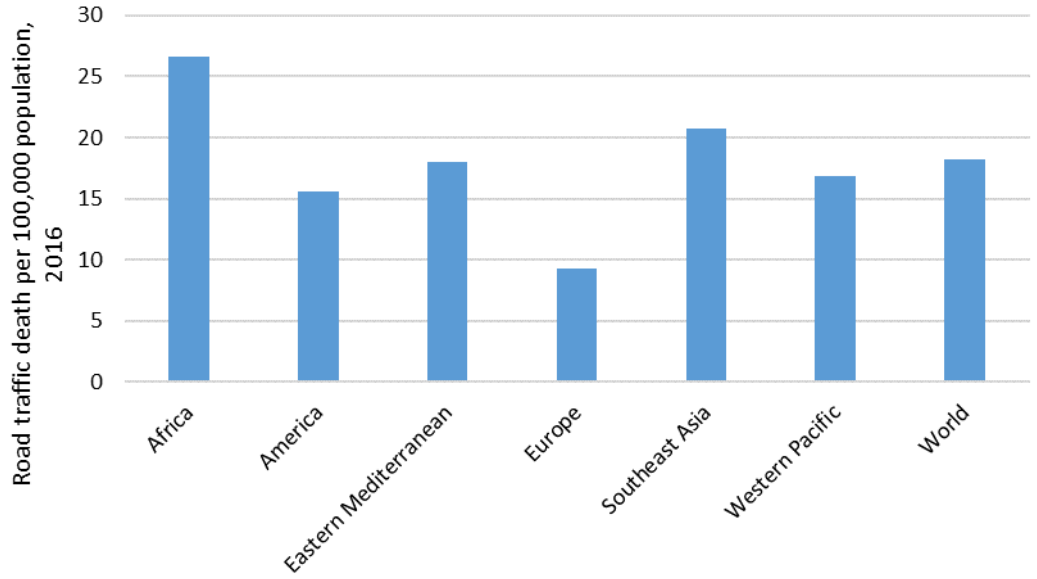

Figure 3 Road traffic deaths per population and region. Year 2016. Source: WHO (2018).

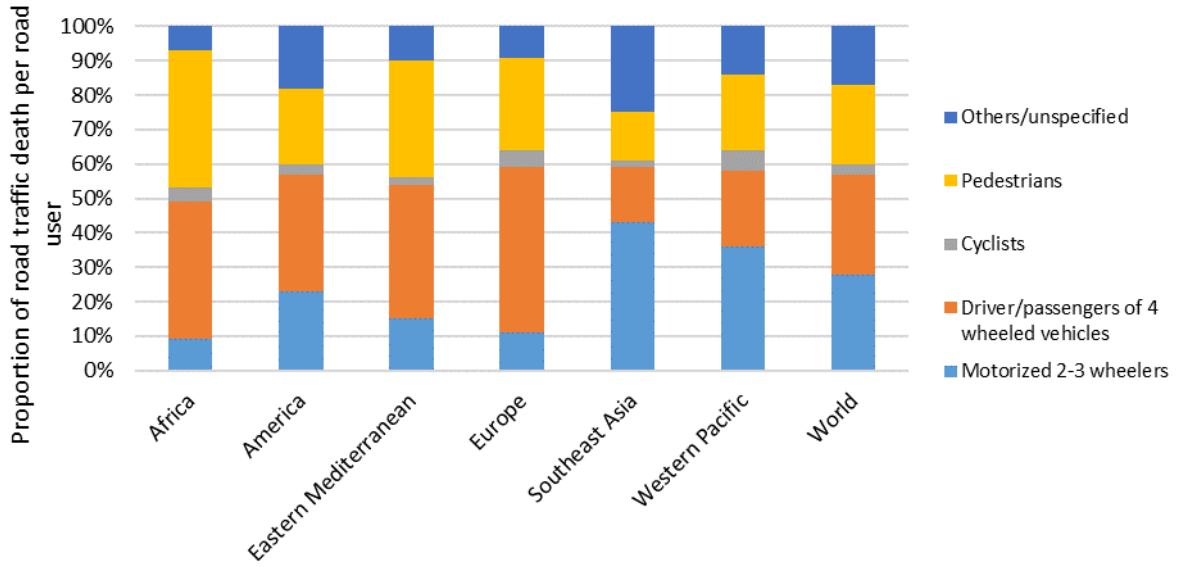

Figure 4 Road traffic deaths per region distributed by road user type. Source: WHO (2018).

5. Expert session #1: Sustainable Practices, Work-Related Issues, and Procurement

This session was moderated by Prof. Claes Tingvall, Chalmers University of Technology, Sweden, and Ms Samantha Cockfield, TAC, Australia, was rapporteur. The discussions were divided into three topics: 1. Inclusion of PTW safety in corporations' sustainability practices and reporting. 2. Best practices for fleet operators and their customers. 3. The role of PTW rider clubs, industry associations, and insurance companies.

The session was linked to two of the recommendations from the Academic Expert Group: #1 Sustainable Practices and Reporting, and #2 Procurement.

5.1. Summary of the session

The text below captures the issues raised during the session and reflects the views of the attending experts, expressed either in the discussion, the chat, or in emails after the session.

Two main concepts framing the discussions were safety footprint and value chain. Safety footprint is a measure of how many riders that have been seriously injured or killed in an organisation or activity. This is used as a reporting tool and is usually reported as a number. By reporting on safety footprint, risks are brought to the attention of corporations who then become more aware of their riders' situation. Value chain includes all transport that creates value for an organisation. This includes first line transport that delivers raw materials to the end of the line, transport delivering a finished product or service.

5.1.1. Topic 1: How can corporations engage their sustainability practices to include PTW safety and report on this?

In low- and middle-income countries (LMICs) PTWs are already a popular mode of transport, and in high-income countries (HICs) the use of PTWs is increasing. PTWs can be a part of employment, and in recent years there has been an increase in the use of 'instant' deliveries. An expert highlighted a survey conducted in Paris, which showed that 25 per cent of PTW and cycle couriers had a crash in the weeks prior to the survey. It is therefore important that organisations actively work with safety. There are some examples of corporations trying to improve safety of their employees with better training, maintenance of vehicles, and reporting of crashes. Another example of this is working with different safety checks, like helmet verification. These safety checks are part of an app-based platform. However, riders who work for several employers might receive different safety guidelines and instructions which could cause confusion. Furthermore, another group, namely self-employed riders, do not benefit from this. This can be seen for example in Venezuela where riders are often hired as independent workers and often lack training and a license, one of the experts reported. Another expert informed the participants that in Malaysia the argument used by some corporations is that they cannot take responsibility for self-employed riders as they are not part of their staff and, therefore, they lack control and influence over those riders. Representatives of multinational corporations agreed with the description that workers are usually hired as independent workers, and that this can be a problem. Owning an operation offers more control of the employees. A challenge for corporations in LMICs is that riders sometimes fail to use the equipment they are offered and instead leave it at home, which has been observed in Kenya. Efforts to raise awareness clearly are necessary.

The discussion raised the question if independent contractors are viewed as part of the value chain and if corporations are expected to report on road crashes. The participants highlighted two sides of this issue. Controlling and tracking independent contractors is a challenge, but corporations often do take their responsibility in promoting safety and reporting on crashes. A solution used in Colombia is a regulation that demands mandatory road safety plans for corporations. This regulation has forced business to become involved in safety work and created new jobs related to road safety that did not

exist before. In Malaysia, multi-national and national corporations are improving their safety reporting. Transparency is important, corporations should report annually, and their reports should be made public. Corporations need guidance in how to report. Instead of only reporting numbers, corporations can also write more descriptive reports with details on what actions they take to improve safety.

The starting point should be to recognize that every fatality is caused in someone's value chain. The participants agreed to view PTWs as part of the value chain and that transports can be part of several value chains at the same time. Viewing commuting as part of the value chain depends on the context and location. Many participants wanted that corporations should collect and publish more data on the type, location, and rate of crashes.

5.1.2. Topic 2: What are the best practices for fleet operators and their customers addressing purchase/procurement, fleet operation, fleet maintenance, continuous training of riders?

Setting standards for equipment and vehicles can be a challenge in some markets where only old equipment and used vehicles are available. In LMICs, riders might be inclined to sell expensive equipment that is offered to them by their corporations. There is also a challenge to find certified trainers in LMICs which must then be imported from other regions instead. If riders are non-compliant to rules, corporations must view it as a problem for their business. Corporate representatives frequently see a challenge in controlling their riders, even though tracking the riders' behaviour can give them some insight. Some manufacturers require safe riding training and work with indicators such as the age of the vehicles. There is a shared responsibility between manufacturers and partners to ensure that safety is taken into consideration. One expert stated that in Japan, food delivery riders are offered discounts on their insurance once they pass specific courses. In Africa, commercial motorcycles are almost exclusively privately- or locally-owned. Many of these vehicles are old and of low quality, and the riders lack training and licenses. In a motorcycle class in Senegal, held by one of the participants, only two of thirty students could identify a stop sign.

App-based companies have an opportunity to innovate new ways of improving safety through their devices. Local governments can pressure corporations to introduce new technology that makes tracking and monitoring easier. Some corporations have taken action to introduce GPS in their vehicles for these purposes. Corporations can also encourage and incentivize workers to utilize other modes of transport, like walking or public transport.

It can be challenging for corporations to be a leader in safety if not all corporations work to improve their safety issues. To avoid competitiveness in this area, broad recommendations should be given to the whole industry. There is a demand for fast deliveries, which creates a pressure for riders to move at high speeds. In order to reduce the pressure, corporations could regulate the time within which riders have to deliver.

To improve safety for children and youth, corporations can report on the safety footprint of them separately. Risk assessments should also be made for children and youth.

5.1.3. Topic 3: What can be the role of PTW rider clubs, industry associations, and insurance companies in promoting value of safe motorcycling and how can we engage them?

The Victims' Associations are important for training and raising awareness, and discussions with victims can be part of the licensing process. Some insurance companies offer safety training to their customers, although the cost of training can be a problem. One suggestion proposed to overcome this is to use fines for traffic rule violations to fund training.

In Kenya, an association is trying to create awareness by encouraging people to discuss safety issues when travelling as passengers with their riders. The idea is that talking about safety on a regular basis will change the norm. PTW clubs should act as role models and set the norm for businesses to choose motorcycles and equipment that increases safety. To lower speeds, there is a need for commitment between the corporations operating in a city, as well as collaboration with the local council.

In Malaysia, a high claims ratio has made insurance companies reluctant to invest in PTWs, according to one of the experts. The Malaysian government therefore introduced a social welfare insurance program, which is mandatory for workers, as a way of encouraging insurance companies to invest in PTW sustainability. In Rwanda, road safety campaigns have been focusing on motorists, making them accountable for crashes involving PTWs. Cooperative associations can make motorists feel responsible for riders and this has significantly improved the conditions. In addition to this they also offer rider training.

The general argument during the discussion was that there is a need for associations, clubs, and insurance companies to step up their support for PTWs and act as role models.

5.2. Recommendations from the session

Recommendations from the session as they were formulated in the rapporteur report (there denoted as priority actions).

- Organisations should examine their value chain to identify where PTWs are used in their own fleets and interacted with, and report on their PTW safety footprint. This should include where there has been an injured rider/passenger in their organisation or value chain, including where PTW riders are injured as third parties, and specifically noting where children have been involved.
- Organisations should have a policy that outlines minimum safety standards for their own riders and passengers, and for PTWs in their value chain. The policy should state the minimum safety features of PTWs, the personal protective equipment that will be supplied, and the occupational health and safety standards relating to the carrying of goods and passengers. The policy should also outline a rider's responsibilities, including that all riders must obey all traffic rules, have all relevant licenses, and must wear the protective clothing provided. Policies should outline clear practices in regard to using youth as employed/contracted drivers, and in what situations a child might be a passenger.
- PTWs used in business should have a specified safety standard that at a minimum includes ABS and a form of ISA.
- Organisations should use mobile phones/connectivity to support safety of riders and third parties.
- Organisations who manufacture, lease, or rent PTWs should set targets for their road safety footprint and report on these targets in their sustainability reporting.
- PTW manufacturers and importers should support the inclusion of the technical/safety features of PTWs used for business.
- Insurance companies should assist corporations using PTWs in business to understand and report on their safety footprint and provide insurance solutions that stimulate safe use of PTWs in business.
- Motoring clubs should support the safe riding of PTW for business through role modelling safe riding and the development of a safe riding culture through their communication channels.

5.3. Comments and scientific references

In this section scientific references related to the topics of the session are presented. Focus is on the most recently published studies.

The session discussed how corporations, associations and clubs could take responsibility for the safety of the PTW riders in their value chain. Two large sectors where PTWs are used are taxi and delivery. Gutierrez and Mohan (2020) examined the pertinent safety and social equity issues of PTWs in the formal and especially in the informal transport sector. In the informal sector, PTW usage is especially problematic as riders do not adhere to official safety regulations. PTWs in the informal sector are often older vehicles and in bad shape. This is more common in LMICs where PTWs are used as taxi service. Lack of regulation and enforcement, high unemployment, and lack of control over demand and supply leads to tough competition, anti-social behaviour, and chaotic driving within the informal sector. Furthermore, other reasons for the high crash involvement within this group include riders carrying too many passengers, a lack of safety equipment or poor standards, riding without a proper license, and riding a PTW they are not familiar with. It is not unusual to work 70 hours per week, leading to exhaustion and increased risk of crashing.

App-based technology is increasingly used among PTW taxi and delivery services which can have both negative and positive consequences. A study in Vietnam showed that mobile phone usage was the most common cause of risky behaviour among app-based motorcycle taxi riders, with 52 per cent of riders using the phone on the road (Nguyen-Phuoc et al., 2020). However, risky behaviour amongst motorcycle taxi riders who used the app was lower compared with regular motorcycle riders. The apps can provide the employer with information about their rider behaviour and therefore quite a lot of control. For instance, their performance can be evaluated using some form of grading; sanction riders with low grades by locking their account temporarily or permanently banning it, and reward those with high grades with higher earnings.

An example of successful risk-reducing training in LMICs is the SafeBoda motorcycle taxi company that begun training their riders in Kampala, Uganda by providing multiphase road safety training, use of helmets, vehicle maintenance, and basic first responder training (Muni et al., 2019). Passengers who are concerned about using shared helmets for hygienic reasons were offered hairnets. A survey on Safeboda riders showed that they were less likely to be involved in road traffic crashes compared to regular riders after controlling for age, license, and education.

6. Expert session #2: Modal shift and urban needs

This session was moderated by Ms Claire Depré, European Commission and Mr Antonio Perlot, ACEM, was the rapporteur. The discussions were divided into three main topics: 1. Cities' and commuters' needs, 2. What role can Powered-Two-Wheelers (and micro-mobility) play? and 3. Solutions to be implemented/piloted.

The session was linked to two of the recommendations from the Academic Expert Group: #3: Modal shift—moving from personal motor vehicles toward safer and more active forms of mobility, and #4: Child and youth health encouraging active mobility by building safer roads and walkways.

6.1. Summary of the session

The text below captures the issues raised during the session and reflects the views of the attending experts, expressed either in the discussion, the chat, or in emails after the session.

Input from the session "Motorcycling in the Regions" was used to set the context of the modal shift discussion. It was noted that PTWs range from:

- being tools for primary mobility (India, SE Asia, Africa, Latin America) to being one of the alternatives for (urban) mobility (Europe, China).
- being used for business (mainly Africa, also SE Asia, Latin America) to being used for leisure (Europe and North America).

Additionally, there is a:

- growing share of PTWs on the roads, although varying between regions
- focus on mobility and accessibility in most regions
- diversity of vehicle types and use, which has impact on the usage.
- recent increase in the use of PTW for commercial purposes, throughout the world.

6.1.1. Topic 1: Cities' and Commuters' needs

As a start, views from Europe and Latin America were presented. In Europe, policies regarding urban mobility are many times driven by challenges such as pollution, noise, safety, and decarbonization. In an urban environment, active travel and public transport are backbones in the mobility system, and PTWs may be a more sustainable alternative than passenger cars. Especially in cities, new modes of transport are being introduced, for example electric scooters. This adds to the spatial issues in cities, where trends of reallocation of space in favour of sustainable modes of transport, as well as private sector actors entering, are being noted. Cities will need to consider how to govern and regulate the new modes. Another trend mentioned is that several cities, at least in Europe, are moving towards "15 minutes cities". PTWs allow for proximity in cities, and take up less space than cars.

As an example from Latin America, the situation in Bogotá, Colombia, was described. The main mode of travel in Bogotá is public transport, and the aim is to maintain, rather than change, the modality mix. During the Covid-19 pandemic, PTWs have become one of the preferred means of transportation. Additionally, it has become a means of making a living, by delivering food, medication, and shopping. With a sharp rise of PTW trips (doubling) it has become a question of how to ensure that children and youth can still be able to move safely in the city.

The perception of PTWs is not always positive, e.g., in Victoria, Australia, the PTW is not necessarily considered as a legitimate mode of transport. It was furthermore expressed during the session that there may be a need to define situations where PTWs may be the soundest decision for mode of transportation.

The discussion then focused on the needs of cities and "sustainable" mobility which must be socially, economically, and environmentally sustainable. To achieve this, it is important that citizens can always choose the most appropriate vehicle for each situation, where the following aspects could be noted:

- HICs focus on reducing the dependence on private vehicles, in particular cars, which affects the opinion on the role that the PTW can take.
- PTWs can play a role in the public transportation system, like in Sub-Saharan Africa, where PTW taxis, in response to commuters' needs for reliable transport, have seen a massive growth. But PTW riders must be safe, and the system should be designed to also include this mode of transportation.
- Needs for the commuters are as varied as the people. Most commuter needs are driven by necessity, such as public transport not being available. Children may have no other way of getting to school than riding as passengers on a PTW. Many African countries have the ambition to develop public transport, but until this is achieved, PTWs will continue to be the most predominant mode of transport. On the other hand, powered-three-wheelers are also more and more used in Africa, especially in urban areas where they are often used to carry goods. This means that the safety of both powered-two- and three-wheelers needs to be supported.

The commuter needs to be considered include road safety, reliability (important for public transport users, Mobility-as-a-Service) and efficiency (PTWs can be used for time-saving and financial reasons). Having more parking spaces for PTWs could also facilitate their use by consumers.

6.1.2. Topic 2: What role can Powered-Two-Wheelers (and micro-mobility) play? Solutions to be implemented/piloted.

If PTWs should play a role in a multimodal setting, or in modal-split journeys, they need to be integrated at the start of the planning process. This also means that PTWs should be considered alongside other modes of transport prioritized by cities—typically public transport and active travel, compared to which PTWs are a less sustainable alternative.

For cities, road safety needs to go hand in hand with sustainability, this is a prerequisite to enhance the role of PTWs as a part of multimodality. Road safety must also address PTW riders as both victims and as threats to other VRUs.

Cleaner technologies can be enablers for PTWs to play a role in sustainable mobility, however with the risk of incurring higher costs. Affordability is an issue, and the cost of a vehicle with newer, cleaner technology is higher. It was suggested to look at good practices in China and India for electric PTWs for LMICs, and possibilities for electric PTWs for Africa were said to have been studied. To make use of electric PTWs, public charging points and incentives may be needed.

There is a large potential for (electric) PTWs to play a role in logistics, not least since PTWs occupy less space than 4-wheel solutions. The gig economy can provide both threats and opportunities for PTWs.

Mopeds in sharing schemes are another opportunity, e.g., by shared e-mopeds to connect to suburbia, possibly taking advantage of investments in super cycle highways for e-bikes, where these are being planned/implemented.

PTWs frequently play the role of a family vehicle and as a school bus, with children of all ages as passengers. What can be proposed for this situation (frequent in LMICs) that also addresses safety?

6.1.3. Topic 3: Solutions to be implemented/piloted.

Experts in the session suggested that the current car-based transport system, where PTWs are an afterthought, needs to be tackled as a systemic, long-term problem (in contrast to helmets, etc., which can be seen more as quick fixes). Tailored approaches are essential, and depend, for example, on public transport networks and the available road space.

Main solutions discussed:

- Professionalization of the industry involving PTW riders, e.g., deliveries and taxis. Private sector that employs the riders need to provide safe conditions for those who work, including realistic time pressures on deliveries.
- City governments and public authorities should analyse PTW needs and have plans for what they (cities) want to do with motorcyclists—similar to plans for public transport and cyclists which are much more present. PTW taxis is one example—what would be the conditions for accepting and promoting them? Research needs to find solutions focusing on the current situation, especially with regard to PTWs in LMICs, and how the number of crashes can be reduced.
- Safety is key to make policy makers promote PTWs as a mode of transport and to integrate it more into the transportation net. Make riders safer and protect other vulnerable road users from the threat of PTWs as well.
- In the email communications following the session the Buenos Aires' Metropolitan Road Safety Plan for Motorcyclists was brought forward as an example of an opportunity for working together with several localities that border the city, a collaboration not only with other governments but also with riders, private entities, and associations of relatives of traffic victims.
- The PTW sector should be called upon to clearly state how it can become a mode of transport in the context of sustainable urban mobility and where sustainability walks hand in hand with safety.
- Capitalize on the pandemic to reimagine the role of PTWs in society, both as a personal mode of transport and its utilitarian use for businesses and delivery. Build on this momentum and make radical changes.

6.2. Recommendations from the session

Recommendations from the session as they were formulated in the rapporteur report.

- Globally, mobility plans acknowledging the presence of PTWs and PTW safety action plans should be developed and implemented by governments, with the active involvement of all stakeholders. The end goal is to have PTW use considered as a legitimate form of transport as part of a government's wholly integrated transport network. Safety action plans are a formal commitment by authorities to improve PTW safety and awareness. Action plans may be as small or as large as is appropriate, should be applied to both HICs and LMICs, and should be adapted to local needs. There is a need to use available solutions (in particular ITF Lillehammer 2008 and 2015 reports), for implementation or for pilots.
- In HICs, PTWs are or can become a core part of the 'new normal' modal mix (where local authorities increasingly consider public transport and active travel as the backbone of a sustainable urban mobility system), however they need to prove and improve their sustainability addressing safety as the highest priority. Improvements are also expected in areas such as environmental performance. There is a need to prove and improve the sustainability of PTWs in view of enabling PTW mobility to benefit from a positive modal

shift policy, either as an individual mobility, more space-efficient alternative to the car or within shared schemes, including in conjunction with public transport.

- In LMICs, PTWs are often the primary transport mode due to their convenience, economy, efficiency, and lack of viable alternatives, offering access to jobs, education, and health services. Shifting the primary PTW transport to public transport is in these regions a long-term goal since the public transport alternatives are still in early stages of development. Addressing safety through the known tools (inclusion, training, vehicle, infrastructure) is crucial to address PTW sustainability.
- There is urgent need for detailed mobility studies on the societal costs/benefits of promoting PTWs in modal shift policy, as a door-to-door solution and/or as part of a multimodal approach. Such studies could be organised through a series of pilots and best practice exchanges on PTW modal shift policy in urban contexts.
- PTW participation in the modal split needs to be improved using known safety policy solutions (helmets, training/education, vehicle safety) to address the risks of inappropriate usage of PTWs. This includes the need, in particular in LMICs, for standards on safety for equipment and auxiliary equipment (solutions such as low-cost helmets, including campaigns supporting their use—including for children), basic education, as well as a call on governments to subscribe to existing UN conventions and regulations relating to PTWs.
- PTW dedicated parking facilities are needed, in line with the size of the local PTW circulating park and especially near public transport hubs—facilitating better mobility for all users and also encouraging partial shift to public transport (integration of first/last mile PTW journeys with public transport).
- New and more radical ideas to better integrate PTWs are needed, especially from an infrastructure perspective, rethinking the system and reorganising infrastructure design, better integrating PTWs, whereas today the designs are made for cars by default. In particular where PTWs are dominant (in some LMICs PTWs represent more than 70% of all vehicles), infrastructure design should be oriented around PTWs rather than cars (including the development of dedicated PTW lanes).
- Regulate use of PTWs as taxis, which has significantly increased in various LMIC regions in recent years. Fleet owners should impose rider training, adequate driving behaviour guidance, and use of adequate personal protective equipment for the rider and their passenger (including children). Best practices should be collected and promoted.
- All stakeholders to work together towards improving safety for all users (including PTW users), from all angles (accident analysis, education, training, vehicle, personal protective equipment, infrastructure, awareness campaigns—supporting mutual understanding and responsible sharing of the infrastructure by all users). Many solutions have already been identified, need to move to implementation, based on comprehensive policies fitting local needs. In some areas, there is still a need for further research.

6.3. Comments and scientific references

In this section scientific references related to the topics of the session are presented. Focus is on the most recently published studies.

The session highlighted the dual nature of modal shift involving PTWs (in most cases PTWs refer to motorcycles). In LMICs it is about encouraging PTW riders to choose public transport, whereas in HICs the passenger car drivers could move to PTWs. However, in LMICs a PTW can be the family vehicle, a prerequisite to earn a living, and the only available or the primary form of transport.

Research gives examples where motorbike taxis play an important role in intermodal and multimodal transports, which is one way to solve scarcity of public transportation for e.g., African cities (Olvera et al., 2015).

The session pointed out that several cities and communities have mobility plans and strategies for public transport and biking while similar strategies or plans for the role of PTWs are rare. The studied literature confirms this gap. A typical focus is infrastructure measures, for instance if PTWs should be separated from other VRUs, whereas there is a lack of a wider discussion on integration of PTWs into the overall mobility system and their potential to help reach community and city ambitions (Rose & Delbosc, 2016).

Safety was obviously a recurring topic in the session when discussing modal choice. Regarding modal shift, it can be noted that PTW riders are overrepresented in crash statistics, and therefore it is necessary to ensure a good level of safety for riders when promoting modal split or shift to PTWs. The session however also noted that PTWs can be a threat to other VRUs' safety. Examples can be found in research, such as a study focusing on Bangkok, Thailand, where motorcycle taxis use the sidewalk to ride. This is a safety risk for pedestrians, and it can also affect their accessibility to, for instance, public transport stations (Pongprasert & Kubota, 2017).

The session pointed out that sustainability is increasingly being demanded by cities and needs to go hand in hand with safety. PTWs are increasingly used in several places, thanks to low maintenance cost and not being subject of tolls is some places, and by providing faster, independent, and affordable transportation. Additional aspects are mentioned in the literature, such as examples from the Netherlands and Iran noting that motorcycles can cause noise pollution and air pollution in addition to traffic crash involvement (Shahbazi et al., 2019; Voinov et al., 2019). However, when discussing the effects on health the main focus in the session was on safety.

An item that was only briefly touched upon was how the trends of digitalization, automation, "greening", and electrification of the mobility system can be used to make PTWs a viable contributor in multimodal solutions that enhance the lives of people, cities, and communities. In this context it is important to understand the motivation for PTW use and the riders' intentions and behaviour. Amani Jordehi (2016) studied this for novice riders in Victoria, Australia. In the literature there are also examples of ICT (information and communication technologies) as an opportunity to increase safety but also increase daily income for PTW taxi drivers in Indonesia (Medeiros et al., 2018).

Areas that need more research and discussion are PTWs' role in moving goods, PTW sharing schemes, and the effects of and opportunities from digitalization. Using PTWs to move goods is a common practice in many LMICs, where PTWs are often noted to be overloaded. The increasing gig-economy also sees increasing movement of goods via PTWs. When it comes to sharing schemes, PTW usage could need clearer ramifications than for example bike sharing, and include requirements of valid licenses, helmet use, and other desired user behaviours. Many cities and regions are making efforts to provide a digital platform for travel planning that can combine several modes of transport. The role of PTWs should be tried out and investigated on such platforms.

7. Expert session #3: Training, education, and licensing

This session was moderated by Mr Martin Winkelbauer, KFV, and Mr Jesper Christensen, FIM/SMC, was rapporteur. The discussions were divided into four main topics: 1. Education, 2. Training, 3. Testing, and 4. Licensing and post-license training.

The session was linked to three of the recommendations from the Academic Expert Group: #5: Infrastructure, #9: Technology and #4: Child and youth health. The main focus in the discussion was on motorcycles.

7.1. Summary of the session

The text below captures the issues raised during the session and reflects the views of the attending experts, expressed either in the discussion, the chat, or in emails after the session. The moderator started the session by presenting a driver education matrix (GDE—goals for driver education). In this matrix four different levels are included:

1. Vehicle control
2. Driving in traffic
3. Goals and context of driving
4. Goals for life.

These levels are then linked to three key training areas:

1. Knowledge and skills
2. Risk-increasing aspects
3. Self-assessment

According to the GDE, education should include all levels. Thereafter the moderator presented a set of suggested recommendations which had been sent to the participants six days before the session.

7.1.1. Topic 1: Education

In the frame of this workshop education was defined as follows: *"***Education** is understood as a general term and includes lifelong learning*"*.

The general view was that education should be life-long and some of the participants would argue that it should start early. One of the participants pointed out that moped riders who had used a bicycle were more likely to pass the test than others.

The aim of school education should be to help the children to protect themselves. One of the participants argued that it was important to teach children traffic rules and added that children are taught to swim even if they very rarely are around water, but not about traffic.

It was also suggested that life-long education and training should be encouraged by policy makers and that riders should receive some form of incentives if they comply with the rules. For instance, Greece was mentioned which gives discounts on insurance if the rider has some form of advanced training. Creating a Traffic Safety Culture, which promotes a safe road user behaviour was also mentioned. One point of view was that this also included taking responsibility for your own actions.

7.1.2. Topic 2: Training

*"***Training** is a dedicated process with a determined goal, i.e., acquire a driving license. Training may be pre- and post-license*"*.

Before talking about minimum hours and training of trainers, the groups discussed the content of the training. Initially, the emphasis was very much on level 1 in the GDE matrix (vehicle control). For instance, teaching about the motorcycle in general and if it is in a good condition, different techniques such as braking skills, counter-steering, and technical systems such as ABS. The added value of rider assistance systems for PTWs and how to deal with them was also mentioned.

One of the participants reminded others about the first introduction of ABS, and that some riders believed that they could ride faster since they expected a reduced braking distance. It was also stated that in LMICs motorcycles tend to be rather basic and therefore teaching them about advanced technical systems would not make sense. This also highlighted the opinion that it is not possible to recommend something which will fit all since the conditions vary in different countries.

The recommendations to teach the riders about gyroscopic forces, which in short means the motion of the motorcycle due to the forces acting on it, generated varied responses. Some would argue that this was too difficult to understand and that it could cause confusion, others that it was very important. However, one point of view was that some groups might benefit from this. More specifically, one of the participants argued that it is important to teach various techniques to show riders better cornering. It was also suggested that the rider is trained on how to handle the bike before mixing with other traffic.

The knowledge of protective equipment is included at the first level of the GDE matrix and should be part of training. This includes both protective clothing and the use of helmets. Although in most countries it is a legal requirement that PTW riders wear a helmet, the rate of compliance can be rather low. Thus, one suggestion was to educate riders about helmets and why they are important.

When discussing the second level included in the GDE matrix (driving in traffic) the importance of teaching riders the needs of other road users was emphasized. Thus, training a motorcyclist should not only be about riding the bike. One of the participants stressed the importance of training the riders to anticipate other road users, since "the rider is not riding on a track". Other examples were training collision avoidance skills and defensive riding. One of the participants described defensive riding as being both about attitude and ability. As an attitude it could be linked to risk perception, and as an ability being able to handle risky situations.

Examples of training included at the third level (goals and context of driving) referred to young passengers but also young riders. The participants from Latin America mentioned that children as passengers are especially at risk, but so are young riders. Child passengers are not allowed to ride a motorcycle but they cannot be ignored, according to the same person.

The teaching goals that were discussed which can be linked to level four (goals for life and skills for living) were risk awareness, hazard perception, and cognitive skills in general, but also 'defensive riding' as mentioned above. One suggestion was that hazard perception skills could be developed using different tools, such as through computer software or virtual reality.

Considering the various topics to be included in the education, the participants emphasized the need to train the trainers. This would not only be done before they get their qualification, but would have to be updated. One problem mentioned was that in some countries the trainers have only been trained for cars.

The minimum hours of training were not discussed at any length, although one of the participants stated that "licenses should only be given to those who have received the minimum training to drive safely on public roads". The reality in, for instance, Africa (Tanzania), is that taxi riders have never

undertaken any formal practical rider training at all. Most of them have been taught to ride by friends and relatives. A taxi rider training programme has therefore been introduced which is over 2 days (one theory and one practical) and after that they receive a certificate. The participants added that this cannot be used as a license. In Thailand they did not need to go to a driving school at all, which means that the users can be self-taught. It was pointed out that approximately 40 percent of motorcyclists in Thailand have no license.

One point of view was that in order to teach all the different levels included in the GDE matrix, compulsory training was necessary, if not "nothing will ever change".

This led to a discussion about cost, both for training and then later for testing and licensing. Considering all the different elements suggested above, the question was how much it could cost. A general agreement was that it should be affordable. Some also reminded the group that getting a license is very important, since some would need it for work. Thus, increasing the cost could mean that some people—especially in LMICs—would be out of work. Furthermore, in some rural areas PTWs are the only form of motorised transport that is available.

One of the participants suggested that it would be possible to cut costs by using internet and an e-learning system. According to the same person this could also be for training cognitive skills. However, in some countries this would not be possible, for instance in Thailand older people and people with a low income would not have access to internet. One of the participants argued that training is still less expensive than buying a motorcycle. He added, with an expensive training the chance of arriving home safely is greater than if they ride an expensive motorcycle. One of the participants highlighted that driver training is an important element in working towards traffic safety, but that it needs the support of politicians and the society at large. This can be linked to the Traffic Safety Culture discussed before.

7.1.3. Topic 3: Testing and licensing

*"*A **driving test** can be theoretical and/or practical. A **driver´s license** is an official document which authorizes the individual that he/she is allowed to ride a motorcycle*"*.

The discussion about testing and licensing focused very much on practical testing, less on the theoretical part.

The recommendation that practical testing in real traffic should be an inevitable part of any license test was strongly supported and based on the fact that testing in real traffic does not always take place. In some countries this is not necessary, which some argued would be a problem. For instance, most of the countries in Latin America do not have practical tests and the participants argued that this would need to be mandatory. The same also applied to Southeast Asia. For instance, in Vietnam they did not focus enough on the practical part and nothing about hazards. According to the same person the test was too simple.

With regard to practical testing, it was suggested that technical skills are tested both in a closed area and in real traffic. Furthermore, a minimum of manoeuvring skills should be tested before the 'on road' testing.

In addition to train the trainers who educate the riders it was stressed that also the examiners need to be trained and re-trained.

One general problem with testing discussed was that level 3 (goals and context of driving) and 4 (goals for life and skills for living) were usually not tested and that this has an effect on training. Therefore, it is not possible to separate testing from training. The questions according to one of the participants was the need to determine what they need to know and from that define a minimum of skills that should be tested. According to one of the participants this is already being practiced in Norway. In this country the training curriculum include mandatory goals to ensure that attitude and

motivation for safe riding is emphasized in training. Others advocated introducing two tests, with a time in between, i.e., similar to a graduating license program.

7.1.4. Topic 4: Post-license training

*"***Post-license training** can be part of the initial rider training and conducted shortly after obtaining the license and/or it can be voluntary in order to update knowledge and/or improve skills*"*.

The participants discussed post-license training, mainly for novice riders shortly after they had received their license. In this instance, it was important to separate this from graduated training which usually includes two tests, before the rider gets a full license and follow-up training for those who already have a license. Whether the latter should be mandatory or not was discussed, with one of the participants being against unless it also applied to car drivers. Another problem raised was that in some countries the offer is very limited, or indeed not being offered at all.

The cost of such post-license training was also discussed, and one of the participants argued that it would not be very expensive if it was carried out by motorcyclists' organisations. He would therefore like to see this as a voluntary option. This was also supported by others, and one argument was that it should be encouraged. Finally, a suggestion was made that drivers who violate rules and regulations should have to undergo further training.

7.2. Recommendations from the session

Recommendations as they were formulated in the rapporteur report.

- Within any activity in the fields of education, training, testing, and licensing, the particular properties of powered-two-wheelers and their users should be considered, along with the regional transport environment and the respective needs of the riders.
- A new Traffic Safety Culture which can raise awareness on interacting with all other road users—in particular the most vulnerable ones—should be developed and implemented preferably by user organisations or similar, including riders. Life-long learning shall be a substantial element of such a traffic safety culture. The GDE matrix shall constitute the basis and all levels should be respectively considered.
- All personnel concerned with teaching, training, and licensing shall be carefully selected and well trained, and regular re-trained.
- A state-of-the-art licensing system includes both theoretical and practical pre-license training, the latter with a reasonable share of practice in real traffic. Extent and content should be clearly defined. Modern teaching methods shall be used, self-education by new media exploited and presence teaching used for the important issues, in particular motivation to comply to rules of safety and self-reflection. Post-license training shortly after acquisition of the license should correct bad habits and use first experience to further develop advanced skills.
- Training shall cover risk awareness, risk competence, hazard perception, visual scanning skills, humans' relation to lean angles, the influence of vehicle characteristics on human behaviour, rider assistance systems and safe transportation of child passengers. In terms of skills, counter-steering and braking techniques are key.
- There should be mandatory post-license training shortly after licensing. Later voluntary training shall receive respective support. Any post-license training shall improve skills and knowledge but avoid any emergence of over-confidence.
- Minimum age is a key factor, riders should be mature to understand the rules of traffic, apply them, and control risk.

- Including recommendations and awareness on how to ride with a child on a PTW during training and education was not agreed, the proposal was made. (It is a difficult topic to discuss, but it needs to be discussed and analysed).
- Education, training, and licensing (except minimum age) do not include particular child & youth topics; however, education, training, and licensing have high responsibility to take the message to the people.
- For LMICs, a key priority is accelerating the availability of effective, affordable, and accessible training and education programs in the regions. The training infrastructure should be developed to reach the majority of riders and adequate policy should ensure that new riders are properly educated. The approach shall vary per country, due to differences in local needs, safety situation, type of use, affordability and existing local vehicle operator licensing policy, legislation, and training infrastructure.

7.3. Comments and scientific references

In this section scientific references related to the topics of the session are presented. Focus is on the most recently published studies.

Studies have shown that motorcycle crashes are related to different factors which can be divided into; individual (Balusu et al., 2020; Chawla et al., 2019; Satiennam et al., 2018; Sætren et al., 2020; Wu & Loo, 2017), social (Balusu et al. 2020; Satiennam, et. al., 2018), structural (Francis et al., 2021; Sætren et. al., 2020), and technical factors (Chawla et. al., 2019). As a consequence, the training of motorcyclists needs to be fully comprehensive. However, if we shall be able to also implement the recommendations presented in this session, we need to look at possible barriers to change.

A number of studies have failed to find any association between pre-license driver training programmes and crash risk (Araujo et al., 2017; Baldock, 2018; Chawla et. al., 2019; Ivers et al., 2016). This in turn has been used as an argument against focusing on driver training, for instance:

> "Given the absence of road safety benefits of rider training, and the substantial challenges in successfully implementing state-wide programs, rider training should be considered a less promising strategy than other aspects of a safe system approach" (Ivers et al., 2016, page 46).

The problem with this argument is that it fails to look at factors which explain the lack of effect. At least four different ones have been identified. The first one is methodological shortcomings and the second, that the content of some training programmes can be counterproductive for road safety. The third is that very few studies have evaluated the training scientifically (Boele-Vos & de Craen, 2015). A fourth reason is that numerous studies were conducted 20 years ago or more, when driver training focused very much on something described as "lower-order skills", i.e., how to handle the motorcycle rather than "higher-order skills". The latter means that risk-perception aspects and self-assessment shall also be included in the teaching curriculum. The notion of lower- and higher-order skills can be related to the Goals for Driver Education (GDE) framework which was first presented by Hatakka et al. in 1999. The framework emphasized that rider training needs to include much more than just teaching motor skills. This was also supported by Elvik et al. (2009) in a meta-analysis which concluded that too much focus on handling the motorcycle (i.e lower-order skills) can have a detrimental effect on road safety since it can lead to an overestimation of skills and greater risk-taking. A focus on "lower-order skills" is not only a remnant of the past, since it can also explain why training in later years sometimes fails (see Boele-Vos & de Craen, 2015).

Teaching, according to the GDE framework, requires new pedagogical methods which some teachers do not feel adequately prepared for (Forward et al., 2018). For example, a teacher who is used to

teaching how to handle the motorcycle might find it difficult to help the rider to increase his/her self-assessment and risk perception.

Since there are several reasons for the poor results, it would be a great error to use them as an argument against training. Instead, it should help us to develop high-quality training, which includes both higher- and lower-order skills. Furthermore, the need for a professional training of instructors cannot be emphasized enough and this was also included as one of the recommendations from the session. However, even if driver trainers are well trained, their impact is rather limited if they do not have enough time with the students. During the discussion in the expert group, several of the members pointed out that it was very common that the training was very 'test-oriented'. The question which remains is how we can make riders better trained if we do not recommend that the training by professionals should be mandatory? The recommendation from the expert group was only that post-training should be mandatory, not pre-training.

We also must acknowledge that even if rider training is excellent, attitudes and norms regarding risk-taking and traffic safety start much earlier and can be difficult to change. Therefore, the suggestion that a Traffic Safety Culture should be developed is a very important recommendation proposed by the expert group.

Post-training was also discussed during the session and resulted in two recommendations. However, if pre-training has its opponents, more voices argued that post-training should not be introduced due to its poor impact (Ivers et al., 2016) and that it can contribute to rider overconfidence (Ulleberg 2003). However, the reason for its poor impact is very similar to those presented above. Indeed, a more positive impact was presented in a study of advanced rider training conducted in the Netherlands, which included many important elements (Boele & de Craen, 2014). The results from that study showed that an improvement in skills did not lead to overconfidence.

The main conclusion from the expert session was that a great deal of work is required in order to reduce the number of road crashes and that education, training, and licensing are important elements to achieve this aim. However, as stressed in this section, if the recommendations shall be implemented in practice, this will only be the start. A great deal of work is required to ensure that what is being implemented is of a high quality, since more is not always better.

> "Driver training is a long-term measure to improve road safety. It might have positive short term effects, no effect or even negative effects if the driver/rider training is unorganised and on a low level". (OECD/ITF, 2015, page 102).

8. Expert session #4: Vehicle safety, Protective safety, and Intelligent Transport System

This session was moderated by Mr Scott Armiger, IMMA, and Dr Cecilia Sunnevång, Autoliv, was rapporteur. The discussions were divided into four main topics: 1. Minimum safety requirements, 2. Personal protective equipment (PPE), 3. New vehicle technologies and 4. Vehicle technical inspection.

The session was linked to three of the recommendations from the Academic Expert Group: #2 Procurement, #6 Safe vehicles across the globe and #9 Technology.

8.1. Summary of the session

The text below captures the issues raised during the session and reflects the views of the attending experts, expressed either in the discussion, the chat, or in emails after the session.

8.1.1. Topic 1: Minimum Vehicle Safety Standards

UNECE WP.29 in Geneva[14] is considered the main centre for development of minimum vehicle safety standards across the globe. It has already been successful for defining existing standards. Thus, it creates a good platform for harmonizing minimum safety requirements on PTWs for all countries. An outreach for more countries to join the UNECE is desired. All countries should preferably adhere to these requirements.

For LMICs, there are some concerns that too strict requirements and legislation will not provide a sufficient cost benefit. Certain safety equipment will increase the price of vehicles, i.e., affect affordability, and thus hamper development or be in conflict with other sustainability goals like access to work, school, and hospitals.

The long-term progression in cost for different vehicle technologies is an important aspect when looking at the evolution of vehicle safety. As technology matures, and new systems are put to mass production as a common commodity, prices often go down over time. Thus, technology that initially is only offered in HICs on high-end products, can in the long run also be affordable in LMICs on cheaper vehicles. An example of this is anti-lock braking systems (ABS). ABS has historically been considered too expensive for broad application in LMICs. The recent development in India, however, is to adopt mandatory fitment of ABS on two-wheelers above 125cc, effective from 2019-04-01. For this reason, it is important to keep pushing the technical development of advanced safety features in HICs. After being introduced to mass markets and further developed, in a longer term LMICs may also benefit from the development effort done in HICs.

In addition to ABS, there were also statements made on lighting, i.e., automatic headlight on (AHO) as well as visibility through reflective tape. There was also a statement that tyre quality should be part of minimum vehicle standards which no one objected to, particularly as tyres greatly impact the effectiveness of systems like ABS.

It is important that organisations, individuals, and other actors push safety standards beyond minimum safety requirements. Performance assessment programs have proven to be an effective tool in advancing vehicle and equipment safety standards. Example of such programs are NCAP, SHARP, and MotoCap.

8.1.2. Topic 2: Helmets and Personal Protective Equipment

Personal protective equipment is an area where much more research, testing, and standardization is required. User choice and behaviour will be as significant as legislation in many areas in determining

[14] https://unece.org/wp29-introduction

safety outcomes. Research in the area of PPE seemed particularly important, highlighting a need for more nuanced information about equipment performance (via, e.g., star ratings rather than a simple pass/fail result of a standard), but also for recognizing the link between wearer comfort and willingness to actually use the equipment, which is not usually compulsory.

Regarding helmets, there is a need to develop injury criteria that also consider rotation, which can cause severe injuries and is not taken into consideration in the standards today. There is also a need to understand more on the issue around the transport of children to relate vehicle safety and PPE to this target group.

Considering consumer testing it is important to distinguish between independent, well-defined testing programs with methodology that has support in scientific evidence, as compared to consumer surveys and ratings by users. The latter may not reflect real-life safety performance but rather personal preferences and perceived safety. Helmet testing, for example, has shown that no strong correlation between price and safety performance exists. Independent testing can support individuals in choosing safe products, but it can also be used by organisations as requirements in procurement, company guidelines, and policies. This practice should be encouraged and promoted as a competitive advantage.

There was also a comment that a safe system approach should refer to "Safer vehicles and equipment", rather than just "Vehicles". They do not have to be separated. For example, if we want all riders to wear helmets, then we should model the association between the PTW and the helmet. One participant pointed out that they were not permitted to show non-helmeted riders in advertising by government safety regulations.

Addressing these issues, two pilot programs were presented. The FIA has been working on addressing helmet standard harmonization[15] (today there are 30 different standards) and developing a low-cost helmet. The pilot concluded that 10-15 USD is a reasonable price for a safe and comfortable helmet. One participant made a comment that to make it possible for everyone to wear a helmet, 10 USD is the price point, and such helmets should be protective up to 40 km/h. ISO could be the place to house a standard (skull fractures and other severe brain injuries), but standards that are developed today are for more advanced helmets.

A question was posed if there is a currently process available for rating helmets and PPE performance. A reference was made to the UK Dept. for Transport's Helmet Rating Programme[16], where helmet performance as well as consumer information on how to buy the right helmet is presented. Motocap[17] was also presented. There is a need to put evidence-based requirements on impact protection performance standards. Price and comfort are most important to end users, and the end user's awareness on a garment's protective effect is not generally known. Rating schemes give riders information on which of the certified garments they can buy, and can encompass more information on protective performance at different speeds, costs, comfort levels, and other useful information. The recommendation was to have global UNECE standards as minimum requirements in addition to evidenced-based rating schemes.

There was a common understanding that airbag jackets appear to hold great promise for motorcyclists, but are limited by cost of development testing, patent restrictions, and cost of certification. Additional

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[15] References to the FIA work can be found at:

https://www.fia.com/sites/default/files/auto30_impospreads_v01.pdf (page 24 to 27), https://www.fia.com/news/fia-leads-global-project-affordable-high-safety-helmets, https://www.fia.com/news/michael-schumacher-inspired-keep-fighting-foundation-becomes-first-partner-fia-affordable-safe

[16] https://sharp.dft.gov.uk

[17] www.motocap.com.au

work is required for test protocols to define the areas of coverage required based on crash injury risks. Shoulders, chest, neck, and back are potentially the priority areas for protection.

8.1.3. Topic 3: New Vehicle Technologies

There is a consensus that ABS for PTWs is highly effective in terms of increasing riding safety.

Many new safety technologies are now being researched and put on the market. These include advanced driver assist systems (ADAS), advanced rider assist systems (ARAS), and intelligent transportation system (ITS) functions through connected vehicles as well as nomadic devices. Connectivity was commonly agreed-upon as an enabler for improved ARAS and PTW safety. Specific functions that are made possible by having connected vehicles include emergency calling (eCall) and intelligent speed adaptation (ISA).

The development of ADAS for other vehicles (cars, heavy goods vehicles) will be very important for PTW riders' safety. Many crashes can be avoided and mitigated by, for example, autonomous emergency braking (AEB), steering assist, automated driving, blind spot detection, and other functions. Therefore, it is important to develop systems that correctly detect and classify PTWs, as well as other road users. As an example, early generation AEB systems sometimes only came with the capacity to detect other cars. Now, many systems boast the ability to also detect pedestrians, bicyclists, PTWs, and large animals. Still, when comparing some Adaptive Cruise Control (ACC) systems' detection of PTWs compared to cars, many PTWs are detected poorly. The capability of detecting PTWs in ADAS systems carried by cars and heavy goods vehicles has a great potential in reducing rider injuries.

Another point worth mentioning is that Euro NCAP is working on improving test protocols for PTW detection (similar to other VRUs). Regarding the passenger car detection and activation of AEBs, it was explained that Euro NCAP will introduce detection of PTWs in several scenarios (rear into PTW, left turn across path, oncoming, overtaking) in the next upgrade in 2023. It was also mentioned that Global NCAP collaborates with MIROS in Thailand. There was also a proposal for industry volunteering to collaborate on AEB development for PTWs.

One key issue for PTW safety is speeding. ISA can provide large safety effects in supporting riders in keeping the speed limit. Concerns were expressed that a crude ISA system, e.g., just killing the throttle, could pose a safety risk in dynamic riding situations. ISA needs to, as the name implies, be implemented in an intelligent way, using more advanced riding situational awareness, and provide support to the rider in a safe manner. ISA systems will also have a positive impact on fuel consumption and thus serve multiple purposes in reaching other sustainability goals.

An opportunity to deploy ISA functions is that fleet operators and other commercial actors could take a leading role in requesting ISA for their vehicles, to ensure safe and efficient operations for their business. Example of such activities have been observed within the trucking industry in the US, which uses speed limited to slightly above the speed limit.

There was one concern that PTW ARAS could take away the rider's focus on the task of driving, and that a safe Human-Machine Interface (HMI) is needed. It was also commented that ARAS/ADAS will avoid some crashes but not all. In addition, active safety airbags (on car exteriors or on PTWs) are needed and effective in PTW-to-car crashes.

8.1.4. Topic 4: Vehicle Technical Inspection

Vehicle technical inspections (also known as periodical technical inspections) aim at assuring, among other things, adequate safety performance of older/used vehicles.

The most prevalent technical failures in the EU that are contributing factors to crashes are defective vehicle lighting, the state of the tyres, and failure of the brakes, all due to a lack of proper

maintenance. There is a large range of options to address poorly maintained vehicles as demonstrated in different countries. India now requires vehicle technical inspections (basic fitness check of brakes, lightning, emissions) to be undertaken for all vehicles (subject to an age threshold). The Netherlands has no such requirement, claiming it has been found to have limited effectiveness. One example from the UK was given of a successful system since 1958. The key is that the government licenses motorcycle repairers and dealers to do the inspections. If a fault is found and rectified speedily, then the next test is free. If it is a minor fault this is usually fixed the same day. A potential problem to be avoided is to have technical inspections that are too expensive or inaccessible, caused by the procedure being too bureaucratic, expensive, or too few providers of inspection/inspection facilities being available.

Upcoming EU directives will put in place vehicle technical inspections schemes for PTWs>125cc, with a potential to increase the scope to include smaller PTWs. However not all EU countries are likely to adopt.

Technical inspections of PPE is an area which is not well developed. For both helmets and garments deterioration is an issue. On this topic, the knowledge situation needs to improve. Knowledge is needed both on how testing can capture failures connected to real safety performance, as well as how PPE deteriorates in correlation to age, wear, and other factors.

8.2. Recommendations from the session

Recommendations from the session as they were formulated in the rapporteur report.

Minimum Safety Requirements

- Good quality braking systems associated with appropriate tyre selection are fundamental to safe motorcycle use. Anti-lock braking system (ABS), combined braking systems (CBS), and use of good quality tyres should be promoted in all regions through training, financial incentives, and regulation. Measures may need to be adjusted to local circumstances but will be similar in all parts of the world pending, as needed, local validation and assessment. Lessons from the experience of implementing mandatory regulations for equipping motorcycles with ABS in Europe and India should prove valuable, confirming that the costs of new technologies fall rapidly once they become standard equipment. Regulatory mandates for effective technologies should therefore spread from higher to lower income economies with relatively short delays, even if priorities for interventions will differ from region to region.
- Policy makers in all regions of the world should develop a progressive roadmap to equipping new motorcycles with ABS. A motorcycle is a vehicle which has a maximum design speed in excess of 50 kph. (A powered-two-wheeler with a maximum design speed of 50 km/h is a moped). Governments should also encourage consumer safety rating programmes for motorcycles.
- In line with the recent UN resolutions (e.g., A/RES/Xin), national and regional regulatory bodies should consider implementing minimum requirements specified under UN WP.29 Regulations 78 and GTR No 3, and plan for making high quality braking systems incorporating ABS and CBS on new vehicles during the current decade.
- On vehicle conspicuity and headlights:
    - Reflective tape is a cheap, simple, and effective way of improving conspicuity of motorcyclists, motorcycles, and other motorised vehicles that present crash risks for motorcyclists. All governments should consider regulation to require the rear of heavy vehicles to be marked with reflective tape as a back-up for faulty lighting.

- AHO, already mandatory in some markets, should also be considered when implementing minimum vehicle requirements as it improves vehicle visibility, rider sight, and reduces risk of a crash.

Personal Protective Equipment

- Further develop Global ECE minimum requirements for helmets and PPE
  - Requirements should incorporate thermal comfort (breathability) and different types of usage based on crash-based injury criteria from published scientific peer-reviewed evidence.
- Develop and publish independent scientific safety ratings programs for helmets and PPE.
- Increase helmet usage through further development focusing on cost (affordable) and comfort (including performance).

New Vehicle Technologies

- Ensure PTWs are included in the passenger car ADAS functionality. (Collaborate with automotive industry to ensure this and learn from car ADAS when developing ARAS).
- Develop safe and appropriate ISA systems that incorporate the unique needs of PTWs without compromising rider safety.
- Consider independent scientific safety ratings programs for PTWs, considering both crash avoidance and rider protection.

Vehicle Technical Inspection

- Vehicle technical inspections schemes to be linked to other incentives like insurance (shared responsibility like in India and UK).
- More research and data needed on effectiveness on potential vehicle technical inspections.

8.3. Comments and scientific references

In this section scientific references related to the topics of the session are presented.

There is a strong consensus on the safety effect of ABS systems for PTWs. ABS for a two-wheeled vehicle is much more important than on a four-wheeled one, as ABS supports the rider in maintaining the control of the vehicle and keeping it upright under heavy breaking. Thus, a locked wheel is more dangerous in a critical situation on a two-wheeler than on a four-wheeler. Research on the safety effects of PTW ABS indicates potential for large safety benefits and reduction in fatalities and injuries (Fildes et al., 2015; Gail et al., 2009; Green, 2006; HLDI, 2013; Hurt et al., 1981; Kato et al., 1996; Koetniyom et al., 2021; Rizzi et al., 2015; Rizzi et al., 2016; Roll et al., 2009; Teoh, 2013).

While ABS is one of the most mature and widely deployed rider assist systems, the industry is now looking to the development of ARAS which may rely on proximity sensors (e.g., radar, camera lidar) and vehicle connectivity. There are challenges when designing such systems for PTWs, but there are still strong reasons to believe that functions such as adaptive cruise control, collision warning, and automatic emergency braking (which has been on the market since 2007 on cars) would be effective for PTWs as well. Research that has tried to estimate the safety effect of ARAS systems is presented in (Lucci et al., 2021; Savino et al., 2013; Savino et al., 2014).

Vehicle conspicuity is especially important for vehicles with limited passive safety capacity. A simple technology to improve the visibility and thus safety of PTWs is automatic headlight on (AHO). For cars, daytime running lights have been adopted in many countries. An overview of AHO and its effect is given in (Davoodi & Hossayni, 2015).

When it comes to helmet use and protective clothing, the scientific evidence is consistent. Numerous observational studies have demonstrated that the use of helmet reduces the risk of death, trauma to the brain, and facial injury by up to one half (see Araujo et al., 2017). Similar results have also been presented with regards to protective (Baldock, 2018) and fluorescent clothing (Wells, 2004). ECE 2206 standard for motorcycle helmets is progressing and rotation is now included. However, when it comes to good helmets for children, a heavy motorcycle helmet for an adult is not suitable for a child, therefore much more work is required.

Although the use of both helmets and protective clothing is beneficial, they are not always used and sometimes are of inferior standard. Rwebangira (2021) pointed out that helmets on sale in Tanzania and some other African countries do not meet the prescribed standard. In most countries, motorcyclists are obliged by law to wear a helmet when driving, although this is not always complied to. Araujo et al. (2017) uses Jamaica as an example where the reported use of helmets is less than 10 percent. One reason, amongst others, is that in some tropical countries, motorcyclists might not use a helmet or indeed wearing protective clothing because of the heat. Hence, if we shall be able to successfully increase the use of helmets and protective clothing, a number of issues need to be addressed.

This session also pointed out the potential to accelerate development of safer products through enlightened consumer choice. This is equally true for vehicles and personal protective equipment. The need for developing independent and evidence-based rating schemes was clearly pointed out. Further information on existing efforts in this direction is given in https://sharp.dft.gov.uk and www.motocap.com.au.

9. Expert session #5: Road Infrastructure and road environment

This session was moderated by Mr Greg Smith, IRAP and Dr Pierre Van Elslande, University Gustave Eiffel, was rapporteur. The discussions were divided into three main topics: 1. Infrastructure to prevent crashes, 2. Infrastructure to protect riders and 3. Infrastructure to protect other vulnerable road users.

The session was linked to three of the recommendations from the Academic Expert Group: #5: Infrastructure, #9: Technology and #4: Child and youth health.

9.1. Summary of the session

The text below captures the issues raised during the session and reflects the views of the attending experts, expressed either in the discussion, the chat, or in emails after the session.

9.1.1. Topic 1: Infrastructure to prevent crashes

The discussion started with a reminder of the principles of a safe system, that anyone can make a mistake or an error but that should not lead to a road user being fatally injured. The basic idea is to avoid injuries and fatalities but not necessarily crashes themselves. However, a remark was made that avoiding the crash in the first place is more important for motorcyclists than for car drivers, since also a relatively mild crash could lead to severe injuries or death. Since PTW riders are more vulnerable than car occupants, the view that they should set the standard for road design and maintenance was advocated. But this view was also questioned: instead of debating which users should be prioritized, a safe system should acknowledge all users.

Design principles and engineering guidelines were topics that came up repeatedly during the discussions. There seems to be a consensus that the infrastructure as it looks today is built and evaluated for cars. Although this might be changing in light of the last years' focus on cyclists and pedestrians in many urban areas, it is still reflected both in written guidelines and in the knowledge of the engineers building the roads. To build a safe infrastructure for motorcyclists, updated manuals and education of engineers are needed, as well as more research on how the current infrastructure solutions work for PTWs, and on new solutions. As a related remark, a suggestion was made that PTW riders should be included when road safety audits were conducted.

The concept of self-explaining roads and what this means for motorcyclists were discussed by several attendees. Roads need to be intuitive and predictable when it comes to friction, alignment, and other features. This can improve choice of speed and positioning in a curve. One problem is that road markings and signs can be difficult to read for riders, and more knowledge on how to design warning signs was asked for. Maintenance of the road was also mentioned as being important for predictability. An example was given from Australia, where low-volume roads often had potholes and other deficiencies which could be harmful to motorcyclists, but not necessarily to car occupants. There is a need for maintenance guidelines which also include the requirements of PTW riders. For example, if the roads are inspected by cars, potholes in the middle of a lane might not be considered a problem.

The challenges are very different in different regions of the world and, therefore, the solutions also need to be different. An example was given that, in some countries in Africa, the lack of infrastructure is the problem, not how safe it is for riders. Therefore, the minimum requirements of roads for PTWs also need to be discussed.

Advanced stop lines or stop boxes at intersections were also suggested as a good safety measure. It is important though that measures in dense urban areas do not lead to new problems between motorcyclists and other vulnerable road users, such as conflicts between PTWs and bicycles in intersections or bicycle lanes. It is therefore necessary to have a holistic view and include all transport modes when designing infrastructure.

Exclusive motorcycle lanes have been implemented in several countries in Southeast Asia with mostly good results. However, there are problems with this solution that need to be managed, such as access points and delineation to the other lanes. An example from Latin America was raised where an exclusive motorcycle lane was implemented with bad results. A reason for this might have been inaccurate design, and the need for detailed design guidelines were stressed. More generally, it is not enough to propose the safety measure in itself, specific guidelines must also be developed for a successful implementation in other areas.

9.1.2. Topic 2: Infrastructure to protect riders

Successfully managing kinetic energy is a crucial part of a safe system, thereby making speed a very important aspect. Several attendees discussed traffic calming measures and the experiences seemed to be that traditional measures, such as speed bumps, do not necessarily work well for PTWs and can even be dangerous. Roundabouts were also given as an example of a measure that successfully could manage kinetic energy and speed compared to traditional crossings. However, different views came up in the discussion as to whether roundabouts are safe for motorcyclists or not. The general perception seemed to be that the design of the roundabouts and good friction is very important, and with the right design, roundabouts could be safe also for motorcyclists. Narrow lanes were also put forward as an example of a successful measure to reduce speeds.

For run-off-road crashes, a dilemma is whether to clean up the roadside from obstacles or to install a barrier. In some situations, a barrier is the only option. In other situations, the choice depends on location, costs, and other prerequisites. A discussion of different types of barriers followed, and it was clear that the design could be more or less motorcycle friendly, but a barrier always poses a threat to motorcyclists. More evaluations of different barrier designs are needed. Apart from the design of the barrier, the location of the barrier relative to the road is also important.

The correlation between infrastructure and speed was also mentioned, as well as the importance of ensuring the right speed for the situation. Geofencing was mentioned as a possible solution, especially in some environments. This was seen as a measure with good potential by some experts, while others raised concerns. One concern was that the technique isn't yet ready for implementation, and it will take a long time before it can be effective. Another concern was that it could in itself induce risks to the motorcyclist. Also, it could be difficult to implement in LMICs. The discussion was made more difficult since there is no clear definition of geofencing, and it was suggested to make recommendations about digital information of speed.

9.1.3. Topic 3: Infrastructure to protect other vulnerable road users

The situation around schools was discussed and two different measures were brought up. The first was to ensure that sidewalks around schools are wide enough so that children do not have to mix with other traffic. The second was to prevent cars and motorcycles to enter the school zones through so-called filtered permeability. An example of how the environment around a children's hospital in Brazil had been rebuilt to improve the situation for pedestrians was also shown as a good example.

Pedestrians that are hit by turning vehicles at intersections was raised as a concern that needs attention. Overall, this third topic was relatively sparsely discussed.

9.2. Recommendations from the session

Recommendations from the session as they were formulated in the rapporteur report.

- Governments should examine infrastructure and related policies to ensure that the safety of PTWs is provided for in all stages of the road network life cycle (planning, design, construction, operation, and maintenance). This process should include participation of all key stakeholders, including PTW riders, researchers, practitioners, and industry.

- Governments should set ambitious targets that align with the Global Road Safety Performance Targets (Target 3: By 2030, all new roads achieve technical standards for all road users that take road safety into account, or meet a three-star rating or better; Target 4: By 2030, more than 75% of travel on existing roads is on roads that meet technical standards for all road users that take road safety into account). They should allocate dedicated funds that are sufficient to implement infrastructure safety improvements that significantly reduce risk for PTWs.
- Road agencies and road operators should regularly review and, where necessary, update road design standards, manuals, and guides to reflect best-practice knowledge in PTW safety. These should prioritize protection of the most vulnerable users and create self-explaining, predictable, and forgiving road environments for PTWs.
- Road agencies and road operators should implement infrastructure safety improvement programs that use best-practice infrastructure interventions to treat the “systemic" types of PTW crashes that cause severe injury or death on various road types. Also, road agencies and road operators should regularly perform PTW risk assessments of their road networks and report on performance relative to targets. Infrastructure interventions may include, for example:
  - adoption of appropriate safe speed limits and accompanying infrastructure, especially in curves and crossroads where most PTW accidents occur, and also in urban areas with critical pedestrian interactions
  - maintenance of good quality pavements and skid resistance
  - predictable alignments and low-impact roadsides and medians, including more forgiving barrier designs installed at a safe distance whether they are in the middle of the road or on the side of the road
  - ensuring there is clear visibility, such as by providing advanced stop lines/stop boxes for PTWs
  - compact and low-impact-energy intersections
  - physical separation of opposing flows
  - allowing PTW access to bus lanes while ensuring no excess risk for pedestrians
  - segregation of PTW and other vehicles where flows, mass and speed differentials are high
  - provision of accessible and wide enough sidewalks and safe crossings where children walk and cycle.
- Researchers and industry should continue to build evidence and knowledge about best-practice infrastructure safety for PTWs that can support the evolution of policy and practice. This includes:
  - Understanding the crash types that account for most deaths and injuries on various road types and contexts.
  - Building the evidence base about the effectiveness of treatments and designs, particularly in Low- and Middle-Income Country contexts.
  - Developing and evaluating treatments that genuinely comply with safe system principles (such as roadside and median environments that are more forgiving for PTWs, and achieving full separation along high-exposure routes).
  - Developing and validating kinetic energy-based conceptual models of the safe system for PTWs to understand the mechanisms of effect of potential infrastructure and speed

measures, and so clarify where adequate (safe system-aligned) solutions can be provided, and where gaps still remain.

- The evidence of impacts of digital information (such as speed geofencing) on PTW safety needs to be built.

- Researchers and practitioners should accelerate dissemination of knowledge and capacity-building by creating global best-practice resources on planning, designing, operating, and maintaining roads for PTWs, and providing high quality training for road planners, policy makers, designers, and managers in infrastructure safety for PTW
- Motoring/motorcycling organisations, federations, and clubs should support government, road agencies/operators, and researchers by actively advocating for safe infrastructure, contributing to the development of policy and programs, and actively participating in risk assessments, research, and training.

9.3. Comments and scientific references

In this section scientific references related to the topics of the session are presented. Focus is on the most recently published studies.

A common opinion in the session was that the infrastructure as it looks today is built and evaluated for cars. There is therefore a need for solutions that improve the safety for PTW riders and facilitate the use of PTWs. Two such solutions that were discussed are advanced stop lines (ASL, also called red boxes or stop boxes) and exclusive motorcycle lanes.

An ASL can be described as an area behind the stop line dedicated to specific vehicles such as bicycles or PTWs. A couple of studies have recently evaluated ASL for PTWs. Pérez and Santamariña-Rubio (2019) studied the effect of ASL in Barcelona, Spain, that was implemented in two phases, 2009 and 2010. The intersections included in phase I showed a significant increase in the risk of collision in the ASL area and 30 m preceding the area, while no change of risk was found in the crosswalk and intersection. No significant changes in risk were found in the intersections included in phase II. Mulyadi (2019) observed the number of conflicts (incidents where at least one vehicle must brake to avoid a collision) before and after implementing ASL in an intersection in Denpasar, Indonesia. This study showed a decrease in the number of conflicts after the ASL was implemented.

The purpose of an exclusive motorcycle lane is to separate the motorcycles from other traffic to decrease the conflicts between motorcycles and other vehicles (Le & Nurhidayati, 2016). It is difficult to find studies of the overall safety effects of motorcycle lanes, but Radin Umar et al. (2000) estimated a 39 percent decrease of motorcycle crashes when an extension of the motorcycle lane along the Federal Highway Route 2 in Malaysia opened in 1993. Since then, several studies have been conducted looking at, for example, the effect of lane width and roadside configurations on speed, lateral position, and overtaking (Ibrahim et al., 2018), users' perception of a motorcycle lane in Colombia (Osorio-Cuéllar et al., 2015), and safety effects of different egress and ingress designs (Khaidir et al., 2016). However, more research is needed to evaluate overall safety effects of exclusive motorcycle lanes with different designs, flows and traffic mix.

The design and use of safety barriers were given much attention at the session. It was clear from the discussions that a barrier always poses a threat to motorcyclists. A study by Ding et al. (2019) showed that, if an upright motorcyclist using a helmet crashed into a barrier at 70 km/h, the estimated risk of being severely injured (MAIS3+) or killed was as high as 51%. However, a crash into a narrow or wide object also resulted in high estimated risks, 64% and 20 %, respectively. For head-on collisions between motorcycles and passenger cars both travelling at 70 km/h, the estimated risk was 70%. Thus, barriers can also play a role in protecting motorcyclists from obstacles in the roadside and from other road users (for example oncoming traffic). There are many suggestions on how to make barriers less

harmful for motorcyclists (see Wilson et al., 2019, for a summary of devices). So-called motorcyclist protection systems (MPS) can be divided into continuous systems, which consist of an additional rail between the barrier rail and the ground, and discontinuous systems which cover barrier posts with protective material (Baker et al., 2017).

Two rather recent studies have evaluated continuous MPS using crash tests. Baker et al. (2017) studied three different continuous MPS fitted to a standard W-Beam. A series of 12 motorcycle crash tests were conducted in accordance with the European test specification (CEN/TS 1317-8:2012). In addition, three passenger car crash tests were carried out. The results showed that two of the MPS demonstrated an acceptable level of injury risk to a sliding motorcyclist impacting at 60 km/h. None of the MPS demonstrated any adverse impact on the injury risk to passenger car occupants.

Atahan et al. (2018) utilized finite element modelling with LS-DYNA to test different design features of a continuous MPS. Based on the results from these evaluations, two full-scale crash tests were performed using the same test specifications as in Baker et al. (2017). The results showed that the MPS successfully contained and redirected the test dummy with minimal injury risk at 60 km/h.

Thus, the crash tests show promising results, but more research is needed to understand injury risks that MPS pose to motorcyclists impacting in an upright or alternative position (Baker et al., 2017), and how MPS perform when implemented with a radius (Atahan et al., 2018). In addition, more research is required to evaluate how MPS perform in real world conditions (Baker et al., 2017). Some examples of case studies can be found in Milling et al. (2016), but more studies with proper before-after analyses of crashes are needed.

10. Expert session #6: Speed management, adapting speeds and behaviour to different environments

This session was moderated by Prof. Fred Wegman, Delft University and Dr Dimitri Margaritis, CERTH, was rapporteur. The discussions were divided into four main topics: 1. Research needs, 2. Actions to prevent speeding, 3. Specific regulations for specific groups and 4. Safe riding in a safe system.

The session was linked to four of the recommendations from the Academic Expert Group: #7: Zero speeding, #8: 30 km/h, #9: Technology and #4: Child and youth health.

10.1. Summary of the session

The text below captures the issues raised during the session and reflects the views of the attending experts, expressed either in the discussion, the chat, or in emails after the session.

10.1.1. Introduction and general discussion

The discussion started with reflections on what is already known about speed management and motorcycle safety. Motorcyclists are vulnerable road users, and the majority of reported motorcycle crashes lead to severe injuries for the motorcyclists. Safe speed is linked to the road situation. It was agreed that more research is needed and there is a need for a research programme to better understand the relevance of speed and speeding in crashes involving PTWs. However, too much focus on the need for more research can prevent us from taking action right now. It is important to stress that a lot can be done with what we already know, and it should be remembered that the primary goal is to save lives.

Safety of PTWs is a complex and diverse problem: there are major differences between regions in road transport systems, modal split, vehicle types, riders, riding patterns, and riding purposes. To increase safety for motorcyclists in general, customized solutions for different regions are needed. However, human vulnerability is the same in all regions and therefore the solutions for speed management might be more similar across regions than for other areas of importance. A general recommendation is to include PTWs in transport policy systems and to focus not only on riders, but also on passengers since many of the victims are passengers, especially in LMICs.

10.1.2. Topic 1: Research needs

The general agreement was that the need for research is substantial. For instance, little is known about the principle causes of motorcycle crashes. Both crash statistics and in-depth crash investigations are needed. The same applies to speeding to determine how common it is. Some countries have data which demonstrates that speeding is a problem, while other countries do not have such data at all. There is also a need to distinguish between “speeding” and “inappropriate speed”, and investigate the extent that speeding or inappropriate speed contributes to fatalities.

The group concluded that the causes of crashes need to be looked at in a new perspective (Hauer, 2020) since speed was not treated sufficiently in earlier evaluations. For instance, data on motorcycle exposure needs to be collected to determine when and where motorcyclists drive, but more research on the impact of protective equipment is also needed. It is important to be backed up by data to be able to find the right actions for each country, but also to be able to present facts to policy makers to enable funding for road safety. The recommendations regarding research that were formulated in the rapporteur report after the session can be found in section 10.2.

10.1.3. Topic 2: Actions to prevent speeding

Speed enforcement and compliance with laws and regulations are essential elements to increase safety. However, many LMICs have none or little enforcement, and some of the reasons mentioned included:

vehicles not always being registered, motorcyclists sometimes having no fixed address, and counterfeiting. Countries need to solve problems with registration and quality before enforcement can work. Another problem related to enforcement (in all countries) is that police do not want to take the risk of pursuing motorcycles.

It was also mentioned that even speed which is in line with the speed limits can cause crashes. In this instance enforcement is not the solution. A discussion followed about the way to deal with these (and similar) problems. Is it to train the riders so that they can handle the vehicle at high speeds or is it to teach the driver how to avoid such situations where they might lose control? This discussion was also related to novice riders and driver training. No consensus was reached regarding this issue during the session.

Rules need to be explained and understood, and the importance of involving the rider community in information campaigns was raised. Positive messages from, e.g., motorcycle organisations, could be used to raise awareness and change culture.

The question was then if incentives could be used to prevent speeding. For some countries, the road tax and cost for insurances are already very low, so there is not much room for incentives. However, a demerit point system can be seen as a type of incentive, and this was considered as a possible countermeasure.

Speed management measures related to infrastructure were also discussed. The importance of forgiving roads and roadsides was stressed. However, these measures are often expensive and there is a need to focus and use the measures where they are needed the most. Motorcycle-friendly support systems on guardrails were suggested. There is a need for self-explaining roads where riders understand what to expect. For instance, in urban environments road paintings and furniture can create a perception that it is a low-speed environment. It was also pointed out that speed-reducing measures like speed bumps or obstacles on the roads can be dangerous to motorcyclists, and are therefore not the best way to reduce speeds. In general, traffic calming measures should not involve creating new hazards for motorcyclists. Some countries mentioned that they work with iRAP (International Road Assessment Programme) for motorcyclists, customizing solutions for local needs.

As regards vehicle-related interventions, ISA will be mandatory for other vehicles in the EU from 2022. There is a need to start discussing a similar technology for motorcycles in order to help the rider keep the speed limit. An argument put forward against this was that active speed adaptations could endanger the rider. For instance, any interference with the throttle could endanger the motorcyclist according to previous studies. It would therefore make sense to implement non-intrusive solutions which warn the riders when he/she drives too fast (responsive pedal, haptic inputs, limited power etc.). Another issue in relation to vehicle technologies was that they might address safety in HICs, but would probably be more difficult to introduce into the vehicle fleet in LMICs. The technology should be made affordable for different parts of the world, and a motorcycle star rating system was suggested.

10.1.4. Topic 3: Specific regulations for specific groups

Specific speed limits for commercial PTWs were discussed. However, this can be difficult since the industry is unregulated in many LMICs, and as previously mentioned enforcement does not work in the same way as in many HICs. It also needs to be considered that there is a strong influence of unions and strong ties with the government which can prevent change. However, the group argued that this could be an area where a recommendation is made even if we do not have the solution.

Another challenge discussed in relation to regulations for specific groups was novice riders. Many riders in Asia and Africa do not have any formal education and are therefore not aware of the rules and regulations.

Regulations also need to be improved in the area of child safety. Children are being transported to schools on motorcycles both in HICs and LMICs. Sometimes young children are not enforced, and riders can be children as well. This is an area that needs further exploration. Helmet use is a crucial requirement, for children as well as for all riders and passengers. The whole society needs to change its perception in order to understand the safety benefits of helmets, as well as other safety-related measures.

10.1.5. Topic 4: Safe riding in a safe system

The consensus was that motorcyclists need to be included as a part of the safe system, and implementing this will decrease their risks. A safe system approach which reduces speeding by other vehicles can also benefit motorcyclists since the former can often be the cause of crashes. However, it is important to also consider if special solutions are necessary to further address the safety of motorcyclists, and where these special solutions are the most effective.

Due to the present state of implementation or non-implementation of a safe system in general, it will take time to introduce a safe system worldwide, and for motorcyclists in particular. However, it is important that the safe system implementation starts straight away and step-by-step using solutions in accordance with the safe system concept.

It was discussed that implementing a safe system requires large investments, although it was argued that a motorcycle crash cannot be completely safe, and more attention needs to be paid to preventing crashes.

Safety around schools and in school zones was discussed. Safe speeds and safe infrastructure are necessary to protect children and young people. It is also a question of equity. Maybe the 30km/h policy for all traffic users, if widely respected, can resolve the most important concern around schools as well. A harmonised speed limit of 30 km/h in urban areas may also reduce the need for physical obstacles, which, as previously mentioned, can be counterproductive to PTW Safety.

The suggestion of a 30 km/h limit is considered as best practice in urban areas, but drivers and riders must accept it. The recommendation of 30 km/h in urban areas has a role to play for all road users, not only for motorcyclists. However, the recommendation is not well-known beyond Europe and requires further promotion in the regions. It needs to be discussed within user groups and policy makers, in order to raise awareness on why this is necessary.

10.2. Recommendations from the session

Recommendations from the session as they were formulated in the rapporteur report.

Speed management

A number of options are available for speed management of PTWs and other road users such as enforcement, incentives, road and vehicle interventions/technology. There is need for a state-of-the-art study assessing the effectiveness of the different interventions (in different regions), and addressing the specific user groups and situations (see the research questions). Some key recommendations:

- (Europe) Recommendation for development and testing (feasibility) of a haptic- or information-based ISA system for PTWs for European region, including OBIS (On Board Information Systems).
- (Global) Development of well-designed road engineering solutions to safely manage traffic speeds of all vehicles (including PTWs).
- (Global) Develop incentives for PTW users in all regions to comply with speed/traffic rules through promotion, enforcement, and insurance, with particular focus on incentives which can

be communicated as the behaviour occurs—such as driver monitoring and feedback for insurance costs, and well-promoted speed enforcement.

- (LMICs) Evaluation of rider (and driver) training and education, in order to teach novice riders the importance of hazard awareness, risk prevention, and control, in the context of a broader road safety culture are of paramount importance especially in most LMICs where this may have, if well done, immediate positive impacts on speeding behaviour. In this context, the implementation of training programmes is recommended, such as appropriate hours of on-road supervised experience (post-licensing), which have been proven to be effective in reduction of crashes.
- (Global) Reinforcing the 2008 Lillehammer workshop recommendation that a fundamental for safety is the inclusion of motorcycling in wider transport policies. Recognition of motorcycles as transport modes within transport policy will unlock investment for road safety initiatives to reduce rider vulnerability—including in areas related to overall speed management.

Speed management and specific PTW groups: professional users and novice riders

Delivery service PTW users may be often under time pressure, leading to inappropriate speed behaviour which requires urgent policy attention. This aspect (that requires regulations, enforcement, and actions by fleet owners/the private sector) should be researched in-depth for each market/region. In LMICs, with relatively young populations, motorcycles are often used as a job opportunity or means of access to education for very young groups in the population.

- (Global, mainly LMICs) Study the issue, develop, and promote dedicated guidance material for fleet owner companies and enforcement officers, and provide training for professional vehicle operators (riders) addressing the risks of speeding. Evaluate application of vehicle technologies, self-regulation, codes of practice, regulations/compliance monitoring, and enforcement including address fleet managers.
- (Global, mainly LMICs) Local authorities should improve regulations and (non-traditional) enforcement of commercial delivery and taxi services that are using PTWs, including speed and use of safety equipment.
- (Mainly LMICs) Safety of young and novice PTW-users deserves high priority, not only for PTW safety but should be treated as a whole taking into account all vehicle categories.
- The rider training curriculum should include promotion of complying to and choosing safe speeds. However, the addition of speed in the curriculum should also include evaluation indices, in order to identify whether this addition has the expected effect on riders' speed behaviour.

Riding in a safe system

The safe system approach is expected to be positive also for PTWs, because speeds are expected to be lower and the environment more forgiving for errors by road users, including PTWs. Some components of the safe system have particular challenges, such as the vehicle. A motorcycle has limited opportunities to improve passive safety protection of the users. The adequate use of helmets and PPE of appropriate standards is challenging in some regions. A safe system approach can contribute to PTW riders' safety by enhancing the overall safety of the traffic environment.

- The safe system approach is recommended for all regions, and the international community is invited to continue to promote the safe system, while PTW aspects should be given additional attention considering their vulnerability in the traffic system.
- The safe system should also include implementing and promoting means to ensure that all traffic participants [pedestrians, car drivers and especially (novice) PTW riders] learn to

identify high-risk situations and how to avoid them, instead of adopting training practices which aim to acquire the skills to master dangerous manoeuvres. Existing best practices in this area should be adopted.

- Promote certified PTW training, that has been proven (in rigorous evaluation) to be a contributing factor to crash mitigation, as part of a safe system approach.
- For developed countries, experts have to investigate whether advanced stop lines that can allow PTWs to gather at the front of queues at traffic lights are contributing to PTW safety. If this is the case, it is a measure that will reduce rider vulnerability in traffic. For LMICs, this can be aspired to, but many basic issues with the day-to-day dynamics of traffic flows will need to be resolved first.

Research needs

- What is a safe speed for PTWs? What collision speeds with other road users are most survivable or lead only to reduced injuries? There is need for recent in-depth research on speed as a risk factor for PTW users.
- Need to research the effectiveness of basic foresighted driving skills for new riders in order to develop an understanding of the need to comply with speed limits.
- Evaluate the impact of "traffic calming" to PTW safety through dedicated research.
- Where children are being transported on motorcycles, how could speed management policies be used to create safer routes to common destinations such as schools?
- Analysis of driving license demerit system data that could provide insights on the speeding behaviour by specific groups at EU level. Could demerit system in the European driving license system be researched to better understand drivers'/riders' risk-taking behaviour?

The need for further research should not be an excuse for lack of action now, based on the substantial body of existing evidence of which measures are effective and which are not.

10.3. Comments and scientific references

In this section scientific references related to the topics of the session are presented. Focus is on the most recently published studies.

In the session it was discussed what a safe speed for PTW's is. What collision speeds with other road users are likely survivable or lead only to slight injuries? In Ding et al. (2019) motorcyclist injury risk is described as a function of real-life crash speed, and other contributing factors are also studied. The risk models were restricted to front and side motorcycle impacts with passenger cars and fixed objects, in which the rider was injured, wearing a helmet, and not run-over. The results showed that there is a strong and significant relationship between relative speed and injury severity in motorcycle crashes. At 70 km/h, the risk for serious injury or fatality in collision with wide objects, crash barriers and narrow objects was 20%, 51% and 64% respectively. It was also shown that, in head-on collisions between a motorcycle and a passenger car both driving at 60 km/h, the risk of at least serious injury for the motorcyclist was 55%.

It was further discussed that it is generally not known how great the problem with speeding is. Some countries have data that shows that speeding for motorcyclists is a problem, but some countries do not have such data. Research about this issue is published in several papers and examples are given from Belgium (Temmerman & Roynard, 2016), Sweden (Greijer & Nyfjäll, 2020), Belgrade (Jevtic et al., 2015), and Malaysia where it is shown that excessive speeding is a widespread problem among motorcyclists, as well as among car drivers. In relation to the discussion about speed management, it has been shown in France that the introduction of the French Automated Speed Enforcement Program

was associated with a decrease in fatalities and injury crashes for motorcyclists by 39% (Blais & Carnis, 2015). Brumec et al. (2019) showed that speeds of motorcyclists could be reduced in curves when traffic signage and road markings were improved.

Behavioural factors which predict speeding are also important to consider. Studies have found that the intention to speed is related to beliefs which minimize the perception of risk. For instance, in a study by Jamson et al. (2005), a belief that speeding was enjoyable was a significant predictor of the intention to speed. This was also supported by Watson et al. (2007), who found that those who had a positive attitude towards speeding were also more likely to speed. Furthermore, those who speeded did not believe that it would hurt or endanger others. Besides from attitudes, speeding is also related to social norms, in so far as those who speed believe that this behaviour is approved by others (Duong & Parker, 2018). It could therefore be argued that the suggestion to increase novice riders' risk-perception is supported by the literature. However, the same attitudes and norms are also shared by some more experienced riders, which support the recommendations for the implementation of a Traffic Safety Culture.

Other suggestions regarding teaching of novice riders were to focus less on development of skills and more on how to avoid getting into dangerous situations. Indeed, focusing on motor skills and less on cognitive skills has been found to develop unrealistic confidence in riders' own abilities, and as a consequence they take greater risks (Elvik et al., 2009; Gregersen, 1996). It could therefore be argued that the training needs to be carefully balanced, including a greater focus on cognitive and emotional skills.

11. Child and youth health

Child and youth health is one of the nine recommendations of the academic expert group and was introduced as a cross-sectional issue to ensure it was covered in all the expert sessions. This area was monitored by two rapporteurs, Dr Hilda Gomez, Consultant, and Dr Jeffrey Michael, John Hopkins University, USA, who wrote a joint report.

Children and youth are exposed to PTW-related risks as pedestrians and cyclists, and as passengers. The recommendations from the sessions are therefore divided in these two areas and they are reproduced from the rapporteurs' report. Recommendations already included in chapter 5 to 10 are not repeated here.

11.1. Recommendations related to child pedestrians and cyclists

- Child pedestrians and cyclists benefit from vehicle safety improvements—to PTWs and other vehicles—that can reduce collisions such as better braking systems, tyres with greater traction, and better lighting systems. (Session #4: Vehicle safety)
- Provisions for safe transport of children and youth should be included in urban safety and urban mobility plans. (Session #2: Modal shift)
- Recognizing the universal concern for the safety of children and youth, speed management approaches following the safe system approach should be implemented in school zones and other areas where children are present, both as a means for protecting children and as a way to introduce safe system concepts for widespread adoption. (Session #6: Speed management)
- The power of corporate and government procurement should be utilized to improve the safety of children on motorcycles in several ways. This includes reducing the risk for child and youth pedestrians by purchasing ABS-equipped motorcycles for fleet use for shorter stopping distances. This also includes requirements that all firms providing services to the corporation have strong policies preventing child or youth passengers on any motorcycles owned by that firm. (Session #1: Sustainable practices)
- Because the safety of children and youth is a universal concern, communities are often able to prioritize safety improvements for their benefit. As corporations work to improve road safety in their footprint, interventions following the safe system approach should be introduced in school zones or other areas where children are present, both as a means for protecting children and youth and as a strategy to introduce the safe system concept for widespread adoption. (Session #1: Sustainable practices)
- To protect children as pedestrians and cyclists, school zones should have wide sidewalks, elevated crossings, and restrictions on all vehicles near the entrance, where possible. (Session #5: Road infrastructure)
- Managing risk for children, not just in school zones but also on their routes to school and places they are frequently present, should be an important component of road design and planning. All intersections should provide for safe crossing by children. (Session #5: Road infrastructure)

11.2. Recommendations related to child passengers on PTWs

- Include efforts to reduce the risk of children and youth on PTWs in urban safety and urban mobility plans. These provisions should include identifying when and where children are passengers on PTWs—including moto-taxis—and strategies for reducing their risk through

such measures as reducing speed, using protective gear, avoiding highways, and others. (Session #2: Modal shift)

- Investigate the potential for speed management techniques to reduce the risks for child and youth passengers on motorcycles, including the potential for lower speed limits for motorcycles carrying children or requirements that motorcycles carrying children only use low-speed roads. (Session #6: Speed management)
- Performing commuter assessments within their footprints is one means for corporations to assess road safety within their footprint. These assessments should include information regarding the transport of children as part of the commute. Where appropriate, these assessments should be followed by interventions to reduce commuting risks, such as corporate-supported bus services to reduce the need for children and youth to be transported on motorcycles. (Session #1: Sustainable practices)
- Research is needed on the epidemiology of this situation and on solutions. Among these solutions may be new devices or vehicle designs that improve the safety of children and youth by providing crash protection and/or improving their stability on the vehicle. (Session #1: Sustainable practices)
- Traffic calming can protect children and youth when riding, or as passengers of a PTW. In the future, geofencing could possibly be used to reduce speeds in, for example, school zones. Regardless of the methods used for traffic calming, they must be designed in a way that is safe for PTWs. (Session #5: Road infrastructure)
- Cycling is a good preparation for PTW use and should be promoted. (Session #3: Training, education, and licensing)

11.2.1. Research recommendations

- Research should be conducted on the risks for child and youth passengers on motorcycles. In some regions, families have no viable alternative to routinely transporting children and youth by motorcycle. Epidemiological research is needed to better understand the extent and patterns of the risks associated with this practice, and to identify approaches for reducing these risks.
- Research is needed regarding the types and causes of crashes that occur between PTWs, and how to protect children that ride as passengers on PTWs.
- Conduct epidemiological research regarding child and youth transport on motorcycles, and the role of speed in contributing to the risk.

11.3. Comments and scientific references

According to the literature, the extent of the problem with PTW-related injuries in children in LMICs is largely unknown. In WHO (2014), it was concluded that India and Thailand were the only two countries out of eleven in the Southeast Asia region that had data on motorcycle-related injuries in children in their injury surveillance systems. Also, Bhalla and Mohan (2015) stated that there is little empirical evidence to describe the magnitude of the problem with children younger than 10 years on PTWs in LMICs. The authors therefore constructed a database with mortality data from 44 countries (both HICs and LMICs) and 5 Indian cities. The results showed that among all PTW deaths, young children (<10 years old) comprised less than 6.0% in all countries. In countries and cities with high PTW use (>20% of vehicle fleet), the average percentage of young children among PTW deaths was 1.5%.

Data from pilot studies in a selection of hospitals showed that, for children under the age of 15, about 17 per cent of all road traffic injuries in India involved a motorcycle, compared to 26 per cent in Nepal

and 60 per cent in Thailand (WHO, 2014). The situation for children on motorcycles have also been described in WHO (2015). This report includes development of motor, cognitive and psychosocial development in children of different ages, and its implications for motorcycle safety, as well as recommendations to improve motorcycle safety for children.

There are several studies that have examined the use of helmets among child PTW travellers. Lambrosquini et al. (2016) observed helmet use among children in three age groups (1–5 years, 6–12 years, 13–17 years) in forty-five cities in six countries in Latin America. The results showed that helmet use was lowest among the youngest children (1 to 5 years). This is even more evident when studying the correct use of approved helmets. This is partly because there are no authorized helmets for children younger than 2–3 years old, but also because the children are not included in regulations or enforced, according to the authors. The helmet use varied a lot, both between and within countries. In Colombia, for example, helmet use among 13–17 year old children ranged from 7.6% in Galapa to 99.6% in Bogotá. Another study observed helmet use in five Cambodian provinces over a four-year period (Merali & Bachani, 2018). The results showed that, overall, only 2.1% of children under 12 years were wearing a helmet. Other studies have observed helmet use in Argentina (Tosi et al., 2021), Laos (Wada et al., 2017), Malaysia (Kulanthayan et al., 2020), and Vietnam (Nhan et al., 2019).

In addition to helmet use, Lambrosquini et al. (2017) and Tosi et al. (2021) also studied the use of high-visibility clothing. Observations outside primary schools in Argentina showed a wearing rate of 1.8% by the child passengers (Tosi et al., 2021). Lambrosquini et al. (2016) also found low wearing rates in Argentina but higher rates in some other countries. In Bogotá in Colombia, 19.0% of PTW travellers 6-12 years old used high-visibility clothing, and 40.4% in travellers 13–17 years old.

Driving behaviour, attitudes, and beliefs among young riders have also captured the interest of researchers. Joewono and Susilo (2017) conducted a questionnaire study of motorcycle riders in Indonesia aged 17–29 years old, with the aim of investigating factors underlying traffic violation behaviours. Another questionnaire study was performed by Yoshida and Koyanagi (2018), who studied hazard perception among high school and college students in Cambodia. Møller et al. (2021) used focus groups to study the underlying beliefs motivating traffic violations among 15–17 year old moped riders in Denmark.

The mentioned references in this section are only a selection of studies in the area of child and youth PTW users. Nevertheless, they indicate an interest in these research questions, not least in LMICs. However, more research is needed to better understand the extent of PTW-related injuries among child passengers and young riders, as well as crash characteristics and possible interventions.

12. Research Recommendations

The final action addresses the need to increase knowledge on PTW safety. The workshop rapporteurs were responsible for formulating research needs within their specific topic. A brief summary of all outcomes is captured by the bullets below:

- Epidemiological research and data collection on PTW rider safety. Include data of crashes leading to serious injuries, further than data leading to fatalities. Priority issues are: relevance and occurrence of speed and speeding, determine scale and nature of crashes involving specific groups such as child passengers, young riders, or professional users. Clarify local and regional differences.
- Research into nature and scale of PTW accidents involving young PTW riders and/or child PTW passengers, and evaluate suitable policy options to address the concerns in LMICs.
- Research into cost/benefit of transport policy solutions supporting modal shift from and to PTWs, including multimodality/combination with public transport as door-to-door transport, considering regional specifics and diversity of users.
- Research the effectiveness of infrastructure design and traffic management solutions enabling safer motorcycling in urban and rural environments, and identify success factors and most suitable concepts.
- Research and develop best practice guidance into behaviour-influencing policies, such as special training and self-regulation/code of practice for taxi-companies or other fleet operators, driving license demerit system, enforcement of recurring speed offenders, etc.
- Develop an ISA system prototype which incorporates the unique needs of PTWs without compromising rider safety for high-income countries.
- Research effectiveness of safety technologies in the regions based on real world data, (e.g., ABS/CBS in India for PTWs above 125cc) and develop guidance material for gradually extending local/regional minimum vehicle requirements for PTWs in LMICs taking into account affordability and cost-benefit).
- Research into crashworthiness of PTW riders, considering road objects, impact speeds, protection materials, and injuries, and deliver recommendations for improving standards of PPE, helmets, and PTW-friendly infrastructure.
- Research effectiveness of training and education modules, and develop recommendations on how to best educate on hazard awareness and risk prevention for novice motorcyclists

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ABOUT VTI

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Our operations cover all modes of transport, and the subjects of pavement technology, infrastructure maintenance, vehicle technology, traffic safety, traffic analysis, users of the transport system, the environment, the planning and decision making processes, transport economics and transport systems. Knowledge that the institute develops provides a basis for decisions made by stakeholders in the transport sector. In many cases our findings lead to direct applications in both national and international transport policies.

VTI conducts commissioned research in an interdisciplinary organisation. Employees also conduct investigations, provide counseling and perform various services in measurement and testing. The institute has a wide range of advanced research equipment and world-class driving simulators. There are also laboratories for road material testing and crash safety testing.

In Sweden VTI cooperates with universities engaged in related research and education. We also participate continuously in international research projects, networks and alliances.

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Swedish National Road and Transport Research Institute • www.vti.se • vti@vti.se • +46 (0)13–20 40 00