Powered two- and three-wheeler safety

A ROAD SAFETY MANUAL FOR DECISION-MAKERS AND PRACTITIONERS

good practice

World Health Organization

FIA Foundation for the Automobile and Society

GLOBAL ROAD SAFETY PARTNERSHIP

THE WORLD BANK

Powered two- and three-wheeler safety

A road safety manual for decision-makers and practitioners

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Powered two- and three-wheeler safety: a road safety manual for decision-makers and practitioners

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Preface

The powered two- and three-wheeler (PTW) fleet is growing rapidly in most parts of the world. PTWs are becoming one of the main means of transporting both people and goods in many countries, and are attracting an increasingly varied user population. However, this mode of transport accounts for more than 286 000 deaths each year globally – about 23% of all road traffic deaths. This alarming number of potentially avoidable deaths highlights the need for increased attention around PTWs and their use in road safety policy. Effective planning for PTW safety requires a comprehensive understanding of the risk factors involved in different settings. The Safe System approach has several benefits as a framework for examining key PTW risk factors and approaches to prevention.

This manual describes the magnitude of PTW death and injury; key risk factors; ways of assessing the PTW safety situation in a given setting and preparing an action plan; and how to select, design, implement and evaluate effective interventions. The manual stresses the importance of a comprehensive, holistic approach that includes engineering, legislation and enforcement measures, as well as behavioural change.

We hope that implementing the steps in this manual – designed for a multidisciplinary audience including engineers, planners, police, public health professionals and educators – will help develop new, evidence-based plans, programmes and other initiatives to increase PTW safety and encourage a critical review and evaluation of existing actions. We also hope it will contribute towards strengthening national and local capacity to implement PTW safety measures worldwide. We encourage all to bring this manual to the attention of those who will use it to save the lives of PTW users and others who use the roads.

Etienne Krug
Director
Department for Management of Noncommunicable Diseases, Disability, Violence and Injury Prevention
World Health Organization

Barry Watson
Chief Executive Officer
Global Road Safety Partnership

Saul Billingsley
Executive Director
FIA Foundation

Jose Luis Irigoyen
Director
Transport and Information and Communications Technologies Global Practice Department
The World Bank

Contributors and acknowledgements

The World Health Organization (WHO) coordinated the production of this manual and acknowledges, with thanks, all those who have contributed to its preparation. Particular thanks are due to the following people:

Advisory committee

Saul Billingsley (FIA Foundation), Gayle Di Pietro (Global Road Safety Partnership), Dipan Bose (World Bank)

Project coordinators

Kidist Bartolomeos, Meleckidzedeck Khayesi

Principal writers

Kidist Bartolomeos, Jane Elkington, Alison Harvey, Rebecca Ivers, Meleckidzedeck Khayesi, Margie Peden, Tamitza Toroyan

Additional contributors

Edwin Bastiaensen, Julie Brown, Martha Hijar, Kacem Iaych, Lisa Keay, Norfaizah binti Mohamad Khaidir, Muhammad Marizwan bin Abdul Manan, Evelyn Murphy, Nam Nguyen, Joan Ozanne-Smith, Jonathon Passmore, Brent Powis, Teri Reynolds, Eugenia Rodrigues, Kamala Sangam, Chamaiparn Santikan, Dinesh Sethi, Geetam Tiwari, Blair Turner, John Whitelegg

Literature review

Julie Brown, Guoqing Hu, Rebecca Ivers, Lisa Keay, Lisa Schonstein

Peer reviewers

Edwin Bastiaensen, Rafael J Consunji, Pierre Maurice, Victor Pavarino, David Sleet, Stephen Stacey, Blair Turner, Joel Valmain, Andres Villaveces, John Whitelegg, George Yannis

Editing

Julie Reza, Angela Burton

Administrative support

Fabienne Jeanne Besson, Angelita Dee, Pascale Lanvers

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Executive summary

Road traffic crashes kill 1.25 million people each year. Like all road traffic crashes, those involving powered two- and three-wheelers (PTWs) such as motorcycles and e-bikes are often predictable and preventable, and should not be accepted as inevitable. Key risk factors for motorcycle traffic injuries are non-use of helmets; vehicle speed; alcohol use; mixed traffic conditions; lack of protection from the vehicle itself during a crash; and lack of safe infrastructure for PTWs, such as poor road surfaces and roadside hazards. Reduction or elimination of the risks faced by PTW users is an important and achievable policy goal, and despite the existence of proven interventions to prevent PTW crashes, in many locations PTW safety does not attract the attention it merits.

This manual provides information for use in developing and implementing comprehensive measures to improve PTW safety. It examines the extent of PTW-related fatalities and injuries, and the importance of addressing the key risk factors for PTW crashes. The steps outlined for conducting a situational assessment aim to help prioritize interventions, prepare a related plan of action and help implement and evaluate PTW safety measures. While the focus of the manual is action at local or regional level, the strategies presented can be applied at the national level. It is hoped that the modular structure of this manual will enable it to be adapted to suit the needs and problems of individual countries. The manual is applicable worldwide but specifically targets decision-makers and practitioners in low- and middle-income countries.

Introduction

Introduction

Implementing good practice in road safety

The 2004 *World report on road traffic injury prevention (1)* provided national governments, international agencies, nongovernmental organizations (NGOs) and the private sector with six key recommendations for reducing the growing global burden of road trauma:

- Identify a lead agency in government to guide the national road traffic safety effort.
- Assess the problem, policies, institutional settings and capacity relating to road traffic injury.
- Prepare a national road safety strategy and plan of action.
- Allocate financial and human resources to address the problem.
- Implement specific actions to prevent road traffic crashes, minimize injuries and their consequences, and evaluate the impact of these actions.
- Support the development of national capacity and international cooperation.

To help countries implement these recommendations, the World Bank, World Health Organization (WHO), FIA Foundation, and the Global Road Safety Partnership (GRSP) agreed to produce a series of "how to" manuals, or implementation guides.

To date, the collaboration has produced six good-practice manuals covering helmets, drinking and driving, speed, seat-belts and child restraints, data systems and pedestrian safety (available at http://www.who.int/roadsafety/en/).

Why was the manual developed?

This manual addresses road safety related to powered two- and three-wheelers (PTWs) as a result of growing evidence from low-, middle- and high-income countries that PTWs, pedestrians and cyclists (all vulnerable road users) are increasingly involved in road traffic crashes that result in injuries. According to WHO's *Global status report on road safety 2015*, while the global number of road traffic deaths has plateaued at around 1.25 million since 2007, nearly a quarter of these deaths occur among users of PTWs. Despite this challenge – created in part by the growth in the number of PTWs in many low- and middle-income countries *(2)* – national policies for the protection of these vulnerable road users are often insufficient.

This manual aims to provide policy-makers, NGOs, industry and advocacy groups with technical advice for setting up policies and programmes on PTW safety that take full account of existing evidence on the effectiveness of known interventions, and apply the principles of a Safe System approach (see Section 1.5). In implementing these measures, countries need to consider the requirements of all road users, not only those using PTWs. Effective measures addressing the core components of road safety that countries can take to make road transport safer – including the road system, vehicle design and road user behaviours – are well documented *(1)*.

Context

Actions to improve global road safety – including those related to PTWs – are guided by the 2010 United Nations (UN) General Assembly Resolution 64/255 that proclaims a Decade of Action for Road Safety (2011–2020) *(3)*.

The overarching goal of the Decade of Action for Road Safety is to stabilize and then reduce the predicted number of global road traffic deaths by increasing traffic safety activities at national, regional and global levels. Its aims include saving millions of lives by improving the safety of roads and vehicles; enhancing the behaviour of road users, including PTW users; and improving post-crash care *(3)*.

The work is guided by a Global Plan *(4)* produced by WHO and UN regional commissions in cooperation with the UN Road Safety Collaboration (UNRSC). The Global Plan sets out priority activities for countries based on five key areas of work (*4*):

- Road safety management
- Safer roads and mobility
- Safer vehicles
- Safer road users
- Post-crash response

The global development community has also highlighted the importance of addressing road traffic injury as a matter of priority to ensure healthy lives and promote well-being for all, as reflected in Sustainable Development Goals (SDGs) 3 and 11 *(5)* that address road safety (see box below).

Road safety-related Sustainable Development Goals and targets

SDG 3: Ensure healthy lives and promote well-being for all at all ages

Target 3.6: By 2020, halve the number of global deaths and injuries from road traffic accidents.

SDG 11: Make cities and human settlements inclusive, safe, resilient and sustainable

Target 11.2: By 2030, provide access to safe, affordable, accessible and sustainable transport systems for all, improving road safety, notably by expanding public transport, with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons.

Source: based on *(5)*.

The Brasilia Declaration on Road Safety *(6)* is another Member State-driven call for action that highlights the disproportionately high and rising number of motorcycle deaths and injuries (especially in low- and middle-income countries), and calls for the development and implementation of comprehensive legislation and policies addressing motorcycle safety.

The Decade of Action for Road Safety, the SDGs and the Brasilia Declaration are strong indicators that road traffic injuries are being recognized globally as a major development and public health concern.

Who is the manual for?

All sectors (including health, transport, police, environment, justice, industry, social services and education) have a shared responsibility to prevent or effectively manage the injuries, deaths and disabilities caused by PTWs. This manual is, therefore, primarily intended for decision-makers and leaders, policy-makers and programme planners in government and NGOs (in low-, middle- and high-income countries) who provide overall policy and practical guidance on road safety, transport and land-use planning.

Successful policy implementation partly depends on qualified practitioners who are knowledgeable about the factors that influence the risk of death and disability associated with PTW crashes and the evidence-based strategies to reduce this harm. The secondary audience for this manual therefore comprises engineers, planners, enforcement professionals, public health professionals and educators with the responsibility of delivering and improving PTW safety practices at national or local level. It also includes researchers and the broader scientific community (including universities, foundations and other private, non-profit research institutes), and NGOs.

What does the manual cover?

The manual covers the key aspects of PTW safety planning.

Module 1: Why is addressing PTW safety necessary? This module highlights the importance of PTW safety in transport and presents data on the magnitude of PTW fatalities, injuries and risk factors.

Module 2: Conducting a situational assessment. This module outlines the steps to assess a PTW safety situation and select particular actions to prevent harm caused by PTW crashes.

Module 3: What interventions address PTW safety? This module presents key, evidence-based interventions that address the safety of PTWs.

Module 4: Implementing and evaluating PTW interventions. This module outlines the steps for adopting a strategic approach – from planning to delivery of evidence-based interventions, as well as evaluating these efforts.

Case studies from several countries and settings are included throughout the modules.

How should the manual be used?

This manual promotes a systematic approach to PTW safety planning and presents key principles and examples that can be adapted to meet PTW safety planning needs in different country settings. Users are advised to adapt the information to their particular country or local situation. While it is recognized that individual sections of this manual may be more relevant to some countries than others, users are advised to read the entire manual before beginning to use the information it contains. It may be appropriate for all users to look at Module 2, which will enable them to assess their own PTW safety situation and select particular actions to undertake for prevention, as contained in other modules.

Each module contains key principles, tools and references to help readers determine a priority PTW safety policy area or level of action relevant to their country or local setting, and to help identify steps that offer the greatest potential for improvement. While the importance of adapting the content to local situations and choosing the appropriate level at which to begin cannot be overstated, users adapting the content for local contexts must ensure that the fundamental principles outlined in each module are not significantly changed or misrepresented.

What are the limitations of this manual?

The PTW safety situation, risk factors and underlying socio-demographic conditions will vary across regions, countries and within states, territories and provinces, and it is not possible to provide (in a single document) suggestions that will be equally useful across all settings and locales. This manual therefore focuses on the key principles of a Safe System approach and its application to PTW safety planning, and gives selected examples of proven effective PTW interventions and programmes in various settings. The manual is not an exhaustive review of PTW safety and provides only a few case studies. It draws upon a literature review and other contributions from expert contributors, advisory groups and external reviewers. Users are encouraged to make use of the references provided at the end of each module for additional information on specific topics.

How was the manual developed?

An advisory committee of experts from the four collaborating agencies – FIA Foundation, the Global Road Safety Partnership (GRSP), the World Bank and

WHO – provided guidance on the content of this manual. An outline of the content for the manual, based on a standard format developed for this series of good-practice manuals – was produced by WHO. The development process began with the presentation of the project's aims and objectives to the United Nations Road Safety Collaboration (UNRSC) in order to define the content. Following this, a literature review was conducted by The George Institute for Global Health, University of Sydney, Australia. A team of experts from WHO prepared the first draft of the manual. The draft was reviewed by the Advisory Committee and experts from health, transport, programme planning and policy sectors worldwide.

Dissemination of the manual

This manual is available in the major languages, and countries are encouraged to translate the document into local languages. The manual will be disseminated widely through the established distribution channels of all four organizations involved in the series.

The manual will also be available as a free, downloadable PDF from the websites of all four partner organizations. This manual is downloadable from http://www.who.int/roadsafety.

How to obtain printed copies

Further copies of the manual can be ordered by emailing traffic@who.int, or by writing to:

Management of Noncommunicable Diseases, Disability, Violence and Injury Prevention
World Health Organization
20 Appia Avenue, CH-1211
Geneva 27, Switzerland

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1

Why is addressing PTW safety necessary?

Why is addressing PTW safety necessary?

GLOBALLY, PTWs accounted for more than 286 000 deaths in 2013, representing about 23% of all road traffic deaths in that year *(1)*. This alarming number of potentially avoidable deaths highlights the need for increased attention to PTWs and their use in road safety policy. The proportion of all road deaths among PTW riders remained largely unchanged from 2010 to 2013 in all regions, except in the Region of the Americas, where the proportion increased from 15% to 20% of total road traffic deaths. This increase is associated with rapid growth in the number of PTWs in that region. Some African countries also experienced an increase in the proportion of road deaths linked with a rapid rise in the use of PTWs. *The Global status report on road safety 2015 (1)* reported, for example, that in the United Republic of Tanzania, the number of motorcycles rose from 46% of registered vehicles in 2010 to 54% in 2013, while the proportion of all motorcyclist deaths rose from 18% to 22% during that period.

This module provides background information on the safety of PTWs and the need for increased attention to the safety of their users by addressing the following:

- the definition of PTWs;
- the importance of PTWs for mobility;
- the magnitude of the PTW injury problem;
- the risk factors for PTWs; and
- the Safe System approach and PTW safety.

1.1 What are PTWs?

PTWs are motor-operated two- or three-wheeled vehicles, powered by either a combustion engine or rechargeable batteries. These powered vehicles can be divided into different categories, for example motorcycles (street, classic, performance or super-sport, touring, custom, off-road); scooters; e-bikes; and tricycles *(2)*. The main categories of powered two-wheelers covered in this manual are motorcycles (which include mopeds) and e-bikes. The only type of powered three-wheeler covered in this manual is an electric, motor or auto-rickshaw. Basic definitions and descriptions of these are provided in Box 1.1. Safety concerns related to e-bikes and auto-rickshaws are summarized using examples from China (Box 1.2) and India (see Box 1.3, page 16).

1.2 The importance of PTWs for mobility

Mobility is a vital aspect of daily life. Activities linked with daily life, working, education, recreation and health care are often located in different places; as such, people and goods have to move from one place to another using different modes of transport.

BOX 1.1: **Definition of types of PTWs**

In this manual, "PTW" refers to powered two- and three-wheelers (including e-bikes). Where research sources are cited, the manual maintains the definition used by the source in order to retain the authors' intended meaning. As much of the literature and research in this area focuses on motorcycles, this term is used when referring to data or reports that specifically considered motorcycles.

POWERED TWO-WHEELERS

Motorcycles and mopeds

A powered two-wheeler is any two-wheeled vehicle propelled by any type of power other than, or in addition to, pedalling. PTWs can be divided into the following sub-categories *(3)*:

	Category I	**Category II**	**Category III**	**Category IV**
	Ultra-light moped	Moped	Light motorcycle	Motorcycle
Engine displacement	50 cc or less	Over 50 cc	125 cc or less	Over 125 cc
Maximum speed	20 km/h	45 km/h	Over 45 km/h	Over 45 km/h
Maximum weight	40 kg	65 kg	Greater than 65 kg	Greater than 65 kg

cc = cubic centimetres, and is a measure of volume (1000 cc =1 litre) referring to engine size

E-bikes are a category of vehicle that includes two-wheeled bicycles propelled by human pedalling but supplemented by electrical power from a storage battery. E-bikes can be further divided into bicycle-style and scooter-style. E-bikes are regulated not to exceed 20 km/h on electric power alone; however, many e-bikes can travel at speeds in excess of that limit and some are advertised as being able to reach 40 km/h or more.

- **Bicycle-style e-bikes (BSEBs):** These are similar in appearance and function to typical pedal bicycles.
- **Scooter-style e-bikes (SSEB):** These are styled more like gasoline-powered scooters and have larger batteries and higher-powered motors.
- **Large electric bikes:** These are bigger and more powerful than a two-wheeled bicycle or scooter (often used for commercial purposes).

	Bicycle-style electric bikes (BSEBs)	**Scooter-style electric bikes (SSEB)**
Type of engine/ power source	Human pedalling supplemented by electrical power from a storage battery	Electrical power from a storage battery and higher-powered motor
Displacement/ engine size (in cc)	36 V batteries and 180–250 W motor	48 V batteries and 350–500 W motor
Design speed	20–40 km/h	Mostly 30–40 km/h Some (illicit in many countries) can travel at speeds up to 100 km/h

POWERED-THREE WHEELERS

Motor-rickshaws: A motor-rickshaw is a three-wheeled vehicle propelled by a motor, generally used for commercial transport of passengers. Most motor-rickshaws (also referred to as e-rickshaws) run on electric batteries.

Source: based on *(3)*.

BOX 1.2: **E-bikes: a growing public health challenge for road safety, China**

E-bikes were introduced into China's traffic mix in the late 1990s to provide a low-cost, (perceived) low-carbon, and convenient alternative to cars in what was already a crowded public transport infrastructure *(4)*. E-bikes were originally designed as power-assisted pedal bicycles, providing greater acceleration and speed *(5)*. Two main types emerged – bicycle style and scooter style. The heavier scooter style e-bike is capable of higher speeds and can be used without pedalling *(6)*.

Since the introduction of legislation to deal with e-bikes in 1998, the number of e-bikes in China has grown from an estimated 40 000 to an estimated 170 million in 2014. The replacement of aging e-bikes is estimated to be approximately 25 million units a year *(7)*. Research confirms that mobility in an ever-increasing urban context is driving demand for e-bikes as a transport option. One survey cited leading reasons for using an e-bike to be speed and ease of use compared to using a bicycle or bus *(8)*. With e-bikes becoming increasingly popular in many other countries throughout Asia and Europe, a worldwide increase in demand is expected – there were an estimated 466 million e-bikes on the road in 2016 *(9)*.

Road safety concerns

As e-bikes have gained prominence on China's roads, e-bike crashes resulting in deaths and injuries have also grown, leading to an increased health and economic burden for individuals and communities. During the period 2004–2008, police records show that e-biker fatalities and nonfatal injuries increased around five-fold (from 589 to 3107), and three-fold (from 5295 to 17 303) respectively *(10)*. A police data surveillance study conducted during the same period in the city of Hangzhou indicated that the e-bike-related fatality rate increased by 2.7 per 100 000 persons per year, while the overall road crash casualty rate fell by 1.1 per 100 000 persons per year *(11)*.

Other recent city-based studies found that e-bikes continue to figure prominently in road crashes, further reinforcing media and community perceptions that e-bikes pose safety risks. In Hangzhou in 2011, there were 5765 reported e-bike-related crashes, representing approximately 29.1% of all road traffic crashes.

Research using hospital records underscores the significance of the issue. For example, between October 2010 and April 2011, a cross-sectional study conducted in the city of Suzhou retrospectively collected information on hospitalized e-bikers involved in road crashes. Injured e-bike users accounted for 57.2% of road traffic hospitalizations over the 6-month study period. Most had head injuries (46.4%), and more than one-third of the study population (35.9%) experienced some form of traumatic brain injury *(12)*.

Despite the lack of comprehensive, national-level research, there is clear and compelling evidence that e-bikes are associated with a high proportion of road crashes resulting in increasing numbers of deaths and serious injuries.

What are the main risk factors for e-bike injuries?

Research indicates that e-bikers with a driver's licence are less likely to be involved in at-fault crashes *(10)*. Given e-bikes are legally classified as "non-motor vehicles", the absence of any licensing requirements may therefore increase the risk of crashes due to riders' lack of knowledge and poor riding practices. Research conducted in the Chinese cities of Suzhou and Hangzhou show that the most common and potentially unsafe e-bike rider behaviours were speeding, carrying passengers illegally, riding counter to traffic flow, disobeying traffic signals, and using a mobile phone when riding *(13)*. Speeding is a key risk factor in road safety for all forms of transport and it is clear that e-bike riders frequently travel at speeds far greater than that permitted under Chinese law. This was highlighted in roadside speed observations in Suzhou where, in one location, up to 83.3% of e-bike riders were observed to be travelling in excess of the 15 km/h limit *(14)*. An important finding supporting the need to strengthen the requirements associated with scooter type e-bikes is that those riding e-bikes equipped with pedals are less likely to break the law.

Continues…

Continued from previous page

In terms of general road safety knowledge, another study conducted in Hangzhou found that 45% of e-bike owners were unaware that road safety laws and regulations existed. Of particular significance was the finding that only 19.8% of owners were aware of the maximum speed limits and only 30% were familiar with regulations concerning traffic signs and markings. The research supported field observational studies, from which it was reported that 68% of riders were travelling above the speed limit; 42% were disobeying traffic signals; 39% were travelling in the wrong direction (i.e. against the traffic); 52% had illegal passengers; 39% were riding while using a mobile phone; and 13% were identified as drink-riding *(15)*.

A major risk factor for two-wheeler road users, including e-bike users, is the non-use of helmets. A cross-sectional study in Suzhou showed that the head was the most commonly injured part of the body, and that 46.4% of e-biker injury hospitalizations included a head injury. Several recent studies have highlighted the low levels of helmet use by e-bike riders, *(15, 16)* despite one study finding that over half of e-bikers (53.9%) surveyed thought that helmet wearing should be required when riding. Only 4.5% self-reported frequently using a helmet *(15)*. This is broadly consistent with on-road observations made of riders in Suzhou, where only 2–9% of riders were observed to wear helmets during summer and winter periods *(16)*.

A recent investigation in Switzerland (where e-bikes are emerging as a road safety challenge) showed that although the most common injuries in e-bike-related hospitalizations were to the head and neck, their proportion of total injury type cases was only 27.4%. The likely reason is that the proportion of e-bike riders wearing helmets was as high as 75% in Switzerland, in contrast to much lower helmet-wearing rates in China *(17)*.

1.2.1 How are PTWs used?

PTWs serve different purposes in different parts of the world. In high-income countries they are commonly used for recreation *(18)*, while in low- and middle-income countries they are more commonly used for commercial purposes, mainly as taxis or delivery vehicles *(19, 20)*. In these regions PTWs are often used for two purposes – for transport (of both goods and people), and as a business or an income source. In India for example, 40% of PTWs are used to transport goods while 60% are used to transport people *(18)*. In Brazil, mainly in cities with significant traffic congestion, a large proportion of new PTWs are used as taxis and to deliver goods *(19)*. In the metropolitan area of Seoul, South Korea, 56% of motorcycles are used to deliver items such as parcels and food *(21)*. In WHO's South-East Asia Region and Western Pacific Region it is common to see PTWs transporting family members. In Europe, PTWs are used for both recreational purposes as well as to escape the problems of urban traffic congestion *(18)*. This phenomenon is reflected in industry statistics on powered two-wheeler production, indicating that, globally, high-powered motorcycles (i.e. over 250 cc) are sold more in North America and Europe (over 50%) compared to South-East Asia (5%) (see Figure 1.1).

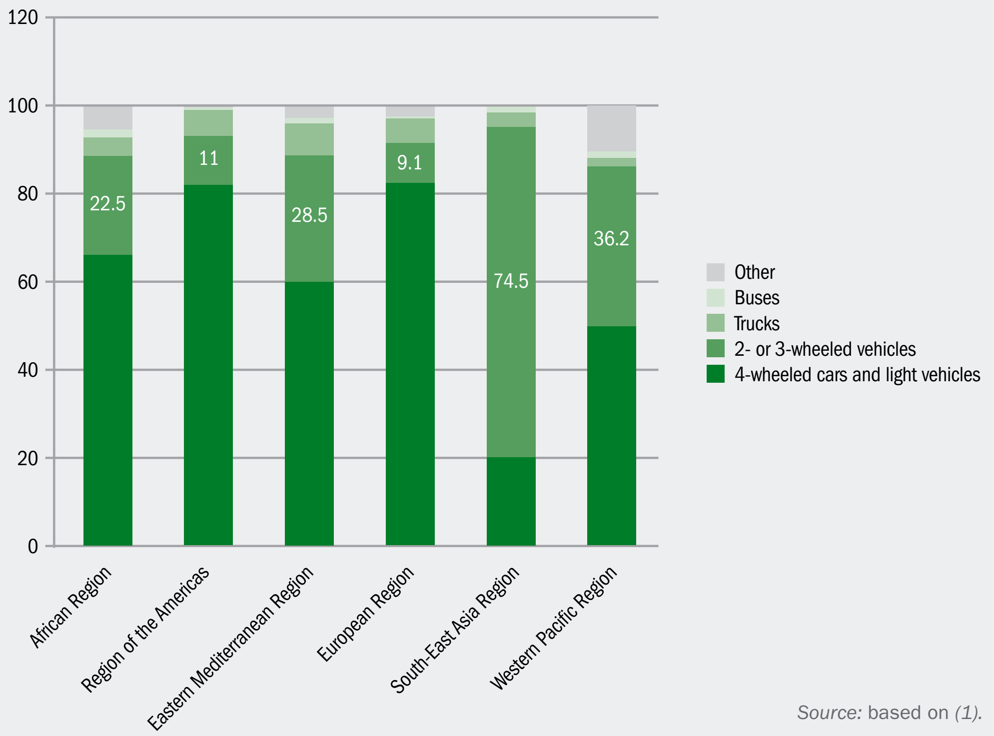
1.2.2 Global distribution of PTWs

There is a growing number of registered PTWs in most parts of the world and it represents a sizeable and varied user population *(18, 22)*. In 2013, there were around 516 million PTWs registered worldwide, accounting for 29% of all registered vehicles *(1)*. It is important to note that these figures exclude non-motorized two- and three-wheelers (which do not need to be registered), and in the absence of a registration system in many low- and middle-income countries are likely to be an underestimation.

Low- and middle-income countries account for the vast majority of the global PTW fleet. According to WHO's *Global status report on road safety 2015*, 88% of all registered PTWs globally in 2013 were in low- and middle-income countries *(1)*.

WHO's South-East Asia Region had the highest proportion of registered PTWs (74.5% of all registered vehicles) in 2013 *(1)* (see Figure 1.1). While the proportion of registered motorized two- or three-wheelers was increasing in all regions, the highest growth (39%) was in WHO's South-East Asia Region *(1)*. China has one of the largest local motorcycle production facilities *(23)*. In just 6 years (2007–2013), the number of motorcycles in China increased by 21%, reaching 109 million *(24)*. In other counties of the Western Pacific Region, such as Viet Nam, motorized two- or three-wheelers represent 95% of all registered vehicles, approximately 7500 newly registered motorcycles each day *(25)*.

Figure 1.1 Global distribution of registered motorized vehicles, 2013



Source: based on *(1)*.

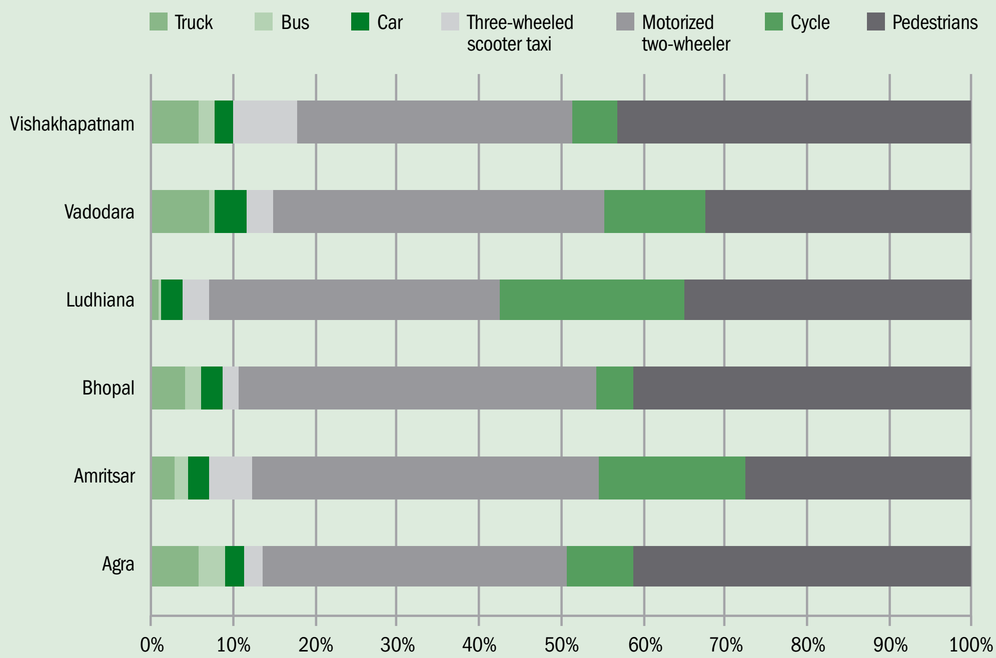
BOX 1.3: **Rickshaws and auto-rickshaws: informal transport sector safety issues, India**

Informal transport systems provide mobility to a large number of urban and rural residents in low- and middle-income countries, often because of a lack of affordable and accessible organized public transport. In India for example, only about 100 of the more than 5000 cities and towns have formal public transport systems. In some settings, ubiquitous but more expensive informal carriers are the only form of public transport available, for example, motorcycle taxis, auto-rickshaws (three-wheeled motorized vehicles), and four-wheeled *jeepneys* and *jitneys (26)*.

When it comes to vehicles for personal use, motorcycles and four-wheeled vehicles are more popular than auto-rickshaws – the three-wheeled motor vehicles that operate as low-cost taxis and fill an important niche in the public transport systems of many cities in low- and middle-income countries. Auto-rickshaws provide last-mile connectivity for a large number of public transport users, including for both metros and buses. They usually have a simple, lightweight chassis with open sides, a canvas top and motorcycle-style engine and controls. There is usually a bench-style seat behind the driver with room for up to three passengers. Some are designed to carry six to eight passengers. The current number of auto-rickshaws in India is between 3 million and 3.5 million, out of approximately 4.5 million globally. In Bangladesh, auto-rickshaws are called baby taxis, in Thailand *tuk-tuks*, and in Indonesia they are known as *bejak*. Diesel-operated auto-rickshaws are now being replaced by battery-operated auto-rickshaws in India and Nepal. This has set the challenge for legislation to keep pace with changing technology, as battery operated rickshaws are not always classified as motorized vehicles, and do not come under the relevant Motor Vehicles Act or comply with the safety requirements demanded of other vehicles.

PTWs such as rickshaws and auto-rickshaws appear to be very vulnerable in traffic streams. Added together, the share of fatal crashes involving PTWs is very high: 70% in Thailand and 60% in Cambodia, Indonesia, Malaysia and Sri Lanka. A detailed study carried out in six cities in India shows that pedestrians represent nearly an equal proportion of road-related fatalities in these cities (see Figure 1.2) *(27)*.

Figure 1.2 Road traffic deaths, by mode of transport, six Indian cities



Source: based on *(27)*.

In all six cities, vulnerable road users such as pedestrians, cyclists and motorized two-wheeler occupants constituted more than 80% of all road-related fatalities. Car occupants constituted less than 4% of fatalities in all six cities and three-wheeler auto-rickshaw occupants constituted less than 5% of fatalities (except in Vishakhapatam, where it was 8%). The study also found that occupant risk per 100 000 vehicles was higher in three-wheelers compared to two-wheelers but when exposure (in terms of estimated kilometres travelled per day) was taken into account, the risk of a fatality was about the same for two-wheelers as three-wheelers. Three wheelers, which are more likely to be taxis than commuter vehicles, are likely to do many more kilometres per day which increases the risk of fatality per 100 000 registered vehicles *(27)*.

Rollover stability – an important safety factor for any vehicle – is generally considered to be poor among auto-rickshaws. One particular study *(28)* provided evidence that the crashworthiness and safety standards of motorized rickshaws needs to be improved. Major modifications on motorized rickshaws (e.g. changing the seat orientation of the passenger from forward- to backward-facing, and using seat-belts) as well as minor changes (e.g. padding hard surfaces) have the potential to reduce the impact of vehicle parts on an occupant's body in case of a crash *(28)*.

1.2.3 Contributing factors to the expanding PTW fleet

Several factors account for the increasing use of PTWs in different parts of the world. In some regions high motorcycle sales are associated with readily available finance and the availability of affordable, low-capacity motorcycles *(29)*. For example, Brazil's growing middle class and a large motorcycle production industry have fuelled a steady rise in the number of motorcycle users. Between 1995 and 2008, the number of motorcycles in Brazil doubled, reaching 2 million in 2008 *(19)*. Other factors contributing to the rise in the PTW fleet include *(18, 23, 29)*:

- growing income levels in different regions;
- an unmet transport demand;
- increasing traffic congestion in urban areas;
- increasing cost of other forms of transport (e.g. in the form of high fuel prices);
- convenience and ease of parking and maintenance; and
- lower fuel consumption.

Air pollution

PTWs have a negative impact on the environment, and so factors such as air pollution should be taken into account when assessing and addressing the role of PTWs in mobility. While this manual focuses on safety, a brief description of the environmental impact of PTWs is nonetheless important (see Box 1.4).

BOX 1.4: **PTWs and the environment**

Transport sector emissions are the fastest growing source of greenhouse gases globally. Air quality is one of the key determinants of health; reducing air pollution by reducing emissions of greenhouse gases through better transport is therefore an effective way to improve health. One way to do this is to improve fuel technology, and a second is to promote a shift in how people and goods are transported.

PTWs' smaller engines have lower fuel consumption than motor vehicles, meaning that a shift to increased use of PTWs from motor vehicles can generally be seen as a fuel-efficient one. However, PTWs (excluding e-bikes) contribute to ground level ozone and particles in the air, as well as other types of pollution that impact human health and welfare. The prolific use of two-stroke fuel (which requires a simpler and cheaper engine type than the cleaner four-stroke fuel) and the use of poorly maintained PTWs in many low- and middle-income countries are both of environmental concern because of the pollution they cause.

Laws requiring engines to be maintained – for example, bans on vehicles that backfire or the requirement that catalytic converters should be fitted at source by the manufacturer when the vehicle is first sold – have been suggested as feasible approaches for low- and middle-income countries to reduce non-e-bike PTW pollution. A diversified package of measures with an emphasis on promoting the safe use of public transport is likely to be the most cost-effective means to reduce greenhouse gas emissions. E-bikes offer a low-emissions alternative to motorized two- and three-wheelers, but they carry the same injury concerns as their motorized counterparts. Manually powered non-motorized bicycles and three-wheelers naturally have the least environmental impact, and offer other benefits to human health through physical activity.

Source: based on *(30–32)*.

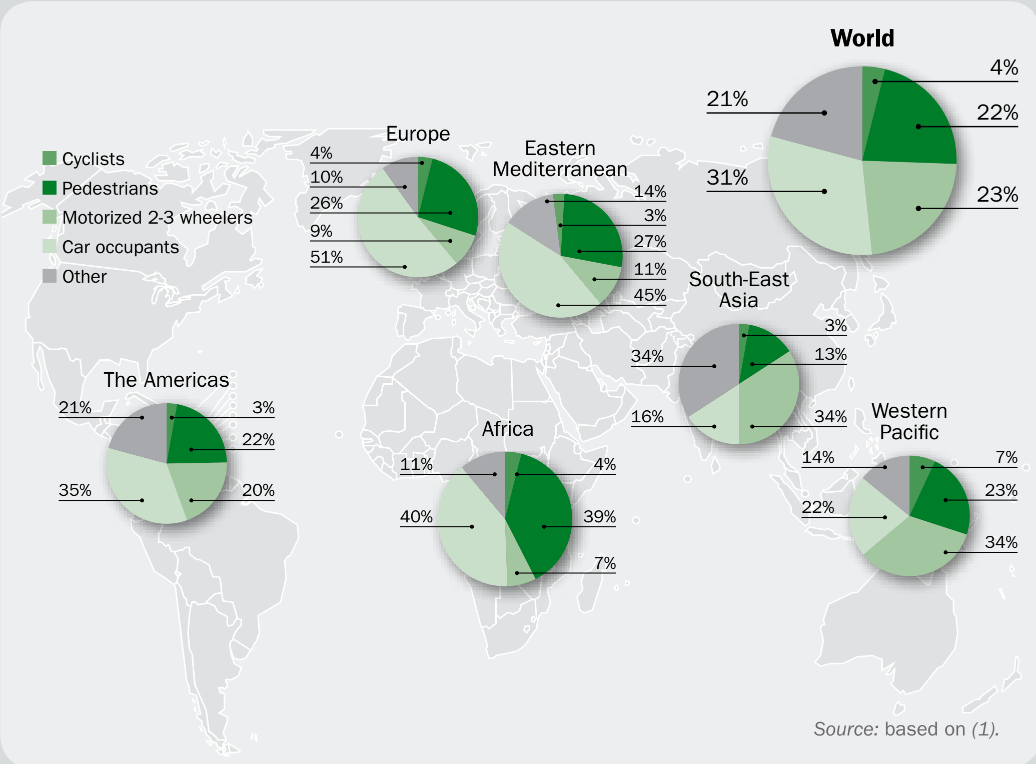
1.3 The PTW-related injury problem

Although PTWs are important for the movement of people and goods, they also pose a substantially increased risk of road traffic crashes. PTWs are a significant contributor to deaths and injuries because of a number of factors, including the large number in use on the roads and users' vulnerability to injury. Compared to cars, PTWs are less visible and PTW users lack nearly all of the protection offered to car occupants. Further details on the many additional factors that contribute to this increased risk are outlined in Section 1.4.

1.3.1 PTW-related injuries and deaths

WHO data show that globally more than 286 000 motorcyclists were killed in road traffic crashes in 2013 *(1)*. This represents almost a quarter of all road traffic deaths in that year. While the majority (90%) of PTW-related deaths globally occurred in low- and middle-income countries, PTW safety is a concern to all regions (see Figure 1.3). Around 17% of road traffic deaths in Organisation for Economic and Co-operation and Development (OECD) countries in 2010 were among PTW users *(18)*.

Figure 1.3 **Road traffic deaths by type of road user, WHO region, 2013**



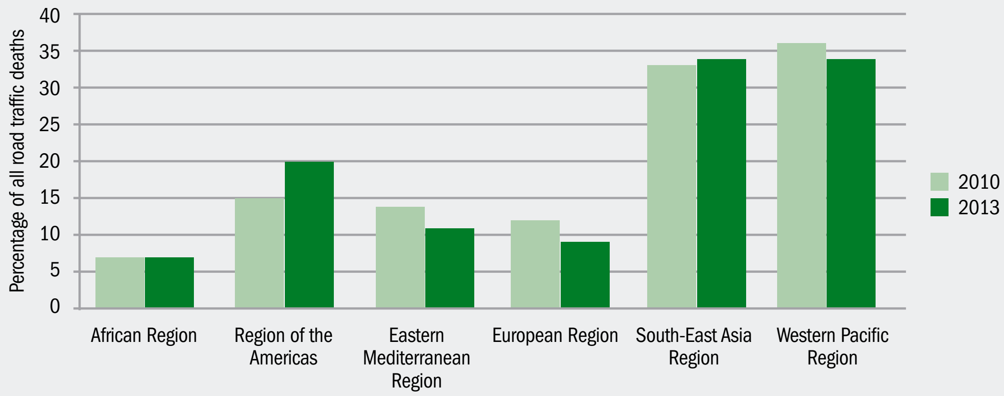
Source: based on *(1)*.

Between 2010 and 2013 the proportion of motorcyclist deaths remained largely unchanged in the African Region and South-East Asia Region, while there was a slight decrease in motorcyclist deaths in the Eastern Mediterranean Region, European Region and the Western Pacific Region. The Americas Region is the only region that saw an increase (see Figure 1.4).

Fatality data for different regions as reported in the *Global status report on road safety 2015 (1)* indicate a large variation within regions in the proportion of PTW fatalities:

- While African countries, on average, had the lowest proportion of traffic-related fatalities among PTW users (7%), some countries in the region had a proportion of PTW fatalities as high as those of the South-East Asia Region and Western Pacific Region.
- In Cambodia and Thailand, where there is a large PTW fleet, motorcycle fatalities in 2013 accounted for 70% and 73% of total road fatalities respectively, while in the same region, in high-income countries such as Australia and the Republic of Korea, motorcycle fatalities accounted for less than 18% of all traffic-related deaths *(1)*.

Figure 1.4 **Proportion of motorcyclist deaths by WHO region**



Source: based on *(1, 25)*.

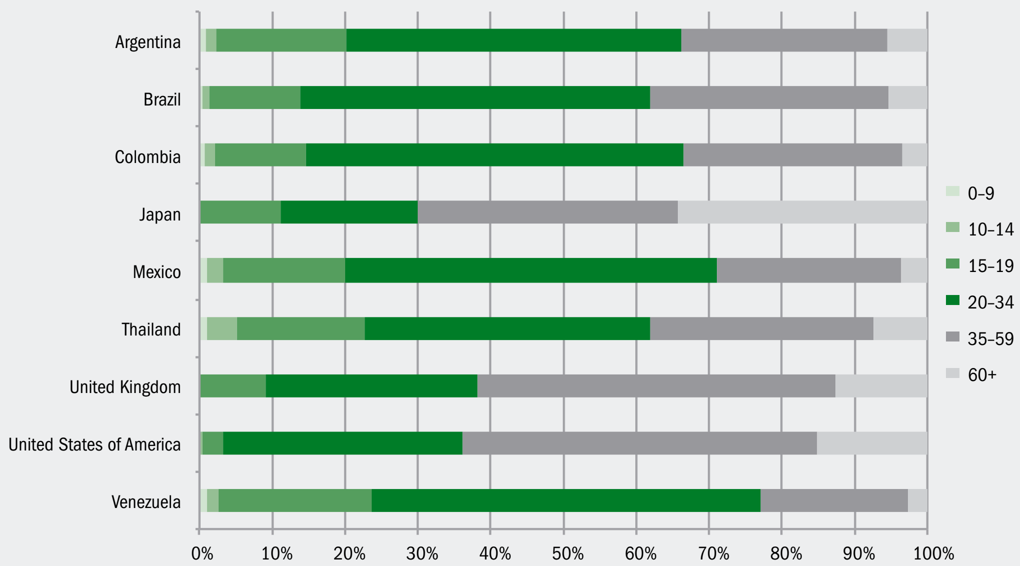
1.3.2 Demographic characteristics of PTW users killed and injured in road traffic crashes

The demographic and socioeconomic profile of seriously and fatally injured PTW users greatly varies by region and country-income level.

- In low- and middle-income countries, most PTW users are aged 15–34 years, while in high-income countries, PTWs are widely used by people aged 35 years or older. As such, in low- and middle-income countries the majority of PTW crash casualties are those in their most productive years of life, with a mean age of 25 years. The peak age for motorcycle-related injury in low- and middle-income countries is in the early to late twenties *(18)*.
- The majority of fatalities in low- and middle-income countries also fall into the same young adult age group (i.e. aged 15–34 years), while in high-income countries the mean age for PTW users killed as a result of a crash is about 55 years. This profile in high-income countries partially reflects how PTWs are used more as recreational vehicles than in low- and middle-income countries, where they are used as the primary mode of transport *(18)*.

Figure 1.5 shows data for most recent year available from selected countries on the distribution of PTW-related deaths by age group, highlighting the variation between countries. In low- and middle-income countries (such as Argentina, Brazil, Colombia, Mexico, Thailand and Venezuela), young adults aged 15–34 years accounted for over 60% of all of PTW-related deaths. In high-income countries (such as the United States of America (USA) and the United Kingdom), almost 50% of the deaths occurred in adults aged 35–59 years; in Japan, those aged over 60 years accounted for 34% of deaths whereas those aged 35–59 years accounted for 36%.

Figure 1.5 Age distribution of PTW users killed, selected countries



Source: based on *(33)*.

Studies from low- and middle-income countries reported that among riders aged 17–19 years, those from lower income groups had an injury rate 2.5 times greater than those from higher socioeconomic groups *(18, 19, 34)*. In the countries examined in these studies, the majority of motorcycle crash injury victims were self-employed and had no social or health insurance cover *(12, 18, 19)*.

1.3.3 Where do PTW crashes occur?

In countries of all income levels, PTW crashes occur most often in large cities and other urban areas. In terms of absolute risk of crashes, low- and middle-income countries have experienced a significant increase in road trauma in urban areas. Large increases in PTW use, combined with these vulnerable road users sharing the roads with a growing number of cars and other motor vehicles, are major contributing factors to this increase *(35)*.

Two studies in Tanzania reported that most PTW crashes (between 75% and 84%) that resulted in the injured motorcyclist being treated in a health facility occurred on tarmac or paved roads *(36, 37)*. One of these studies reported that higher traffic density on such roads contributed to the reported crashes *(37)*. In high-income countries such as France, it has been reported that PTWs account for almost a quarter of all urban crashes resulting in injury, despite the relatively low level of PTW use (1.4% of all weekday travel) *(38)*.

There is evidence that compared to urban areas, traffic crashes in rural areas may have a two to three times higher case fatality rate and hospitalization rate, even after controlling for injury severity *(39, 40)*. There are indications that the time it takes to receive medical care may be a contributing factor to this *(41)*.

1.3.4 When do PTW-related deaths occur?

Day and night-time travel have distinct risks for PTW users (see Module 2). In low- and middle-income countries, PTWs are often used for business, providing public transport services or being used as delivery vehicles. Accordingly, most crashes occur during daytime business hours. Night-time crashes associated with missing and faulty headlights are also reported in some countries *(42)*.

1.3.5 Costs of road traffic injuries associated with PTW use

The costs of PTW-related crashes are borne by the individuals involved in the crash and their families; the health-care system that provides care and rehabilitation services; and society in general, through increased carer and infrastructural needs and support services, and productivity losses. Data from high-income countries on the cost of acute treatment and care, and reimbursement issues for uninsured PTW-user casualties, highlight the high burden that treating PTW-related incidents places on the health-care system. A recent study of 323 e-bike injuries admitted to hospitals in China estimated an average treatment cost of US$ 1286 *(12)*. Non-use of helmets increases injury severity, the duration of hospital stay and intensive care treatment, as well as the chance of the final outcome being severe disability or mortality *(43)* (see Box 1.3 on the emerging public health issue in China). Non-use of helmets adds to the cost of treatment. When looking at acute care cost savings from prevention efforts, studies show that the costs of medical care are estimated to be 40–66% lower for patients who were wearing a helmet at the time of the crash than those who were not *(44, 45)*.

1.4 Risk factors for PTW-related injuries

The key risk factors that contribute to PTW-related crashes, injury and death are associated with the road user, the road environment, the vehicle and the standard of available trauma services. These factors, which are key pillars of the Safe System approach, are summarized here. Intervention measures to address these risk factors are described in Module 3.

1.4.1 Risk factors related to the road user

Road user-related risk factors concern the behaviour of riders as well as other road users with whom they interact in the traffic environment. Although some of the most common road user-related risk factors (such as speeding, drinking and driving, and lack of experience) apply to all road users, there are some behaviours specific to PTW users that put them at increased risk of fatal crashes or injuries.

Non-use of helmets

The non-use of helmets by PTW users is an important factor influencing the risk of road traffic crash-associated head injuries and fatalities. Injuries to the head and neck are among the main causes of death, severe injury and disability among PTW users. During a PTW crash there may be two principal mechanisms of injury to the brain: through direct contact with a surface or other object, and through acceleration–deceleration forces *(46)*. Each mechanism causes different types of injuries. The purpose of a helmet is to reduce the risk of serious head and brain injuries by reducing the impact of force to, or collision with, the head. The risk of head injury and fatality also varies according to the quality of the helmet and face coverage – while not wearing a helmet is a risk factor, it is important to point out that wearing poor quality and non-standard helmets also put the rider at increased risk of head injury and fatality in the case of a crash.

Alcohol (drinking and driving)

Impaired driving due to alcohol consumption is an important factor influencing both the risk of a road traffic crash as well as the severity and outcome of injuries that may result from it *(47–52)*. According to the European SARTRE4 study on road safety attitudes, European motorcyclists from several countries reported drinking and riding, although there were significant regional differences in frequency between northern, eastern and southern European countries. In general, declared drinking and riding was higher among the following groups: males; those with increased exposure (amount of riding); those who tended to underestimate their risk of crashing; people who had been involved in a previous crash or had incurred a penalty for riding under the influence of alcohol *(53)*.

Alcohol consumption is also associated with other risky PTW rider behaviours, such as speeding and non-use of helmets *(54–57)*. A study in Australia showed that motorcyclists involved in crashes due to intoxication had the highest average length of admission and the longest average periods with disability before returning to their previous occupation, compared to a number of other causative factors for rider error and loss of control *(51)*. Although limited, there is some evidence from low- and middle-income countries on the impact of alcohol on driving performance. In one hospital-based study of PTW-related injury cases in Sri Lanka, the majority (67%) of night-time crashes were related to alcohol *(58)*.

Speed

Excessive and inappropriate speed is the leading cause of road trauma in many countries *(59, 60)*. The higher the speed at which a vehicle travels, the longer the stopping distance. The lack of protection for PTW users during a collision means they are particularly vulnerable to severe or fatal injury associated with excessive speed. Speed is implicated in a higher proportion of fatal motorcycle crashes compared to other road users, which makes speed a particularly important risk factor for this road-user group *(18)*. In the USA in 2013 for example, 34% of all motorcycle riders involved in fatal crashes were speeding, compared to 21% for car drivers, 18% for light truck drivers and 8% for large truck drivers *(61)*. Other research has shown that motorcyclists – particularly those riding sports bikes – drive faster, and engage in extreme speeding more often than other road users *(62)*. Speeding is also reported as a factor in PTW crashes in segregated motorcycle lanes *(63)*.

Rider's age and level of experience

Young and older riders have a higher risk of injury. While the increased crash risk among young riders is predominantly associated with their lack of experience and greater propensity to adopt risky behaviours, the increased injury risk and injury severity among older riders tends to be associated with physical fragility and decrease in riding practice (i.e. the distance ridden every year). Riding ability and performance of older riders has been shown to decrease in riders over 60 years of age *(18, 64–66)*. For young riders, factors relating to their physical state and condition, motivations, riding style and awareness of other road users may also put them at increased risk of crashing *(18)*.

Being unfamiliar or inexperienced with motorcycles and the road environment as a rider are associated with an increased risk of crash involvement *(67–71)*.

Braking errors

In emergency situations, riders often fail to use full braking capacity. Braking errors lead to loss of control of the PTW, putting both the rider and any passenger(s) at an increased risk of serious injury and death *(72–74)*.

Drug use

Studies that looked at the relationship between riding and drug use found that riding under the influence of a drug increases the risk of fatal crash *(18)*. Studies that looked at the prevalence of different types of drugs used by injured riders in OECD member countries showed that the proportion of drivers consuming drugs was higher among PTW riders than car drivers *(18)*.

Other risk-taking behaviour

Risky behaviours of PTW riders include: high acceleration, very high speeds, lane splitting or "zigzagging", competing, and aggressive behaviours. These put PTW riders and other road users at increased risk of road traffic injury and death. Different types of risky behaviours are specific to different modes of PTW use (see Table 1.1).

Lack of conspicuity

Situations in which the motor vehicle driver may have looked but failed to see the approaching PTW have been documented as among the most significant contributing factors to PTW crashes in high-income countries such as the UK *(75, 76)*. An increase in approach speed by motorcycles contributes to a higher number of "looked-but-failed-to-see" crashes at intersections, likely due to the motorcyclist being outside the other driver's field of view at the time *(77)*.

Because of their smaller size and rapid acceleration, PTWs are often not seen in time to avoid a collision. Problems of other road users detecting approaching PTWs at junctions, and right-of-way-violations, are some of the problems that can lead to crashes. The more conspicuous PTWs can be, the more likely they will be seen by other motorists *(75–78)*.

Table 1.1 Relationship between the main purpose of motorcycling and type of risky behaviours

Motivation for use	Characteristics	Justification for use	Type of risky behaviors
Convenient vehicle for commuting	Young and older riders	• Economical • Easier to park • Only means of transportation for self and family	• Most do not use a helmet • Disobeying traffic rules • Illegally giving rides to family/children without the use of a helmet
Occupational transportation needs	Young and older experienced riders	• Economical • Easier to park • Mandated by employers	• Illegally transporting cargo and passengers • Not using a helmet when employers do not mandate • Disobeying traffic rules
Recreation and sensation-seeking	Youth unlicensed riders	• Challenge, push limits (aggressive competition, racing), recreation (hobby)	• Engaging in aggressive competition, speeding, and performing stunts • Driving while under the influence of drugs/alcohol
Criminal activity	Young unemployed and unlicensed riders	• Organized and individual-based crime	• Unlikely to use a helmet • Riding with peers • Riding in high school and areas where young people gather • Unlikely to use a helmet • Disobeying traffic rules • Driving while under the influence of drugs/alcohol • Hit and run

Source: based on *(79)*.

1.4.2 Risk factors related to the road environment

Mixed traffic

Operating PTWs in mixed traffic (i.e. with no segregation) significantly increases the likelihood of PTW collisions. In countries where there is a large PTW fleet, mixed driving conditions (in which interaction between PTWs and larger vehicles is frequent) result in an increased crash risk *(80–82)*. Traffic conflict is the most common causative factor in PTW crashes *(83–85)*. An increase in traffic volume on both major and minor roads, as well as at junctions, increases the exposure of PTWs to other vehicles moving at different speeds and, consequently, increases the likelihood of crashes *(86, 87)*. In high-income countries particularly, low familiarity with PTWs for some car drivers – as well as challenges in detecting PTWs and judging their speed – can make the mixed traffic environment dangerous for PTW users *(88, 89)*.

While some countries or jurisdictions do not permit it, lane-sharing by PTWs and other traffic, also known as lane-splitting or filtering, is common in many countries. There are reports of advantages of lane sharing in terms of reducing traffic congestion and travel time by PTW riders – with associated economic and environmental benefit *(90)*. There are few studies available, however, that have examined the risk to PTW riders' safety posed by lane sharing. The main safety concern is associated with the movement of other vehicles into the path of the PTW rider, when the drivers have not seen or are not expecting the PTW to be there *(91)*. One review of lane sharing indicated that this practice is associated with between less than 1% and up to 5% of motorcycle crashes, although the relative risk does not appear to have been the focus of the research *(90)*. As traffic congestion is set to increase in most urban areas of the world, there is increasing pressure for lane sharing by PTWs.

Design of road infrastructure

Road infrastructure design (such as road geometry, road layout) can influence both the likelihood and severity of a motorcycle crash *(81)*. Studies have shown that motorcyclists are particularly vulnerable to collisions on curves, bends, slip roads (i.e. roads with a tight radius) and roundabouts. This is mainly due to acceleration or deceleration, or where stability is at stake, making loss of control likely. Intersections and roundabouts are commonly associated with motorcycle crashes involving right of way violations *(76)*, an increase in approach speed *(85, 87)*, and violating traffic signals *(92)*. However, a recent study using data from Australia and New Zealand demonstrated that the risk of motorcycle crashes on curves and other road features such as intersections or straight roads also varies by travel purpose (commuting or recreational) *(93)*. The study showed that a higher proportion of crashes occurred on curves during the recreational period while most of the crashes on straight roads and at intersections occurred during the commuting period *(93)*. The same study demonstrated that road infrastructure design can have an impact on crash severity.

Specific design elements identified as contributing to increased severity include lane and shoulder width, surface friction, curve type and radius, horizontal and vertical sight distances, and turning provisions, including signal phasing at intersections *(93)*.

Other poorly designed road treatments, such as ones dedicated to lowering the speed of other road users, and the choice of location of other roadside equipment used for lighting or signage, can also have a negative impact on PTW safety *(18)*.

Road surface conditions

The road surface condition presents a unique level of crash risk to PTW users *(93)*. Uneven road surfaces, deterioration, potholes, unpaved curbs, manhole covers, bumps, drainage, spillages, poor road markings and debris are road surface factors that have been shown to increase the risk of PTW crashes *(42, 94, 95)*.

Roadside hazards

Roadside hazards can be fixed roadside objects such as trees, sign posts, guardrails, utility poles and drainage structures, as well as transient objects such as parked cars, and they all present the greatest risk to PTW users. A crash involving a fixed roadside hazard is 15 times more likely to be fatal than a crash on the ground with no physical contact with a fixed hazard *(96)*. The severity of a PTW crash with a roadside object is dependent on collision speed, impact angle, the surface area of the object and the impact absorption properties of the object *(93)*. In a study that looked at such risk factors, combined with speed, roadside objects were the primary mechanisms by which fatal injuries were sustained by motorcyclists *(97)*. Another study using data from Australia and New Zealand concluded that almost all roadside objects are hazardous to PTW users *(93)*. This is mainly due to the fact that all objects have been designed for safety of cars and their occupants rather than for PTWs.

1.4.3 Risk factors related to the vehicle

PTW stability

The stability of PTWs depends on travel speed and on there being sufficient friction between the tyres and the road *(72)*. Certain types of PTWs can become unstable when the available friction limit has been exceeded (such as on wet roads) or when acceleration or braking forces are too high *(72)*. Unlike four-wheeled vehicles, motorcycles have the ability to lean during cornering. The roll angle that occurs while a rider is leaning during cornering is very sensitive to any changes in applied force, and any sharp increase or decrease in roll angle may lead to loss of control and thus to increased crash risk *(72, 98)*.

Lack of crash protection

The inherent lack of crash protection to PTW riders and passengers puts them at a higher risk for traffic-related injuries and deaths *(28, 99, 100)*. The injuries sustained tend to be more serious in PTW users than car occupants because of this lack of protection. In addition to head injuries, the lower extremities (including the pelvic region) are the second most commonly injured part of the body among motorcyclists who have crashed *(69, 101)*.

1.4.4 Other risk factors

Lack of inclusive urban planning

The rapid growth of cities and urban populations has outpaced the development of urban transport infrastructures that cater to PTWs, resulting in an increase in PTW fatalities *(102)*.

Limited public transport infrastructure

Lack of alternative means of transport in urban settings in low- and middle-income countries limits commuter choice. The increase in the demand for (and use of) PTWs increases the pressure on urban infrastructure, with competition for space on roads shown potentially to further exacerbate the risks of injury and death among riders *(102)*.

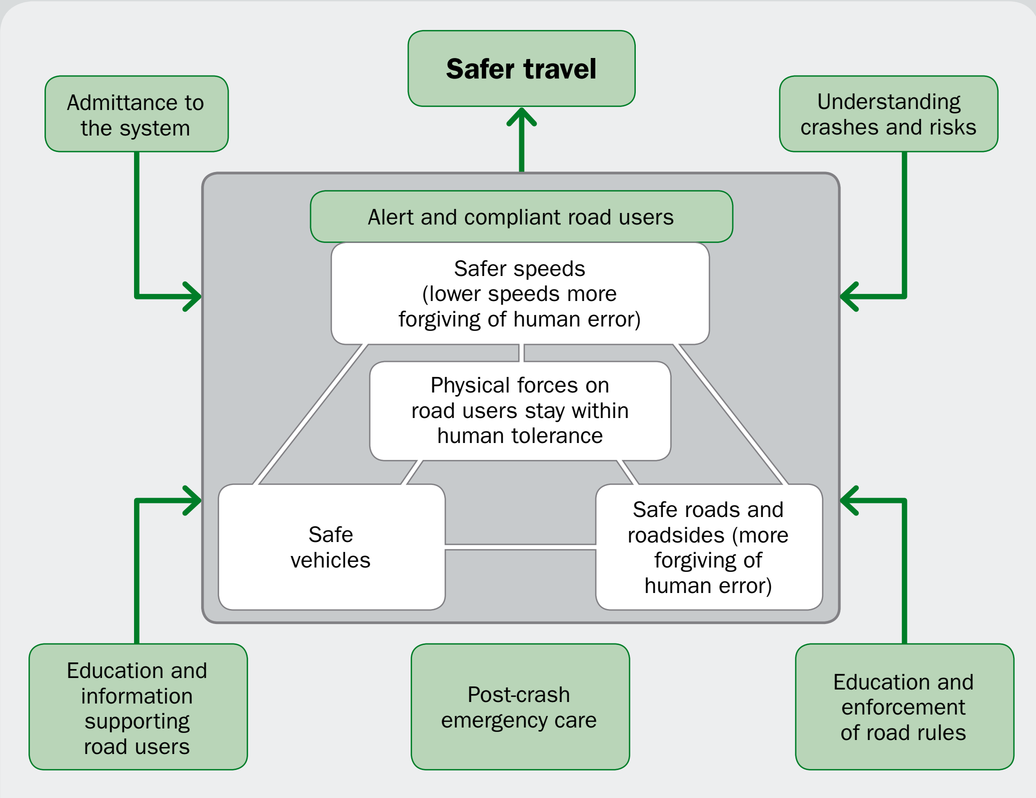
1.5 The Safe System approach and PTW safety

Road traffic injuries should not be accepted as inevitable *(47)* and there are measures that can be implemented to improve the safety of PTW users and other road users. However, this requires identifying and measuring the contributing risk factors. The Safe System approach (see Figure 1.6) addresses risk factors and interventions related to road users, vehicles and the road environment, and post-crash response, in an integrated manner *(103–105)*.

The Safe System approach to road safety recognizes that transport is important to society, and that travel should be safe for all road users while they interact with roads and vehicles. The Safe System approach aims to eliminate fatal crashes and reduce serious injuries through provision of a safe transport system that is forgiving of human error and takes into account people's vulnerability to serious injury. This is done through a policy focus on road infrastructure, vehicles and travel speeds, and is supported by a range of activities in education, regulation, enforcement and penalties.

The Safe System approach has been shown to be applicable in several settings around the world – in some cases facilitating road safety gains where progress had stalled *(106)*.

Figure 1.6 The Safe System approach



Source: based on *(107)*.

The key principles of the Safe System approach are summarized as follows *(103)*:

- **Recognition of human error in the transport system.** People will make mistakes in traffic that can easily lead to injuries and death. The Safe System approach does not ignore road user behaviour interventions but emphasizes that behaviour is just one of many essential prevention focus areas.
- **Recognition of human physical vulnerability and limits.** People have a limited tolerance to violent force, beyond which serious injury or death occurs.
- **Promotion of a systems approach.** Combined road safety measures yield better results than single measures.
- **Promotion of a shared responsibility.** Responsibility for traffic safety must be shared between road users and system designers. While road users are expected to comply with traffic regulations, system designers and operators have a responsibility to develop a transport system that is as safe as possible for users.
- **Promotion of ethical values in road safety.** The ethical value underlying the Safe System approach is that any level of serious trauma arising from the road transport system is unacceptable. Humans can learn to behave more safely, but errors will

inevitably occur on some occasions. The errors may lead to crashes, but death and serious injury are not inevitable consequences.

As noted in the Decade of Action on Road Safety, 2010–2020 *(105)*, the principles of the Safe System approach are upheld via coordination across five pillars of action: road safety management, safer roads and mobility, safer vehicles, safer road users and post-crash response. The approach sees a shift from the view of individual responsibility of the road user to a shared responsibility by many different arms of government, politicians, NGOs and industry. The approach aims to not only reduce road user errors, but importantly to reduce the risk of serious injury if an error occurs – through coordinated planning addressing all pillars of action.

The Safe System approach has several benefits as a framework for PTW safety:

- **Examination of a range of risk factors**. PTW safety should be researched from a systems point of view to allow for consideration of the many factors that expose riders to risk, such as vehicle speed, poor road design and maintenance, and inadequate enforcement of traffic laws and regulations. Effective planning for PTW safety requires a comprehensive understanding of the risk factors involved. It is difficult to achieve this understanding, however, when research focuses only on one or two risk factors. The Safe System framework moves PTW safety research away from a narrow focus on one or just a few risk factors.
- **Integration of comprehensive interventions**. Improving PTW safety requires attention to vehicle design, road infrastructure, traffic controls such as speed limits, and enforcement of traffic laws and regulations – the focus areas that comprise the Safe System approach. A narrow focus on any single aspect is less effective than taking an integrated approach to the multiple factors involved in PTW safety.
- **Collaboration among agencies**. While different agencies may have responsibility for specific aspects of PTW safety, the reality is that a coordinated approach, involving collaboration among policy-makers, decision-makers, researchers, political leaders, civil society and the public, is required in order to improve PTW safety. Collaboration may take many forms, including sharing responsibilities or activities in a PTW safety programme.

Summary

The information in this module can be summarized as follows:

- The PTW fleet is growing in most parts of the world, attracting an increasingly large and varied user population.
- The global registered PTW fleet increased by 16% between 2010 and 2013.
- PTWs are becoming one of the main means of transport used to move people and goods in many low- and middle-income countries. Their use in high-income countries is more mixed.
- PTW users account for almost a quarter (23%) of global road traffic deaths. There is great variation between and within regions in the distribution of deaths by road user category.
- Key risk factors for PTW traffic injury are: non-use of helmets, use of alcohol and drugs, speeding, traffic mix, roadside hazards, vehicle stability and braking errors.
- Effective planning for PTW safety requires a comprehensive understanding of the risk factors involved in different settings. The Safe System approach has several benefits as a framework for examining key PTW risk factors and approaches to prevention.

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2

Conducting a situational assessment

Conducting a situational assessment

Module 1 shows that PTW safety varies between and within regions and countries, and that many factors contributing to the increasing burden and risk need to be addressed. A comprehensive situational assessment is required to decide which actions and interventions are needed to address PTW safety.

This module addresses the following questions:

- What is a situational assessment?
- Why is a situational assessment needed?
- What does it assess and what are the components?
- How are the findings of a situational assessment used to plan for increasing PTW safety?

A summary of interventions that can be implemented to improve PTW safety are presented in Module 3.

2.1 What is a situational assessment?

A situational assessment involves a series of activities related to the gathering, review, analysis and interpretation of information necessary to understand a given road safety situation for a defined population *(1)*. An effective PTW safety situational assessment will employ a detailed and methodical examination of the magnitude of the problem, risk factors, prevention needs, the policy environment, existing programmes and stakeholders involved. The assessment will examine each element as well as the interactions and interrelationships between the different elements, and the environment in which each element exists *(2)*. A situational assessment requires the systematic gathering and examination of key data on the following:

- **The magnitude of the problem of PTW crashes** – such as the number of injuries, fatalities, disability, and cost, together with the trends and patterns of crashes, injuries and fatalities.
- **The risk and protective factors for PTW-related injuries** – what puts people in this region, subregion or country at risk of these injuries, and what factors reduce that risk?
- **The context of PTW-related injuries** – what characteristics of the transport infrastructure, local politics, public perceptions and social norms are likely to impact the risk of injury due to PTW crashes and the likelihood of adoption of possible strategies to reduce the risk?
- **Interventions already in place** – including: existing PTW-related polices and their enforcement, programmes in place, and strategies that have already been adopted to promote a safer environment for PTW users.

- **The partners or stakeholders** that will be central to the planning and implementation of safety measures. What is their capacity to address this issue? What are their concerns? What is their level of commitment? Are there any existing examples of these partners working together?

The situational assessment will often be for a defined location and based on a given PTW road safety objective or set of objectives. Both the location and the objectives will define the depth and scope of the assessment.

2.2 Why is a situational assessment needed?

A situational assessment provides key information that will inform the prioritization and help make decisions about managing, reducing or preventing PTW crashes, injuries and fatalities.

A situational assessment helps to:

- **Identify the problem and the priorities for action.** Analysis of information gathered will illustrate the types of injuries common among PTW users in a given area; where the greatest needs for intervention are; the cost to PTW users of compliance (and non-compliance) with a specific intervention; and the reasons why PTW users do or do not comply with road safety laws.
- **Provide evidence on why a specific intervention should be supported.** Successful PTW safety programmes need the support of all stakeholders, especially policy-makers, PTW users and the general public. Accurate data on the burden in a given project area and the potential of the proposed intervention to reduce this burden will help show policy-makers what can be gained by implementing evidence-based, effective interventions.
- **Provide baseline data and evidence of progress on key programme monitoring and evaluation indicators.** Monitoring and evaluation (M&E) is an integral component of any PTW safety strategy. Data from the situational assessment help define baseline M&E indicators. Such indicators range from outcome measures (such as deaths and injuries) to process measures linked to specific interventions (such as compliance with legislation and public opinion on a given PTW policy). Continued support for a specific action often relies on being able to provide evidence that things are moving in the right direction *(1)*.

2.3 What is assessed and what are the components of a situational assessment?

A comprehensive situational assessment involves the systematic gathering of information on the magnitude of the problem of PTW crashes, injuries and fatalities; risk factors for these outcomes; and the prevention needs, opportunities and barriers (i.e. the context of implementing change to reduce PTW-related injuries). This information can be gathered through four types of assessment:

- **Epidemiological assessment**: provides information on the magnitude of the problem, risk and protective factors.
- **Policy assessment**: allows analysis of contributing and facilitating factors as well as identification of gaps in existing policies, laws and regulations.
- **Intervention assessment**: appraises past and current interventions.
- **Stakeholder and target group assessment**: systematically maps supportive, neutral and opposing partners and their capacity to engage in change.

2.3.1 Assessing the burden of PTW-related injury and death

Identifying the number of PTW-related injuries and deaths and their context, and how they compare to deaths among other road user groups, is a starting point for any PTW safety planning. Having detailed information on the burden of PTW-related injuries and deaths provides evidence that can contribute to appropriately designed and targeted interventions that will lead to measurable outcomes. Such types of assessment, referred to as epidemiologic assessments, involve a scientific study of the occurrence, distribution, causes and risk factors of PTW-related injuries and deaths in a given population *(3)*.

The epidemiologic assessment is done by:

- measuring the incidence of PTW-related injuries and fatalities;
- defining the age and sex distribution of people that suffer PTW-related injuries and fatalities;
- describing the times and places where PTW-related injuries and fatalities occur;
- analysing the causes, risks and protective factors involved; and
- assessing the consequences of PTW crashes.

Depending on the availability of data, the following variables can be considered for an additional assessment:

- **Time:** on what day of the week and at what time of day do most PTW crashes occur?
- **Severity:** how serious are the PTW-related injuries (types of injury by severity and fatalities)?
- **Cost:** how big is the PTW problem in terms of health and socioeconomic costs?
- **Disability:** what type of PTW crashes lead to disability or life-threatening outcomes?

The extent of the epidemiologic assessment in a given setting will be limited by the availability of information. In most low- and middle-income countries, the availability of data on a particular road user group (which includes the number of PTW-related injuries and deaths), the circumstances leading to them and data on intervention coverage (such as the helmet-wearing rate) are often missing. According to the *Global status report on road safety 2015,* less than a quarter of the 180 countries responding to the WHO survey concerning their official road traffic data had combined data on fatal and nonfatal road traffic injuries, while only 41% of countries reported data on their motorcycle helmet-wearing rates *(4)*. Even if data are available on the number of road traffic injuries and deaths, often data systems are not sufficiently well developed to allow for the disaggregation of data by road user type (e.g. PTW, pedestrian) in order to conduct a comprehensive epidemiologic assessment. It may be expected that helmet-wearing rates vary enormously within countries, as well as between countries. In such circumstances it may be helpful to look for secondary data sources or other context-specific local data from research projects. Despite their limitations, the most easily available, accessible and immediately relevant data sources tend to be used first (see Table 2.1 for key sources of road traffic injury data.) In settings where there are no data, or where routinely collected data sources do not provide adequate information, new information on key indicators may be collected through purpose-built surveys.

2.3.2 Assessing existing PTW policies, laws and regulations

A policy environment assessment seeks to provide an understanding of the types, characteristics and specifics of existing road safety policies, laws and regulations (and any gaps in these), and the context within which legislative and policy changes can be made *(5)*. The assessment can reveal the adequacy of existing laws and/or their enforcement, and is thus a necessary step in defining the direction of future PTW policies. Enacting PTW-related laws, however, is influenced by many factors, including: the policy environment and the political will of policy-makers; the resources made available by the government for their enforcement; and the acceptability of the laws to a majority of the public. As such, planning and implementing a comprehensive policy environment assessment should be carried out in a step-wise or systematic manner, to ensure all factors are taken into account. The steps are summarized in Box 2.1.

The scope of the task of conducting a policy assessment will vary between countries. It is important that the approach is tailored to the context in which the new or amended policy will be adopted, and the specific objectives of the policy that serve to enhance the safety of PTW riders in that nation, region or subregion. For effective use of findings it is also important that the analysis provides some insight about the institutions primarily responsible for the formulation and enforcement of the law and regulation. See Box 2.2 for an example of the use of information from a policy analysis to inform policy change related to motorcycle helmet standards in Kenya.

Table 2.1 Key sources of road traffic injury and incident data

Source	Type of data	Observations
Police	Number of road traffic incidents, fatalities and injuries PTWs involved, other vehicles involved Age and sex of casualties Police assessment of cause(s) of crashes Use of safety equipment (e.g. helmets) Locations and sites of crashes Prosecutions/enforcement activities	Level of detail varies from one country to another, and there are typically large in-country differences too Police records can be inaccessible Underreporting is a common problem Precise location data (e.g. map coordinates) may not be available
Health settings (hospital in-patient records, emergency room records, trauma registries, ambulance or emergency technician records, health clinic records, family doctor records)	Fatal and nonfatal injuries Age and sex of casualties Nature of injury Type of care provided Alcohol or drug use	Level of detail varies from one hospital to another Cause of injury may not be properly coded, making it difficult to extract road traffic injury data for analysis Information on the injured person may not be disaggregated by type of road user
Vital registration	Fatal injuries Age and sex of casualties Type of road user(s) involved	Completeness and comprehensiveness varies between countries Cause of death may not be properly coded, making it difficult to extract road traffic injury data disaggregated by road user for analysis Population coverage may be poor
Government departments and specialized agencies collecting data for national planning and development	Population estimates Income and expenditure data Health indicators Riding exposure data (e.g. kilometres travelled) Pollution data Energy consumption Literacy levels	These data are complementary and important for analysis of road traffic injuries The data are collected by different ministries and organizations (although there may be one central agency that compiles and produces reports, including statistical abstracts, economic surveys and development plans). These data can be important for planning interventions and garnering support for these interventions
Special interest groups (research institutes, nongovernmental advocacy organizations, victim support organizations, transport unions, consulting firms, institutions involved in road safety activities, insurance companies and others)	Number of road traffic incidents, including fatal and nonfatal injuries Type of road user involved Age and sex of casualties Vehicles involved Causes Location and sites of crashes Social and psychological impacts Risk factors Interventions Insurance claims/costs	The various organizations have different interests and data collection and research methods may not be reliable

BOX 2.1: **Steps for conducting an assessment of road safety laws and regulations**

Step 1: Conduct an institutional assessment

Identify the national and state or provincial bodies responsible for road safety and their roles and responsibilities with respect to initiating and implementing legislation and regulation.

Step 2: Review national laws and regulations

Review all existing national road safety laws and regulations and any amendments being prepared.

Step 3: Assess gaps in laws and regulations

- Are there inconsistent or conflicting provisions in the law?
- Are there too many exclusions and exceptions to the law or regulation?
- Do laws or regulations cover all the risk factors?
- What challenges do the problems identified present to enforcement?
- Can the provisions of the law be implemented or enforced?
- Does the law achieve the purpose for which it was enacted, on the basis of data analysis and other information?

Step 4: Assess the comprehensiveness of laws and regulations

Assess comprehensiveness for the five main risk factors:

- Are they based on evidence?
- Do they include enforcement provisions?
- Do they include appropriate penalties?

Assess the comprehensiveness of laws and regulations relating to post-crash care, bearing in mind it is part of a wider system of trauma care in a country:

- Conduct a rapid assessment of the institutional framework for trauma care.
- Ensure that laws and regulations address the topics generally covered in a mature trauma care system.

Source: based on *(5)*.

BOX 2.2: **Motorcycle standard helmet promotion, Kenya**

Policy assessments should be tailored to the context in which the new or amended policy or law will apply, and provide insight into the institutions that will be mainly responsible for its formulation and enforcement. A good example of this was in Kenya in 2012, when a national, multisectoral committee on road safety (including representatives from the Ministry of Transport, Ministry of Health, police, a safety NGO and the Kenya Bureau of Standards – KEBS) identified revision of the national helmet standard (KS-77) as a priority and pre-requisite for the promotion of a helmet product safety standard in Kenya.

The revision of KS-77 took place over 18 months and involved a technical review of existing helmet legislation; an expert meeting to review national existing road safety legislation; and expert input requiring that helmets meet a recognized safety standard to more effectively reduce head injuries during a crash.

A draft standard developed by KEBS was shared with the working group for input and a revised document was widely circulated for public review. A revised standard was approved in September 2012, but implementation has been postponed until quality helmets meeting the standard are more widely available.

Source: based on *(6)*.

2.3.3 Assessing existing PTW interventions and programmes

An intervention or programme assessment takes stock of existing and potential PTW prevention programmes and PTW initiatives. It is important to have this information in order to inform the prioritization process and, ultimately, mobilize the support of stakeholders for maximum uptake of new initiatives. Unlike the epidemiologic assessment described in Section 2.3.1, the intervention assessment is used for defining and prioritizing possible areas of intervention. It requires an understanding of the current situation in terms of programme implementation and is particularly important to minimize duplication of efforts and ultimately maximize the impact of any PTW-related injury prevention effort. Some of the issues that the interventions assessment can address regarding existing PTW safety intervention programmes include the following:

- **The status of past and existing programmes and interventions:** what is already being done in the country, municipality, state or province?
- **The types of interventions and implementation level:** which interventions have been implemented and tested in the locale? What is the level of implementation for each (i.e. national, regional or local)?
- **The effectiveness of existing programmes:** what is their potential effectiveness (based on available evaluation findings or latest research data)?
- **Gaps in knowledge:** which key information areas are lacking in relation to target groups?
- **Available resources:** is there an allocated government budget for road safety and, specifically, for PTW safety? Are other stakeholders (government, private sector or NGOs) providing resources?
- **Visibility of the issue:** do any of the potential stakeholders provide opportunities to raise the profile of PTW safety?

2.3.4 Stakeholder and target group assessment

While the assessment of existing national laws and regulations (Section 2.3.2) is meant to provide planning information on the policy environment, the stakeholder and target group assessment sheds light on the social environment in which policies are being developed and implemented. See Table 2.2 for a list of potential stakeholders in the development of PTW safety policies.

Key objectives of a stakeholder and target group assessment include the following:

- Identifying key partners and their characteristics, and examining how they will affect or be affected by a policy (e.g. their specific interests, likely expectations in terms of benefits, changes and adverse outcomes).
- Consulting with the target group to identify their concerns, motivations, and issues that may impact the success of the strategy. Participatory research is an important component of the situational assessment. What are the sociocultural

factors that need to be considered in selecting the intervention? How can it be made equitable and accessible to those who are socially and economically disadvantaged in the target group?

- Assessing partners' potential influence on the development, approval and implementation of the policy – including possible conflicts of interest – to understand the relationship between stakeholders; the capacity of different stakeholders to participate in policy development; and to assess the likelihood of their contributing to the policy development process.
- Deciding how stakeholders should be involved in the process to ensure the policy is as strong and viable as possible; in particular, to consider whether they are a partner (such as part of a taskforce or working group) or an advisor (e.g. brought in for advice on a single or limited number of issues).

Understanding the position of key stakeholders, the relationship between different entities and clearly identifying the supporters and opponents of road safety policies (i.e. those of divergent views) is key for effective engagement of all concerned parties. A summary of the stakeholder analysis process related to closing a loophole in helmet legislation in Cambodia is summarized in Box 2.3. It presents the process the Cambodian Red Cross (an agency that works on road safety advocacy) went through in order to identify key stakeholders and to gather information from them.

BOX 2.3: **Understanding key decision-makers to inform legislative change, Cambodia**

In Cambodia, PTW-related head injuries are a major public health issue. Despite evidence of the effectiveness of a comprehensive helmet law in preventing head injuries, Cambodian motorcycle legislation did not provide for the use of helmets by motorcycle passengers. The effect of this was evident from the low helmet-wearing rate among motorcycle passengers.

In 2013, coordinated by the Cambodian Red Cross, the process to close this loophole began. It required understanding the legislative process and mapping the steps in the process and the agencies and key individuals involved at every step. As the lead programme implementer, the importance of engaging key decision-makers and obtaining their full support to push for legislative change was identified early on by the Cambodian Red Cross.

Efforts made to understand the key decision-makers included:

- identifying key individuals within each agency (at both the review and approval stages); and
- determining their role in the process and which individuals carried the greatest influence at particular stages of the process.

The process provided an opportunity for the Cambodian Red Cross to take part in the legislative review process and to ensure the insertion of a key clause in the legislation covering helmets for motorcycle passengers. It also engaged appropriate legislators that could be effective in advocacy.

Source: based on *(2).*

Table 2.2 Potential stakeholders in the development of policies for PTW safety

Type of stakeholder	Possible members
Government (at different levels)	Elected/appointed officials
	High-level policy-makers
	Ministries and related departments
	Institutions, institutes, agencies and centres
	Committees, councils, commissions, liaison groups
	Administrators and professional staff
	Regional and local governments
Academics	Universities and related faculties and departments
	Research institutes
	Think tanks
Civil society organizations (NGOs, non-profit entities and organizations)	Local associations (e.g. professional, motorcycle riders)
	National and international associations
	Advocacy groups
	Community groups and individuals
	Community leaders, key influencers
	Volunteer groups
	Sponsors
Private and for-profit entities	Media outlets (e.g. print, television, radio, Internet)
	Professional (e.g. labour associations, trade unions)
	Manufacturers of PTWs and safety equipment
	Retailers of PTWs and safety equipment
	Importers and exporters
	Insurance industry

Source: adapted from *(1, 2)*.

2.4 Using situational assessment findings for targeted action

Data gathered through the situational assessment, together with information on the effectiveness of known PTW interventions, provide the evidence to inform the process of prioritizing intervention activities. The list of evidence-based PTW interventions and their documented level of effectiveness are summarized in Module 3. The prioritization process that should be considered in identifying an evidence-based intervention, its implementation and programme execution are presented in Module 4.

Results of the situational assessment should be used to prioritize a target group with the following attributes:

- Jurisdictions with comprehensive and effective laws and a strong enforcement culture.
- Target areas with the strongest political will.
- Communities that are supportive and fully on board.

These three factors are key to creating a favourable environment to successfully implement a given PTW intervention and achieve a positive outcome in terms of reduction in number of injuries and deaths, or reduction in risky behaviour.

Summary

The content of this module is summarized as follows:

- A situational assessment is key to making an appropriate decision on the actions and interventions needed to address PTW safety.
- An effective assessment employs a methodical examination of the magnitude, risk factors, prevention needs, the policy environment, existing programmes and resources, and the stakeholders involved.
- The information gathered through a situational assessment, together with information on effectiveness of interventions, provides evidence to inform the prioritization process.
- Prioritizing actions where there is a favourable policy environment, good law and strong enforcement – with high community acceptance and support – is expected to lead to a better PTW safety outcome.
- A checklist for conducting a situational assessment and data sources is included.

References

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3

Interventions to address powered two- and three-wheeler safety

Interventions to address powered two- and three-wheeler safety

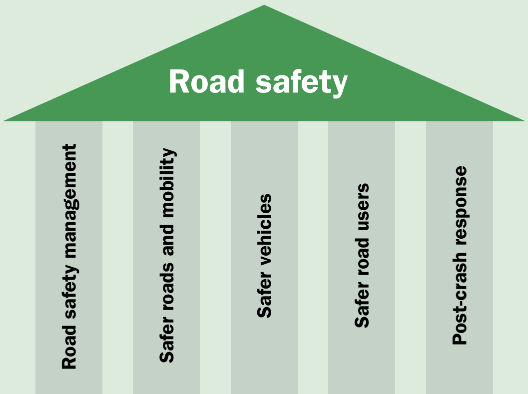
Module 1 discussed the magnitude and risk factors for PTW-related injuries, while Module 2 discussed the importance and key components of a situational assessment for PTW safety planning. This module presents a summary of key measures and interventions that can be undertaken to improve PTW safety. Note that the Decade of Action for Road Safety (2011–2020) (*1*) identifies a framework for PTW safety (see Box 3.1), and a strong road safety programme will benefit all road users, including PTW riders.

The information is presented as follows:

- **Specific interventions to improve PTW safety:** this section summarizes the key effective and promising interventions for which there is PTW-specific evidence.
- **General road safety interventions that could improve PTW safety:** this section summarizes a number of interventions known to work for all road safety issues but for which there is no PTW-specific evidence. These include many general, good road safety practices as well as post-crash care for road users involved in nonfatal collisions.

BOX 3.1: **The Decade of Action for Road Safety (2011–2020):[1] a guiding framework**

The evidence for improving PTW safety can be grouped using the five pillars of the Decade of Action for Road Safety (2011–2020) as the guiding framework. These are: road safety management, safer roads and mobility, safer vehicles, safer road users, and post-crash response.



Some of the activities under each pillar are summarized below.

Road safety management: Activities include creating multisectoral partnerships and the designation of lead agencies with the capacity to develop and lead the delivery of national strategies, plans and targets, supported by data collection and research in order to design countermeasures and monitor implementation.

Safer roads and mobility: The focus of action is on improving the safety and protective quality of road networks for the benefit of all road users, especially the most vulnerable, including PTW users. This is to be achieved using road infrastructure assessment and safety-conscious planning, design, construction and operation of roads.

Safer vehicles: Activities promote the universal deployment of improved vehicle safety technology for both passive and active safety through harmonization of relevant global vehicle safety standards and incentives to accelerate the uptake of new technologies.

Safer road users: Activities focus on improving road user behaviour, using a combination of interventions that utilize sustained or increased compliance with laws and standards, combined with public awareness and education to increase helmet-wearing rates, and to reduce drink-driving and other road safety risk factors.

Post-crash response: Activities focus on improving the ability of the community and the health system to provide appropriate emergency care (pre-hospital and emergency) and longer term rehabilitation for crash victims.

1 Full text can be found at http://www.who.int/roadsafety/decade_of_action/plan/en/.

3.1 Specific interventions to improve PTW safety

A number of specific interventions, both effective and promising, have been evaluated worldwide. These include interventions that focus on road engineering measures to minimize exposure to high-risk scenarios; interventions that promote standardized vehicle safety features; and the introduction and/or enforcement of key road safety legislation combined with strong social marketing to promote the uptake of and compliance with legislated interventions.

A summary of effective road safety interventions specific to PTW safety are summarized in Table 3.1 according to the five pillars of the Decade of Action for Road Safety *(1)*. The effectiveness of an intervention listed relates to the reduction of fatalities or injuries as well as other measureable change(s) in the behaviour of the road user targeted by the intervention. The evidence on interventions is categorized into one of three groups: effective, promising or insufficient evidence. The assessment of effectiveness and impact was made using several tools developed in evidence-based medicine and policy research *(2, 3)*.

For the purpose of this document the following definitions are used for each of these categories:

- An effective intervention means that evidence from studies such as systematic reviews, experimental trials, case–control or cohort studies demonstrate that these interventions are effective in reducing PTW-related fatalities and injuries, or in bringing about desired behaviour change, combined with likely feasibility or cost-effectiveness.
- A promising intervention means that evidence from studies show that some safety benefits have resulted from this intervention, but further evaluations from diverse settings is required and thus caution is needed when implementing such an intervention.
- An intervention with insufficient evidence refers to a situation where the evaluation of an intervention has not reached a firm conclusion about its ability to reduce fatalities and injuries or bring about desired behaviour change. This may be due to a lack of quality evidence on this intervention or what evidence exists may be equivocal. Also this group may include strategies that do not appear to work – but evidence is limited to the contexts under which they have been evaluated.

A brief description of each of the interventions summarized in Table 3.1 and some examples of how they have been implemented in different countries are provided in the sections below.

Table 3.1 **Key measures and specific interventions for improved PTW safety**

		Effectiveness		
Key measures	**Specific interventions**	**Proven**	**Promising**	**Insufficient evidence**
Safer roads and mobility	Exclusive motorcycle lanes	■		
	Protected turn lanes and widened shoulders or lanes		■	
	Removal of roadside hazards		■	
	Speed limiters and traffic calming structures		■	
	Improving road surface conditions		■	
	Modifying the composition of roadside barrier building material			■
Safer vehicles	Antilock brake systems (ABS)	■		
	Headlights at night		■	
	Daytime running headlights		■	
	Configuration to enhance stability			■
	Airbags for motorcycles			■
	Intelligent transport systems			■
	Brake lights			■
Safer road users	*Setting and enforcing legislation*			
	Mandatory helmets	■		
	Helmet standards	■		
	Strengthening penalties	■		
	Demerit point system		■	
	Wearing reflective and protective clothing			
	Reflective clothing use		■	
	Protective clothing use		■	
	Thermal resistant shields			■
	Regulating and licensing PTWs			
	Mandatory registration of vehicles and licensing of PTW operators	■		
	Graduated licensing system		■	
	Age restrictions for children riding or as passengers on PTWs			■
	Restriction on multiple pillion passengers			■
	Periodic inspection for mechanical defects			■
	Minimum height for pillion passengers			■
	Smaller engine size for learner riders			■
	Training			
	Compulsory skill test for motorcycle permit	■		
	Post-licence training			■
Post-crash response	On-site helmet/collar brace removal		■	

3.1.1 Effective and promising interventions

Interventions related to safer roads

The only documented proven effective intervention in this category is that of exclusive motorcycle lanes. Other road engineering measures such as the introduction of protected turn lanes, widened shoulders and the removal of roadside hazards are reported as promising PTW safety interventions.

Exclusive motorcycle lanes

One of the main risk factors for PTWs in traffic is their interaction with other high-speed and heavier vehicles. Exclusive motorcycle lanes are mainly used to separate motorcycles from general traffic, and comprise a track that is separated (either by a physical barrier or a structure) from the main road or highway where other vehicles travel. The aim of providing such a lane for motorcyclists is to reduce the risk of collision or injury to motorcyclists by removing them from conditions where interaction between motorcycles and larger vehicles is frequent *(4, 5)* and may result in a crash *(6)*. In many settings the same roads are used by PTWs as are used by various other types of motorized vehicle, non-motorized vehicles and pedestrians, all travelling at different speeds. Given that most roads were originally built for cars, there is a need to either regulate the use of PTWs on higher speed roads (motorways, expressways and multi-lane roads) or separate PTWs from other vehicles in order to reduce crashes and improve the road capacity *(7)*.

Segregation is likely to be of benefit and be acceptable to the general public when the proportion of road users using PTWs is more than 20–30% of all vehicles on the road – as is the case in many low- and middle-income country settings *(8)*. Segregation of motorcycles from other vehicles using exclusive motorcycle lanes is one of the extensively applied interventions in counties in the Western Pacific Region such as Malaysia *(9)*. The first exclusive motorcycle lane was built in Malaysia in the early 1970s and its effectiveness in reducing crashes has been well documented (see Box 3.2). It has been reported that it has contributed to an almost 40% reduction in motorcycle crashes in the areas of Malaysia where it has been implemented *(8)*. Speeding is often reported as the causative factor for any PTW crashes that occur in those lanes *(10)*.

BOX 3.2: **Segregated motorcycle lanes, Malaysia**

Muhammad Marizwan bin Abdul Manan

Segregating motorcycles from other vehicles using exclusive motorcycle lanes is likely to be of benefit (and be acceptable to the general public) when PTWs represent more than 20–30% of all vehicles on the road – as is the case in many low- and middle-income countries *(8).* Segregation is an extensively applied intervention in counties in the Western Pacific Region such as Malaysia *(9),* where evaluation of motorcycle lanes along Federal Highway Route 2 found they reduced motorcycle crashes by up to 39% *(11).* Motorcycle lanes were of greatest benefit for a traffic volume in excess of 15 000 vehicles per day, when the proportion of motorcycles in the traffic was between 20% and 30%. The benefit-to-cost ratio of providing an exclusive motorcycle lane was reported to range from 3.3 to 5.2 depending on assumptions used in calculating the motorcycle crash costs and the capacity of the exclusive lanes *(12).*

However, speeding is often reported as a key factor for PTW crashes in segregated lanes *(10)* and not all motorcyclists use the lanes. In addition, during initial construction of the segregated motorcycle lanes in Malaysia there was limited knowledge of design standards and experience related to motorcycle needs and behaviour *(13, 14),* so some of the design criteria used were possibly unsuitable for motorcycles *(14).* For example, the use of guardrails, implemented as a means to separate motorcycles from the main road carriageway, may have constituted an injury risk to motorcyclists *(14, 15).* To mitigate this risk, secondary metal rails or plastic tubes that fit below the existing barriers were used, preventing riders from sliding under the horizontal beams and offering protection from the metal support posts.

While motorcycle lane width varies in Malaysia, an observational study using digital recordings of motorcyclists using exclusive motorcycle lanes suggested that lanes should be at least 1.7 metres wide to allow slower vehicles to be overtaken. An egress or ingress itself could also be seen as the most hazardous location of an exclusive motorcycle lane as motorcyclists are required to make a critical decision on whether to join or leave a traffic stream *(16).*

Road design

As described in Module 1, PTWs are at particular risk of collision on curves, bends, slip roads (i.e. roads with a tight radius) and roundabouts (due to acceleration or deceleration), or because PTW stability is at stake. Some road surface materials, including road-marking materials, provide better grip than others and this aspect of road design is important for motorcyclists. The layout of roads and intersections, alterations to existing road designs, as well as appropriate shoulder widths have been shown to have a significant impact on motorcycle collisions and injury severity. A study of 36 intersections in Malaysia demonstrated that exclusive or protected (right hand) turn lanes may reduce rear-end crashes for motorcycles (*17*). This study also found that 25% more motorcycle crashes occur at intersections without a shoulder than those with a shoulder wider than 1 metre, and the results suggest paved shoulders wider than 1 metre may help to reduce motorcycle crashes.

Wider lanes on major and minor roads and an increase in the number of lanes on major roads are associated with a reduction in motorcycle crashes *(17)*. Adequate visibility and signage around intersections and roundabouts also helps motorcyclists manage their speeds as they approach the intersection. Appropriate signage providing motorcyclists with a clear understanding of road conditions ahead is also important to help them be prepared. As motorcycles are relatively small vehicles, other vehicles on the road, signage, vegetation and other objects can easily obscure them, and intersection and roundabout design needs to take this into consideration.

Speed limits and traffic calming

Traffic calming measures have been effective in reducing the number of crashes for all vehicles. However the design of such interventions can have a negative impact on motorcyclists. One OECD report (*7)* cites obstacles placed on the road, such as speed humps, and other small vertical objects designed to minimize speed as examples of how such interventions can be hazardous for motorcyclists. Motorcyclists need to be warned of these through the use of some other form of traffic calming such as horizontal makings on the road (with adequate grip or skid resistance). The location of these types of traffic calming features (primarily aimed at other vehicle types) also needs to consider the ability of motorcyclists to navigate them safely *(7)*. On the other hand, a recent systematic review of effective interventions to prevent motorcycle injuries indicated that two of three studies found a reduction in motorcycle crashes following the introduction of lower speed zones in urban areas *(18)*.

Removal of roadside hazards

Impact with a roadside obstacle increases the severity of a crash *(14, 19, 20)*. Fixed hazards in the road environment present a substantial risk to motorcyclists and result in many serious injuries and fatalities *(21).* Elimination of roadside hazards such as trees, posts, utility poles, or the use of less aggressive road equipment can significantly reduce injury severity of motorcycle crashes *(7, 22)* by creating a “clear zone” that not only minimizes the risk of a motorcyclist impacting any hazardous object, but also provides room for motorcyclists to correct errors *(7)*. Choice of location of roadside equipment used for lighting or signage can also have a negative impact on PTW safety *(7)*. Guardrails and crash barriers are often used to separate vehicles from roadside hazards but the design of such devices needs to take motorcyclists into account. There has been much debate about the best guardrail or crash barriers for motorcyclists. Exposed posts within the guardrail system are the major cause of injury *(23–25)*. The OECD report notes that there are a number of solutions that can be used to protect sliding motorcyclists from impacting exposed posts (*7*). Wire rope barriers are increasingly used as barriers to roadside hazards, as well as roadway dividers. One study found no significant differences in the effectiveness between wire rope and other types of discontinuous guardrails *(26)*. There is increasing evidence that the position of motorcyclists when they impact a guardrail may be more important than the type of guardrail *(26)*. The OECD report provides recommendations for crash barrier designs that allow a fallen motorcyclist to slide along the surface rather than impact any specific component of the system. Importantly, there is evidence that impacts with fixed hazards such as posts and poles are more hazardous to motorcyclists than impacts with barriers *(21)*, supporting the need for barriers to prevent impacts with such objects. The report also recommends that priority be given to improving barriers and guardrails on curves and reiterates the importance of proper installation and maintenance of guardrail and crash barrier systems *(7)*.

Interventions related to safer vehicles

There are two interventions in this category that have been shown to be effective. These are antilock brake systems (ABS) and the use of headlights at night. The use of daytime running headlights is reported as promising.

Antilock brake systems (ABS)

ABS on PTWs are designed to help the rider maintain control of the vehicle during an emergency braking situation. The system prevents wheels from locking during braking, and may make users more confident to brake fully *(27)*. ABS improve the stability and handling of PTWs. Studies on the efficacy of ABS have found that the rate of fatal crashes among motorcycles equipped with optional ABS is around 37% lower than those with non-ABS brakes *(27)*. Almost half of all severe and fatal motorcycle crashes in vehicles above 125 cc could be avoided by using motorcycle ABS *(28)*. On 1 January 2016 the EU passed legislation for mandatory ABS installation on all motorcycles with an engine displacement greater than 125 cc.

Antilock brake system – how it works

The motorcycle ABS is a safety system that prevents the wheels from locking during braking. It helps riders to maintain stability and steering control when braking hard by allowing the wheels of a PTW to maintain traction with the road surface. In certain emergency conditions, ABS helps to reduce stopping distance. While the ABS is technically suitable for most types of PTWs, in practice it is only available on motorcycles with engine capacity above 250 cc.

Source: based on (7).

Headlights at night

The literature reveals that while the accuracy of judging approach speed in cars remains constant in all light conditions, the accuracy of judging approach speeds on motorcycles (with a solo headlight) becomes significantly less accurate when lighting is reduced in early night and night-time conditions *(29, 30)*. Thus, use of headlights at night and attending to the positioning of the lights will improve safety for PTW operators by maximizing visibility of – and the field of vision for – the rider. A study identified that the incorporation of a tri-headlight formation instead of the usual solo headlight on the standard motorcycle frame led to improved accuracy of approach-speed judgments *(29)*.

Daytime running lights

Encouraging the use of running headlights during the day increases the visibility of PTWs to other road users, reducing visibility-related crashes by between 29% and 40% *(31)*. In Europe, PTW users who use daytime running lights have a crash rate that is about 10% lower than that of PTWs who do not *(28)*. In countries where daytime running lights have been implemented, non-compliance has been documented as an issue *(32)*, but compliance by PTW riders is key to getting the full benefit of any road safety intervention. Compliance with daytime running light legislation is impeded by various factors (such as a faulty lighting systems) as well as by personal choice on whether or not to switch on headlights. Manufacturers can play an important role in promoting the use of daytime running lights. For example, the incorporation of automatic lighting when the engine starts, inclusion of other signalling features built into the dashboard of the PTW indicating the failure of any lighting system (including the headlights), and the inclusion of a spare bulb facility on the PTW are some of the measures that manufacturers can undertake to help improve compliance *(33)*.

Interventions to improve road users' safety

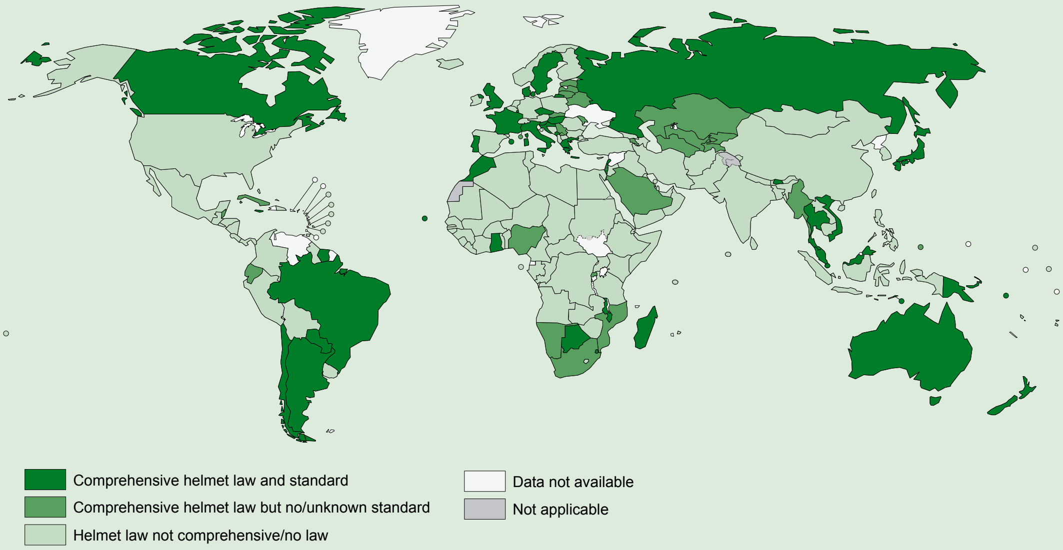
Setting and enforcing comprehensive helmet legislation

Enforcing helmet laws significantly reduces both fatal and nonfatal injuries, with the nonfatal injury rate decreasing by approximately 20% *(34)*. The number of motorcycle-related head injuries in particular has been shown to decrease by up to 33% after implementation of a mandatory helmet law, alongside a decrease in the length of hospital stay and severity of injury (*35*). There is evidence from both high- and low-income countries that maximum compliance (i.e. over 95%) with a mandatory helmet law is attainable with active enforcement (*36*). Although several countries have introduced mandatory helmet legislation over the past few decades, in many low- and middle-income countries it is still absent. According to the *Global status report on road safety, 2015 (37)*, only 50% of countries have a comprehensive helmet law that applies a helmet standard and covers all riders, all roads and all engine types (see Box 3.3). In countries where local governments have repealed or weakened existing mandatory helmet legislation, the negative effects of this action have been associated with a decrease in helmet use and a rise in overall fatalities and traumatic brain injury fatalities *(38, 39)*.

BOX 3.3: **Global motorcycle helmet laws and helmet standards coverage**

According to WHO data, between 2010 and 2013 there was an almost 20% increase in the number of countries with a comprehensive helmet law covering all PTW users, all road types and all engine types, and that also apply a national or international helmet standard *(37)*. The map below shows the coverage of motorcycle helmet laws and helmet standards by country/area, as reported in 2015.

Motorcycle helmet laws and helmet standards, by country/area



Source: based on *(37)*.

Comprehensive motorcycle helmet legislation generally involves passing a mandatory helmet law requiring the use of a standard helmet by all motorcycle riders, on all roads regardless of the engine size, with an effective enforcement, penalty and regulatory mechanism for its full implementation *(40)*. Table 3.2 provides a checklist for assessing the comprehensiveness of legislation on motorcycle helmets.

Table 3.2 **Checklist for assessing comprehensiveness of helmet-wearing legislation**

Does the content of current legislation address:	Yes	No
1. Helmet use		
Includes compulsory helmet wearing for all riders (i.e. drivers and passengers)		
Defines helmet wearing as including proper strapping and wearing of a helmet that meets national standards		
Requires all riders to wear a helmet on all roads		
Requires riders of all motorized two- or three-wheeled vehicles (all engine types) to wear a helmet		
Sets a minimum age for riding a motorcycle		
2. Helmet standards		
Specifies recognized helmet safety standards based on internationally recognized standards		
Includes product labelling requirements and addresses tampering		
Specifies requirements for child helmets (e.g. age or height) depending on the age at which children are allowed to ride on motorcycles		
3. Enforcement		
Specifies who has authority for enforcement		
Allows primary enforcement: no other traffic offence is required to stop a violator and enforce helmet-wearing law		
4. Penalties		
Specifies financial penalties		
Includes provisions for motorcycle impoundment		
5. Other regulatory measures for helmet wearing		
Establishes penalties for sale of de-specified helmets		
Establishes penalties for tampering with product labelling		
Sets requirements for passenger helmet-wearing for public service two- and three-wheeled motorized vehicles		

Source: based on *(41)*.

Mandatory helmet laws

Helmet laws are standard practice in most high-income countries and are well accepted, with correspondingly high compliance *(42)*. In countries where comprehensive helmet laws exist, but there is limited enforcement, the effectiveness of the legislation is not evident.

Evidence of the effect of legislation can be seen from studies in the USA where mandatory helmet laws have been repealed. Laws requiring all motorcyclists to wear helmets – initially introduced in 1983 – were repealed in the states of Arkansas and Texas in 1997. When the helmet laws were in place, 97% of riders wore helmets, but by May 1998 observed helmet use had dropped to 52% in Arkansas and 66% in Texas *(43)*. Similar reductions in wearing rates were later observed in other states that repealed their mandatory helmet-wearing laws *(44)*. The same reductions on overall helmet wearing was observed when laws were changed from being "universal" (i.e. requiring all riders to wear helmets) to applying only to riders under a certain age, on certain types of motorcycle licence or good medical insurance *(44, 45)*. In one particular state, Louisiana, helmet laws have been amended a number of times over the past 30–40 years. A systematic review of the literature indicated that there was a 12% to 23% increase in mortality in states that repealed the helmet laws, compared with states that did not *(18)*. This clearly demonstrates the effectiveness of mandatory helmet-wearing legislation, and specifically the effectiveness of laws that require all riders to wear helmets.

In many countries children travel by motorcycle. Helmet use for children travelling on motorcycles is mandated in many jurisdictions throughout the world *(46)* – for example in Viet Nam, Malaysia, the USA and Australia. However it is clear from studies that helmet-wearing rates by children vary considerably between these jurisdictions *(46–50)*, demonstrating that simply mandating helmet use alone is not always enough to ensure high usage rates. One study in Viet Nam *(47)* noted that while legislation requires children to wear helmets, there is no provision within the legislation for issuing infringement penalties to children under 14 years (or their parents), making enforcement impossible. However, even in countries like Malaysia where legal provisions allow enforcement, relatively low rates of helmet use occur, possibly due to low levels of public awareness and enforcement activities *(46)*. Furthermore, in the USA, where a number of states have repealed mandatory helmet use laws for adults but kept them for children, studies have demonstrated that rates of head injury among young motorcyclists are higher in those states than in states where the laws apply to all riders *(51)*. This indicates lower helmet-wearing rates among children in states that allow adults to ride without helmets *(52)*, highlighting the importance of addressing legislation, enforcement and awareness to increase helmet-wearing rates among children.

Another barrier to compliance with helmet legislation may be inconsistent use of helmets by the police. Making helmet wearing mandatory for government workers may be a good starting point for enforcement of a motorcycle helmet law.

Lack of quality helmets is also an issue in some countries and this undermines the potential gain from helmet use programmes *(53, 54)*. Issues around availability of good quality, adequate sized helmets is a particular problem for young children *(46)*. This highlights the importance of safety product standards and systems to monitor the quality of products such as helmets.

Helmet standards

For a helmet to be effective it needs to be of sufficient quality to provide maximum protection to the head *(55)* (see Figure 3.1 for types of helmet). Helmet standards are used as a regulatory measure to ensure a uniformly recognized safety level for helmets on the market and used by riders.

Figure 3.1 Helmet styles and their level of protection

Motorcyclists wearing standard-approved helmets have a lower risk of head and traumatic brain injury than those not wearing helmets *(34, 56–61)*. Proper fastening of the helmet is also important for a helmet to be fully effective. Supporting legislation and law enforcement by informing and educating the public on the importance of the proper use of standard-approved helmets has the potential to create a shared social norm, which has been shown to lead to increased helmet use *(55)* (see Box 3.4). While there have been relatively few studies of helmet effectiveness specifically among children using motorcycles, studies on injured child motorcyclists that examine injury outcome by helmet status have found less head injury and/or less severe injury among children that use motorcycle helmets *(49, 50, 62, 63)* (see Box 3.5).

BOX 3.4: **Motorcycle safety in Viet Nam**

Motorcycles are the mainstay of transport in Viet Nam. In 2015, more than 44 million motorcycles were registered, representing 94% of all registered vehicles – a number that grows by approximately 8000 each day *(64)*.

Road traffic injuries are a leading cause of death and disability in Viet Nam. In 2015, official data reported 8435 deaths and 20 815 serious injuries on the roads; an estimated 75% of these deaths occur in motorcycle riders and passengers *(64)*.

Viet Nam has had partial motorcycle helmet legislation since 1995, but for a variety of reasons implementation and enforcement have been limited. Viet Nam's first comprehensive mandatory helmet law came into effect on 15 December 2007, covering all riders and passengers on all roads nationwide. Penalties increased 10-fold and police were mobilized for enforcement (*36*).

Significant increases in helmet wearing were immediately documented in selected provinces. In Da Nang for example, helmet wearing increased from 27% to 99% *(65)*. In the 3 months after the law took effect, surveillance data from 20 urban and rural hospitals found the risk of road traffic head injuries and deaths decreased by 16% and 18% respectively *(66)*.

Political leadership, intensive public education and stringent enforcement have contributed to successful implementation of the law. Through continual monitoring of the legislation, loopholes have been identified, including requirements to fasten helmets, helmet wearing for children and motorcycle helmet quality.

While the 2007 helmet legislation clearly mandated that all riders and passengers must wear helmets, it was inconsistent with existing legislation on enforcement of road safety legislation in relation to children under the age of 16 years. This, combined with misreported and incorrect information about how helmet weight could increase the risk of neck injury in young children, led parents to restrict helmet use by their children. To resolve the situation, a high-level national consultation on motorcycle helmet wearing for children was convened by the Ministry of Transport in 2009, which contributed to an update of national legislation mandating helmet wearing by children from 6 years of age and made adults transporting such children legally responsible for their wearing a helmet *(47)*. Age-specific application of legislation posed an enforcement challenge as children in Viet Nam do not have proof of age and parents are not required to carry a copy of the birth certificate. This challenge has led to police adopting practices of school-based enforcement where children wearing a school uniform are identified as being of the age range where helmet use is mandatory. Latest monitoring of estimates of motorcycle helmet wearing in Viet Nam were around 70% in 2015, up from 46% in 2012 *(67)*.

Enforcement of national legislation has resulted in a substantial increase in motorcycle helmet wearing in Viet Nam. However, concern remains over the type of helmets being worn by riders and passengers. A roadside survey in eight provinces (Bac Giang, Bac Ninh, Ha Nam, Ha Noi, Ho Chi Minh City, Ninh Binh, Quanh Ninh and Vinh Phuc) exchanged helmets being used by riders for a new, national standard helmet. A total of 1382 helmets were exchanged and tested in a nationally certified laboratory. Of these helmets, 85.9% failed to provide the minimum impact protection as required under the national helmet quality standard (QCVN2). Further testing of 280 new QCNV2-labelled helmets randomly sampled from the list of approved helmets registered with the Ministry of Science and Technology and purchased through reputable suppliers found that more than 58% of these helmets failed to meet head-impact protection requirements *(68)*. Compliance with helmet quality standards is primarily self-regulated by helmet companies, and with no mechanism nor an independent national standards agency to conduct random sampling and testing, the potential exists for manufacturers to supply high-quality helmets for testing and lower quality helmets for market. With the QCVN2 logo currently not representing a guarantee of quality, national authorities need to revise the terms under which manufacturers can use it to ensure that it is used only on helmets that meet the national quality standard.

In the past decade Viet Nam has made substantial progress in the implementation of evidence-based interventions to address the major risk factors for road traffic injury. Much of this action is yet to reach a scale that will have an impact on national rates of road traffic mortality, but national leaders have demonstrated their commitment to saving lives and preventing injuries on Viet Nam's roads.

BOX 3.5: **Helmet use among children**

There is sufficient evidence that helmets are effective in preventing head injury or death in the event of a crash. In studies on injured riders and pillion passengers, injuries are more frequent and more severe among children involved in a crash and not using a helmet compared to those using helmets *(50, 69)*. There is evidence that helmet-wearing rates can be much lower for children than for adults in some low- and middle-income countries (*47*).

In countries where it is common for young children to use PTWs as riders or passengers, helmet availability and the adequacy of available helmets in terms of quality is also a safety concern. Even in places in low- and middle-income countries where helmets are reported to be widely available, there is a concern about the adequacy of those helmets for children, both in terms of size and quality *(46)*. Very few helmets include requirements for small "child-size" motorcycle helmets. Use of oversized helmets not only reduces the protection provided by the helmet but can also negatively affect the position of the helmet and chin strap on the child's head *(48)*. During a crash, this could increase the chance of the helmet coming off, and during riding the helmet may obscure a child's vision. There are few countries that have local standards for child helmets, although Viet Nam has recently introduced one. The smallest helmet sizes regulated by these standards would approximate to the head size of a child aged 5 to 7 years.

Strengthening penalties

Police enforcement plays an important role in strengthening compliance with traffic rules by all road users. One of the ways governments operationalize enforcement is by setting maximum penalties for various road traffic offences. A systematic review of the literature *(18)* identified evidence from two studies that indicated a small but significant reduction in crashes associated with increased financial penalties, and criminalization of drink-driving and speeding offences. A longitudinal study in the USA (1980–1997) found that states where rider licences were revoked for drinking and driving were generally associated with reductions in motorcycle-related fatalities.

Criminalizing offences

Enforcing laws that criminalize different behaviours related to speeding and alcohol consumption has consistently been an effective legal sanction in reducing road traffic fatalities *(70)*. Little evidence is available on the broader issue of criminalizing (non-alcohol related) offences and reductions in motorcycle-related injuries. In order to create conformity and adherence to road rules by motorcycle riders, sustained media publicity and awareness campaigns are necessary to accompany enforcement activities *(71)*.

Demerit point system

A demerit point system is a penalty system where a number of points are added to the record of a driver or a PTW rider for a traffic offence, depending on the severity of the traffic law violation (see Box 3.6 for an example of a demerit point system in Ontario, Canada). In some settings, the rules applied for assigning a demerit point could be tailored to whether a driver is a novice or is experienced with a full licence. A penalty point system using demerit points has been shown to reduce crashes, specifically among moped riders on urban roads in Spain *(72)*.

BOX 3.6: **Demerit point system, Ontario, Canada**

In Ontario, drivers and motorcycle riders start with zero points on their driving/riding record and gain points for being convicted of breaking certain traffic laws (while most countries start with about 12 points and lose their licence when they lose all 12 points).

Demerit points stay on the driver/rider's record for 2 years from the offence date. If they collect enough points they may lose their motorcycle licence.

The number of points added to a motorcycle rider's record depends on the offence. For example:

- **7 demerit points** if a rider fails to remain at the scene of a collision or stop when signalled by a police officer;
- **6 demerit points** if a rider is convicted of careless driving, speeding over 50 km/h or failing to stop for a school bus;
- **4 demerit points** if a rider exceeds the speed limit by 30–49 km/h or is found to be following another vehicle too closely;
- **3 demerit points** if a rider is driving while holding or using a hand-held wireless communication or entertainment device; exceeding the speed limit by 16–29 km/h etc.;
- **2 demerit points** if a rider makes an improper right or left turn, prohibited turns, fails to obey signs, or fails to stop at a pedestrian crossing etc.

The consequences of gaining demerit points depend on how many points a driver/rider has on their record. The number of points will differ depending on whether they have a full licence or are a novice driver/rider.

Penalties for demerit points: rider or driver with a full licence

2 to 8 points: A rider will be sent a warning letter.

9 to 14 points: A licence could be suspended unless the rider attends an interview to discuss and provide reasons why the licence should not be suspended. If they do not attend, the licence could be suspended.

15+ points: A licence is suspended for 30 days. If the rider does not surrender the licence, they may lose it for up to 2 years.

Penalties for demerit points: new or novice rider

2 to 5 points: A rider will be sent a warning letter.

6 to 8 points: A licence could be suspended unless the rider attends an interview to discuss and provide reasons why the licence should not be suspended.

9 or more points: A licence will be suspended for 60 days. If the rider does not surrender the licence they may lose it for up to 2 years.

Source: based on *(73)*.

Wearing reflective and protective clothing

The use of reflective and protective clothing such as jackets, trousers, boots and gloves is a promising intervention for prevention of PTW-related injuries. Reflective clothing that improves the visibility of the rider and passenger by increasing the brightness contrast between the motorcyclists and their surroundings *(74, 75)* has been consistently shown to improve motorcycle visibility and thus contribute to reduced risk of motorcycle crashes and serious injuries or deaths by almost one-third *(76)*. For effective implementation there is a need for a multifaceted approach that includes complementary helmet safety laws and educational campaigns focusing on raising awareness about PTW conspicuity *(29, 77)*. Regulations requiring the use of such clothing and enforcing compliance are equally important to highlight the importance of this measure.

The use of protective clothing reduces the likelihood of injury, hospitalization and disability. Motorcycle protective clothing is specifically designed to provide adequate abrasion resistance and impact protection for motorcycle use. Protective clothing is a viable measure to protect against abrasions and fractures – the most common types of PTW-related injuries in nonfatal crashes *(78)*. Most common PTW-related injuries to arms and legs can be reduced or prevented by protective clothing *(79, 80)* which has been shown to reduce soft tissue injury, the likelihood of hospitalization and the likelihood of impaired function 2 months post-crash *(81, 82)*. Despite its documented effectiveness, there is limited use of protective clothing in low- and middle-income countries *(82)*. The use in high-income countries also varies considerably between countries and within countries, ranging from 50–81% *(82, 84)*. Promoting and enforcing compliance is key to successful implementation of this intervention.

Mandatory registration and licensing of PTW operators and vehicles

General road safety interventions that target all road users form the basis of successful road safety management in high-income countries *(42)*. These include registration and licensing systems, and strict enforcement – with penalties – of road safety laws. In some low- and middle-income countries most PTWs are not registered, and studies show that riders who are unlicensed tend to be involved in crashes more than those who are licensed *(39)*. In other classes of powered vehicles, such as cars and buses, it is well established that mechanical defects can contribute to crashes *(85)*. Illegal modifications of PTWs have also been shown to compromise the roadworthiness of vehicles. In low- and middle-income countries, there is widespread illegal modification of powered two-wheeler vehicles into three-wheel vehicles in order to carry passengers and/or goods *(86)*. While there appears to be little data about crash involvement, studies that have looked into the roadworthiness of modified vehicles show that there is no regulation of these vehicles through any registration process, and that many of the riders of these vehicles are unlicensed *(86)*. A study of crashes involving three-wheel vehicles in Sri Lanka, for example, reported that modifications made to the handle lock of these vehicles increased the turning angle for the driver – a contributing factor in almost 30% of the crashes in the study sample *(87)*.

Graduated licensing system

A graduated licensing system is a regulatory mechanism whereby a power and engine size restriction is applied to young and novice PTW riders in order to give new riders the opportunity to gain experience and skills in a lower-risk manner over time. There is documented evidence that implementation of a graduated licensing system leads to a significant (up to 22%) reduction in motorcycle crash-related hospitalization *(88)*. Although a graduated licensing system is common in high-income countries, the type of restrictions enforced as part of regulations varies considerably between high-income countries. These variations include restrictions on engine size, the age of the rider, on being allowed to carry passengers, and on night riding. Some systems set specific blood alcohol concentration (BAC) limits for less-experienced riders below a certain age, and some include tests for a motorcycle permit, driver training and longer duration of a learner's permit *(7, 89)*.

Training

The introduction of compulsory training and a skills test to obtain a motorcycle permit or licence has been shown to be an effective intervention in PTW safety, although there appear to be limited benefits of post-licence training *(90)*.

Compulsory skills test for a motorcycle permit

Compulsory training and skills testing prior to obtaining a licence have been shown to contribute to a reduction in both crash and mortality risk *(89)*. Where this intervention has been implemented, it has been done through PTW operation and licensing regulations *(34, 89, 91)*. The effectiveness of this intervention is well-documented in high-income countries, but its effectiveness in low- and middle-income countries is yet to be validated. Based on evidence from high-income countries, the ITF/OECD Working group on the Safety of Powered Two-Wheelers has made recommendations (summarized in Box 3.7) to its members on training *(7)*.

BOX 3.7: **ITF/OECD Working Group recommendations on PTW training**

The ITF/OECD Working Group on the Safety of Powered Two-Wheelers made the following recommendations in 2014:

- National (or provincial/state) authorities should consider that riding a PTW requires a certain level of personal maturity, as for all road users.
- Access to PTWs should be gradual, with a licensing system aimed at managing young and novice riders' risk as they gain experience.
- The purpose of the licensing system should be to ensure riders, regardless of age, possess the skills, knowledge and correct attitude to ride as safely as possible without unduly restricting mobility.

Source: based on *(7)*.

Post-licence training

There is no reliable evidence that post-licence rider training decreases the risk of a crash. One review found there was no reliable evidence of benefits of rider training (either pre- or post-licence) *(92)* and a subsequent large trial of a post-licence on-road coaching programme showed no crash reduction, but an increase in rider confidence and self-reported speeding *(90)*. Training programmes are therefore best focused around mandatory pre-licence training aimed at basic riding skills.

Post-crash care

Initiation of swift post-crash care minimizes the risk of severe injury and death *(93)*. While general pre-hospital care standards – such as a quick response time and the application of uniform treatment protocols – are shown to be effective for minimizing the risk of severe injury and death associated with road crashes, two interventions specific to PTWs have been shown as promising: on-site helmet removal and on-site application of a cervical collar brace to the injured individual(s). Both interventions, if properly applied by a trained pre-hospital care provider, have been shown to minimize injury severity and long-term disability. Helmet removal by trained professionals is important when it is evident that there is vomiting or obstruction of the airway *(94)*. The application of a cervical collar brace to protect the crash victim's spine at the scene of an incident has equal priority. The type of injuries sustained by motorcyclists who use full-face helmets, chin straps and some types of protective clothing suggest that there are a number of unique aspects of airway, circulatory and spine management for motorcycle crash casualties, and that professional training is important to be able to assess the threats to breathing versus the threat of spinal injury *(94, 95)*. Additional information on non-PTW-specific post-crash care interventions is presented in Section 3.2.3.

3.1.2 Interventions for PTW safety with insufficient or weak evidence

In addition to the effective and promising interventions described, there are other interventions for which the evidence base is insufficient to recommend widespread implementation. These interventions tend to be limited in scope and their applicability beyond the intervention site has not been validated. Often evaluation of such interventions is unable to reach a firm conclusion about the interventions' ability to reduce fatalities and injuries, or to bring about the intended behaviour change. This is due to a variety of reasons, including insufficient time between the intervention and expected impact on injuries; small number of cases leading to lack of statistical significance; or that there are very few studies to evaluate. Although such interventions cannot be promoted as effective or promising, they may be considered for local adaptation and further evaluation to confirm efficacy and define areas for modification.

The list of interventions for PTW-related injuries with insufficient or weak evidence include the following:

- Improving road surface conditions.
- Modifying the composition of roadside barrier building material.
- Designing the PTW to enhance stability.
- Airbags for motorcycles.
- Intelligent transport systems.
- Installing or using brake lights.
- Regulating and licensing PTWs.
- Wearing thermal resistant shields.
- Age (or height) restriction for children as passengers or riders on PTWs.
- Periodic inspection of the PTW for mechanical defects.
- Setting a minimum height for pillion passengers.
- Smaller engine size for learner riders.
- Post-licensing and training for returning riders.
- Using on-site helmet removal/collar brace.

Adoption of these strategies (other than in trial form) in order reduce PTW-related injuries is not recommended until robust evidence of their effectiveness is available.

3.2 General road safety interventions that could improve PTW safety

General road safety interventions that target all road users have the potential to improve PTW safety. A summary of general, non-PTW-specific road safety interventions are presented in Table 3.3 (see Section 3.1 for definition of effectiveness).

A brief description of each of the interventions is provided below, and examples are provided of how some countries have implemented these approaches. The interventions fall under the safe roads, safe road user and post-crash care categories of the Decade of Action for Road Safety.

Table 3.3 General road safety measures and specific interventions that could improve PTW safety

		Effectiveness		
Key measures	**Specific interventions**	**Proven**	**Promising**	**Insufficient evidence**
Minimizing exposure to high-risk scenarios	Expanding public transport	■		
Modifying PTW use behaviour	Setting and enforcing speed limits	■		
	Setting and enforcing alcohol impairment legislation (randomized breath testing)	■		
	Prohibiting mobile phone use while driving/riding			■
	Social marketing	■		
Improving post-crash medical care and response times	Introduction of uniform treatment protocol		■	
	Quick response time		■	
	Offer early rehabilitation	■		
	First aid training			■
	Mandatory health insurance			■

3.2.1 Interventions related to safer roads

Expanding and improving public transport

Creating well-maintained, sustainable public transport systems is increasingly seen as an important aspect of making overall mobility safer, with the additional benefit of reducing congestion, particularly in urban areas where there is increasing traffic congestion *(42)*. Expanding public transport also contributes to improved health by encouraging increased physical activity and reducing greenhouse gases.

Increased use of public transport is associated with lower road fatality rates *(96–98)*. However, in many low- and middle-income countries, while public transport is often the only means of transport for the majority of people, it can be unsafe, particularly when run by private entities. An effective public transport system should employ a comprehensive approach that ensures safe, accessible, reliable and affordable transport for all.

3.2.2 Interventions related to safer road users

Speed management

As illustrated in Module 1, speeding is a major contributing risk factor for PTW crashes and injury severity, hence efforts to reduce the speed of PTW riders, as well as other road users, on both urban and rural roads should contribute to a positive outcome *(99)*. In addition to reducing the force of impact, lower travel speeds allow drivers of other vehicles greater time to see the PTW, reduce the distance travelled after braking, and stop when reacting to any unforeseen circumstances. It also increases PTW riders' ability to judge the speed of other vehicles and the time for reaction in case of an impending collision.

The effectiveness of speed reduction and speed control legislation on reducing speeding-related crash and injury severity has been well documented *(99, 100)*. Setting vehicle speed limits is closely associated with road type and road design. Setting general speed limits according to road type, and the enforcement of limits by the police, have also been shown to reduce PTW-related deaths and injuries *(99)*. The effect of reduced speed on the number of PTW crashes has been demonstrated in studies evaluating the effect of congestion in urban areas. It has been reported that congestion can lead to reduced speed for all vehicles and subsequently to a reduction in the severity level of PTW crashes *(101)*. A UK study also reported that traffic congestion, depending on the road type, can be associated with a reduction in the number of PTW crashes. One study *(102)* found fewer PTW crashes occurred on peri-urban and urban roads during congested times, while on motorways, PTW crashes increased during congested times.

Setting and enforcing alcohol impairment legislation (randomized breath testing)

The link between alcohol consumption and impaired driving is well established. Setting and enforcing legislation on blood alcohol concentration (BAC) limits via random breath testing has been shown to be effective in reducing alcohol-related crashes *(103)*. Interventions targeted at reducing drinking and driving, which target all road users, have the potential to benefit PTW users. Some high-income countries mandate lower BAC limits (enforceable via blood, breath or urine testing) for younger road users as part of a graduated licensing system. Only a few countries in the Americas and some other low- and middle-income countries follow WHO's recommendation of establishing lower BAC limits for younger or novice drivers *(42)*. In general, alcohol limits are based on motor vehicle studies, but some findings indicate a lower threshold for motorcycle alcohol-related riding errors is needed *(104–106)*. Despite strong evidence, less than 50% of countries globally have adequate and comprehensive drink-driving legislation and good enforcement of such laws *(42)*. Only half of all countries have the recommended 0.05 g/dl or lower BAC limit.

Road safety campaigns and social marketing

Road safety campaigns are often used to influence road user behaviour, but are only effective when used in conjunction with legislation and law enforcement *(107–109)*. However, safety promotion in road traffic injury prevention is rapidly changing. Rather than disseminating messages in one-way, top-down communications, safety promotion now focuses on communicating messages according to the knowledge, needs and perceptions of the target audience, as well as the context in which messages will be delivered. This includes a much stronger focus on use of social media and interactive communication *(109)*. While there is little or no evaluation of motorcycle-specific campaigns, it seems likely that ongoing campaigns that support legislation and enforcement are likely to impact positively on PTW safety.

Given that social marketing programmes should have a specific target audience, planning involves in-depth research about the target group and ongoing evaluation to inform and modify the programme as needed. As such, consultation, research and evaluation are integral parts of a social marketing programme.

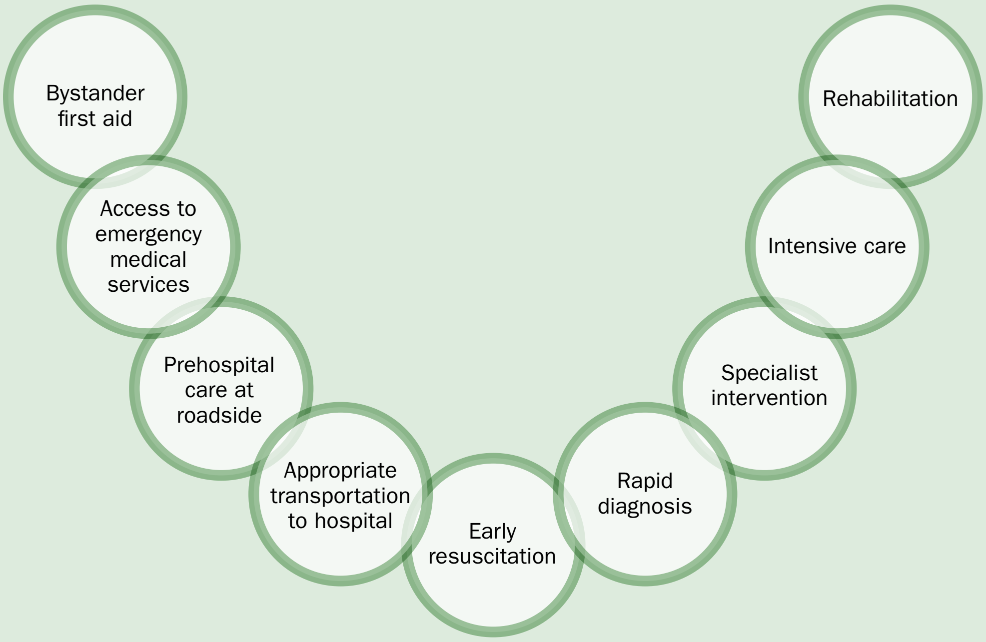
3.2.3 Improving post-crash care

Preventing road traffic crashes is the goal of any road safety intervention. Nevertheless, appropriate post-crash emergency care and follow-up medical care for those injured is essential to mitigate consequences. Timely and appropriate post-crash care can increase chances of survival, reduce complications, improve functional outcomes and decrease the financial impact of long-term medical care and lost productivity. Post-crash care includes a sequence of actions aimed at reducing the impact of injury (see Box 3.8 for the chain of post-crash trauma care from the scene of the crash to rehabilitation).

Introduction of uniform treatment protocols

Improvements in the general standard of post-crash care lead to enhanced outcomes after injury. A systematic approach in the early management of injured patients has been shown to reduce both morbidity and mortality *(110)*. Delivery of effective trauma care requires a functional pre-hospital and facility-based emergency care system, with appropriate post-crash care capacity *(111)*.

BOX 3.8: **Chain of post-crash trauma care**



Source: adapted from *(112).*

Pre-hospital care

Pre-hospital care is the medical care received and the transport provided to injured patients before they reach the health-care facility and is often called an "emergency medical service" (EMS). But for most low- and middle-income countries this also includes the informal systems via which injured persons are brought to facilities for care (e.g. by bystanders, commercial drivers or others).

Hospital-based care

Hospital-based care includes acute care rendered within the first hour or two of arrival, typically in a casualty ward or emergency department. It also includes the definitive care rendered elsewhere in the hospital, such as in operating rooms, intensive care units and general hospital wards.

Rehabilitation

Rehabilitation implies the optimization of the physical and mental function of the injured person and a return to meaningful life as close as possible to pre-injury status. This may involve facility-based care (sometimes in the same facility that provides acute emergency care). It may also imply assistance to the injured person in their home environment, and work to maximize their recovery and resumption of social roles.

Source: adapted from *(112).*

Emergency alert – quick response times

Quick and accurate ways to rapidly activate emergency care (such as universal access numbers) coupled with functional emergency service accessibility contribute to a reduction in response time (i.e. the time between the crash and the provision of emergency care). A longer medical response time corresponds to a higher probability of death in the case of serious crashes. There are a number of studies in high-income countries that demonstrate the benefits of rapid retrieval, appropriate on-site care and initiation of medical treatment in post-crash care *(113)*. Some studies suggest that a 10-minute reduction in the medical response time would result in an average decrease in the probability of death by one third, both on motorways and conventional roads *(114)*. In many high-income countries there are well-established health facilities with the capacity to provide timely and appropriate pre-hospital and emergency care for the injured. However, in low- and middle-income countries the majority of deaths from road traffic injuries occur prior to the patient reaching a hospital. In the absence of a formal emergency and trauma care system, giving first aid training to other road users (particularly taxi and truck drivers) in low- and middle-income countries has proved to be beneficial *(42)*. Well-planned initiatives that enhance the role of citizens (who often fill the gap in transporting injured road users to hospital) would benefit all road users, including those using PTWs *(115)*.

Early rehabilitation intervention

Road traffic injuries, including those involving PTWs, are a major cause of injury-related disability, especially among young people *(116–118)*. Motorcycle riders often continue to experience physical disability 1 year after their injury *(119)*. The most common sites of injury leading to disabilities in motorcyclists are the lower extremities *(120–122),* the upper extremities *(120)* and the head *(123)*. Spinal cord injuries are less common motorcycle-related injuries, however they are a major cause of severe impairment and disability *(6)*. Rehabilitation is a "set of measures that assists individuals who experience, or are likely to experience, disability to achieve and to maintain optimal functioning in interaction with their environments" *(124)*. Provision of early rehabilitation programmes and association of rehabilitation with better outcomes have been demonstrated in several settings *(125–131)*. For example, for people with very severe traumatic brain injury, implementation of early, centralized and intensive rehabilitation programmes which is formalized and interdisciplinary in nature, delivered in specialized centres, has been shown to improve both functional and Glasgow Coma Scales *(132)* (see Box 3.9 on components of effective early rehabilitation interventions).

BOX 3.9: **Early rehabilitation as an intervention**

Early rehabilitation intervention should start in acute medical units immediately after the injured person is stable, and while they are still in hospital.

The rehabilitation process involves identifying a patient's problems and needs; relating the problems to relevant factors about the person and their environment; defining rehabilitation goals; planning and implementing measures; and assessing the effects.

Rehabilitation objectives:

- Preventing loss of function
- Slowing the rate of loss of function
- Improving or restoring function
- Compensating for lost function
- Maintaining current function

Rehabilitation outcomes:

- Decreased length of hospital stay
- Increased independency
- Decreased burden of care
- Return to role/occupation that is age, gender and context relevant (home, work, school)
- Social and occupational reintegration

Most common types of injuries leading to disability:

- Injuries to upper and lower extremities
- Traumatic brain injury

Evidence:

- Starting rehabilitation early is associated with shorter comas and lengths of hospital stay, higher cognitive levels at discharge, and a greater likelihood of being discharged home.

List of interventions for traumatic brain injury:

- Centralized and intensive sub-acute rehabilitation programme delivered in specialized centres
- Early formalized rehabilitation programme during acute hospitalization
- Formalized programme (average of 2 days to initiation of therapy) with a non-formalized programme (average of 23 days to initiation of therapy)
- Early admission to acute rehabilitation programme (before 35 days post injury) compared with late admission (after 35 days post injury)

Timing:

- Early physical medicine and rehabilitation consultations (sooner than 2 days after hospital admission)

Sources: adapted from *(123, 126, 127, 131)*.

Summary

The content of this module is summarized as follows:

- There are effective proven and promising interventions that are specific for improving PTW safety, as well as general interventions effective for other road safety issues that are of equal benefit to PTW safety.
- Implementation of proven and promising interventions should take a comprehensive approach whereby interventions related to road users, vehicles and the road environment, using engineering, enforcement and education, are applied in integrated manner.
- The Safe System approach provides a framework for the planning and implementation of effective and promising interventions.
- Interventions that have been found effective and promising are as follows.
  - ▹ Road safety management: including a strong government role in setting legislation and policy enforcement, and in licensing PTW operators and registering vehicles.
  - ▹ Safer roads and mobility: separation of PTWs from other traffic, mainly where at least 20–30% of road users are PTWs.
  - ▹ Safer vehicles: advanced braking systems, such as antilock braking systems (ABS) and addressing mechanical defects in all PTWs.
  - ▹ Safer road users: legislation and enforcement related to alcohol use, speeding, helmet and protective clothing use; instituting a programme for graduated licensing schemes; increased conspicuity of PTWs.
  - ▹ Post-crash response: introduction of uniform treatment protocols and quick and accurate mechanisms for the rapid activation of emergency care systems.

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4

Implementing and evaluating PTW safety interventions

Implementing and evaluating PTW safety interventions

Promising interventions discussed in Module 3 can improve PTW safety and help save lives if they are implemented consistently. An effective implementation programme requires a strategic approach from planning to delivery. Every step is based on evidence, and continuous quality improvement should be an integral part of programme planning. The objective of this module is to present the process of the PTW safety implementation process (including evaluation). Strategic implementation (as presented in this module) comprises four steps *(1)*:

- Defining desired outcomes
- Prioritizing evidence-based interventions to define programmes
- Developing a monitoring and evaluation plan
- Developing and executing a plan of action

4.1 Defining desired outcomes

The first step of any programme implementation is defining the desired outcomes using goals and objectives. Goals are usually visionary, specifying neither a timeframe nor a quantified target – but indicate a clear direction of intent. Objectives, on the other hand, describe the outcomes that, through the implementation of a programme, are expected. Baseline information, including data on the burden of injuries (e.g. incidence of PTW-related injury, deaths, and socioeconomic measures), and the prevalence of risk factors (e.g. level of exposure) gathered through the situational assessment are therefore necessary to quantify objectives.

Objectives should:

- be specific, measurable, achievable, relevant and time-bound (SMART);
- be evidence-informed, derived from the situational assessment as well as available literature;
- include fatality and injury reduction targets, and reductions in risks that may result from improving conditions for PTWs (behavioural change objectives should also be considered);
- be a range of short-, medium- and long-term *(2)*.

Table 4.1 provides a set of general road safety and PTW-specific objectives that have been extracted from existing national road safety strategy documents.

Table 4.1 National road safety and PTW objectives

Country	Objectives	Baseline (2005–2008 average)
Ireland	Reduce the number of motorcycle fatalities by 50% by 2014	101 deaths per million registered vehicles per year
	Reduce the number of motorcycle injuries by 50%	478 injuries per million registered vehicles per year
	Increase rates of wearing high-visibility clothing by 75%	40% of riders wearing high-visibility clothing

Source: based on *(3)*.

4.2 Prioritizing evidence-based interventions

As outlined in Module 1, all road traffic injuries, including those among PTW riders or passengers, result from circumstances related to the road user, vehicle, road environment, infrastructure and other socioeconomic conditions. Prioritization will require evaluating each intervention in terms of capacity for implementation and acceptability with those responsible for implementation, as well as the target group. The policy and stakeholder analyses described in Module 2 are aimed at providing such information to help appraise the overall policy environment and likely level of support for the various interventions being considered.

The New South Wales (NSW) Motorcycle Safety Strategy 2012–2021 *(4)* and its goals and objectives are rooted in the Safe System framework, as summarized in Box 4.1.

BOX 4.1: **The New South Wales (Australia) Motorcycle Safety Strategy 2012–2021**

Motorcycles in New South Wales (NSW) are used for commuting and recreation, and in recent years, motorcycle use has increased in the state. From 2006–2011 the number of motorcycle registrations rose by 41% (compared to 8% for passenger vehicles) and the number of motorcycle licences increased by 17%.

The rate of fatalities among motorcycle riders is 20 times higher than for car drivers. As such, motorcycle riding is a higher risk alternative than other means of transport. As the number of motorcycles increases, the number of fatal crashes also increases. The situation in NSW reflects the motorcycle safety situation in other parts of Australia.

In an attempt to address this emerging public health issue, the Minister for Roads and Ports (the minister then responsible for road safety in NSW) introduced the NSW Motorcycle Safety Strategy 2012–2021.

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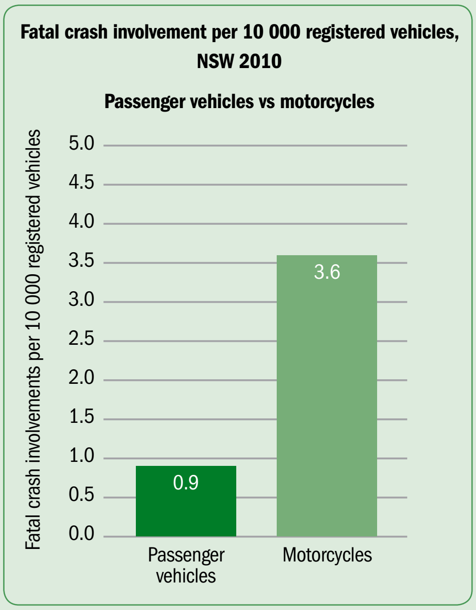
Defining desired outcomes

The Motorcycle Safety Strategy sets out a comprehensive plan with a range of actions for implementation to improve motorcycle safety for all riders. The plan is based on the Safe System approach that guides road safety policy in all jurisdictions across Australia. The Safe System approach encompasses the following elements: safe road users, safe vehicles, safe roads, safe roadsides and safe speeds.

The Motorcycle Safety Strategy formed a component of the NSW Road Safety Strategy 2012–2021, which addresses all road users (including motorcycle users), and supports achievements against a set of outcomes linked to that strategy. The overall outcome target for the Road Safety Strategy is a 30% reduction in road deaths and serious injuries by the end of 2021.



Safety initiatives

The Motorcycle Safety Strategy includes a set of stated safety initiatives corresponding to each part of the Safe System framework. Each set of safety initiatives includes stated actions. The actions include some that are for early implementation; some for further research to ensure alignment with best practice principles before implementation; and some for continued monitoring during the strategy period and beyond. An example of initiatives for the "safe roads" element of the Safe System approach include the following.

Safe roads safety initiatives

1. Research road safety engineering treatments to improve motorcycle safety.
2. Ensure safe-road principles are understood and applied by people looking after the road network – designers, road maintenance bodies and engineers.
3. Contribute to the National Road Safety Strategy by introducing a motorcycle blackspot/length programme.
4. Investigate ways to improve post-crash emergency response.

Action plans for first 3 years

1. Investigate effective road environment incident reporting available to the motorcycling community.
2. Review traffic engineering specifications that increase motorcycle safety while balancing road safety requirements for other road users.
3. Educate road asset owners to consider motorcycle safety when roads are designed, constructed, maintained and operated.
4. Establish opportunities for road design, engineer and maintenance practitioners to share motorcycle safety expertise.
5. Continue research into safety barriers in relation to motorcycles.
6. Use road safety audits to review and improve motorcycle routes and safety features.
7. Document the clear zone policy and continue to communicate safe motorcycle roadside needs to other agencies, including utility agencies.
8. Contribute to the National Road Safety Strategy: Safety improvements on popular motorcycle routes.
9. Explore emergency location detection for motorcyclists.
10. Investigate feasibility for safety phones along popular motorcycling routes.

The actions under each component include both new initiatives and modifications to existing actions and programmes.

Source: based on *(4)*.

4.3 Developing a monitoring and evaluation plan

Module 2 presented the evidence base on PTW safety and outlined which interventions and approaches work best, and why. Knowing what works in PTW safety is only part of the answer. Monitoring is needed to get objective measures on what works when linking the evidence to road safety practice and action in a specific context. A well-conducted evaluation makes a significant contribution to evidence-based PTW action by focusing measurement on results and subsequently promoting results-based accountability. Key elements of monitoring and evaluation, and how they are an integral part of programme implementation, are summarized in Box 4.2.

BOX 4.2: **Monitoring and evaluation**

What is monitoring and why do it?

Monitoring is defined as the process of supervising activities in progress to ensure they are on course to meet the programme's objectives and performance targets.

In road safety, monitoring or surveillance activities comprise the regular collection of key road safety information on health and other road safety performance indicators, and routine analysis of the information over time, place and between population groups, using predefined criteria *(5)*. For public health surveillance or monitoring it also includes the regular dissemination of results to support informed policy-making *(6)*.

Monitoring is essential for early identification of implementation problems; to respond to bottlenecks or gaps in programme performance; and to adequately capture contributing factors to observed negative and positive changes in road safety performance and impact *(7)*. Depending on programme objectives and complexity, monitoring can be directed at measuring impact, output and outcome indicators.

What is evaluation and why do it?

Evaluation is defined as the process of determining a programme's direction (shaped by the context in which the initiative sits); utility (how useful it is to achieving a defined objective); effectiveness (a programme's performance as compared to available evidence); and strengths (aspects of the programme and lessons learned that can be used to improve public health *(5)*. Evaluation is a critical function of programme management and is used for effective planning, budgeting, and the measurement of effectiveness and efficiency.

Through evaluation, programme planners can ascertain how well programme components are functioning. Evaluation also provides clues as to why components may or may not work, aids programme accountability and transparency, and is a key part of long-term, strategic planning *(8)*.

In road safety, programmes aim to prevent or control injury, disability and death. As this means taking account of the different elements of the Safe System framework and the differing needs of stakeholders, programmes themselves can be very complex. In addition, since most of the effective interventions involve significant and often challenging changes in road user attitudes and behaviour, it adds to the complexity of planning an effective PTW safety programme.

Posing the right questions on effectiveness is key for any evaluation. Questions about programme effectiveness require implementers to pay attention to measuring and documenting the implementation of the programme and its success as it relates to the achievement of the intended outcomes. The effective use of such information makes implementers accountable to key stakeholders.

4.3.1 What to monitor and evaluate

Once an intervention has been identified as a priority and a strategy has been developed for its implementation, the measurement "metrics" for the implementation need to be defined and regularly monitored. Metrics include indicators on input (resources, coordination mechanisms, plans); output (achievements, tasks completed, products delivered that are attributable to the initiative); and outcomes (changes sought regarding risk or protective factors, e.g. a reduction of roadside hazards in "blackspot" areas, or increased helmet-wearing rates, or enhanced infrastructure, e.g. road design and reductions in injuries and fatalities). Areas for monitoring and evaluation are usually presented in a monitoring and evaluation plan (see Box 4.3 for an example of a monitoring and evaluation component of a motorcycle safety plan of action).

BOX 4.3: **PTW monitoring and evaluation indicators**

	Input and process **What is being measured**	**Outputs** **What has been achieved**	**Outcome** **Targets reached**
What is measured	Multisectoral efforts Funds allocated	Implementation of activities related to each safe system element: roads, vehicles, speed, road users % of road safety budget allocated	% change in injuries and deaths
What shows progress	Innovative, evidence-based planning	Each system element is becoming increasingly safer	Ongoing reduction in injuries and fatalities
How it will be measured	Action plan implementation	Example of data sources: speed survey data Regular evaluation of road safety initiatives	Hospitalization and fatality data

Source: adapted from *(9).*

4.3.2 Data sources for monitoring and evaluation

PTW safety monitoring and evaluation data can take many different forms and be collected in a number of ways. Data sources may include routinely reported data from all facilities or sentinel sites; population-based surveys; infrastructure assessment data (such as lists of operational works that address road safety issues); surveillance data (such as police-attended crashes, hospital admissions resulting from PTW crashes); observational studies on riders to measure speeding rates or helmet-wearing rates; and periodic evaluation. Table 2.1 in Module 2 provides a summary of these data sources, the type of data they offer, and observations on the strengths and limitations of each source.

4.4 Developing and executing a plan of action

The information gathered through defining outcomes, prioritizing interventions and developing a monitoring and evaluation plan should be summarized in an action plan for easy reference by all PTW safety stakeholders and programme implementers. While road safety lead agencies are responsible for the implementation of a national plan of action, the support of stakeholders and advocacy groups is also essential to ensure wider uptake and sustainability of effective and promising PTW interventions.

4.4.1 Core components of a PTW safety action plan

The process of developing a PTW plan of action transforms information gathered through the situational assessment into a clearly defined implementation strategy. It requires input and support from all stakeholders, typically coming together as a multisectoral working group, facilitated by a lead agency (if one is available). Strong action plans have several components in common *(2)*:

- **A well-defined problem:** a clear statement of need, focused on the most important PTW issue(s).
- **Clear objectives:** a set of performance measures that would lead to achieving a specific PTW safety goal (see Section 4.1 for the set of general principles to consider in defining objectives).
- **Action steps:** an outline of planned interventions and how they will be undertaken. It is important to document what was done (things that went to plan and those that did not), as the evaluation needs to conclude not only whether the intervention worked or not, but what worked. Part of the evaluation will be assessing what was actually implemented compared to the plan.
- **Performance indicators:** a measure of progress linked to an objective. Performance indicators inform key activities and linked deliverables and outcomes of an action plan. Each performance indicator should have specific targets, either quantitative or qualitative.
- **A realistic timeline and realistic milestones:** a schedule of activities setting out the start and end dates for executing different activities included in the plan of action. Defining key milestones across the timeline will provide a focus during the implementation process. These milestones can be used to measure progress. Effective implementation requires flexibility to accommodate necessary modifications.
- **Identify roles and responsibilities:** a plan of action needs to clearly assign who, or which agencies, are responsible for which actions or steps. If this is not identified and agreed at the outset – often it will be assumed that someone else is responsible.
- **Adequate resources:** the availability of both financial and human resources is a key component of a plan of action. Successful implementation of the action plan depends on adequate resource allocation. Resources may come from reallocation

of existing funds or mobilization of new funds at the local, national and/or international levels.
- **A monitoring and evaluation system:** a system that provides continuous information that can help guide the ongoing surveillance and assessment of progress as well as periodic evaluation of the key PTW actions, objectives and overall goal (as stated in the plan of action). Performance indicators and targets are defined and stated in the monitoring and evaluation section of a plan of action, and the monitoring and evaluation results are used to adjust PTW safety activities.

An example of a PTW safety plan of action is presented in Box 4.4.

4.4.2 Mobilizing and sustaining support

In addition to leadership provided by a lead agency, the involvement of individuals, the private sector (such as manufacturers, insurers, retailers) and agencies with direct or indirect interest in the different aspects of PTW safety will maximize the likelihood for ongoing and sustained support for the plan of action and linked programmes. Advocacy groups comprise one such stakeholder. In some instances the private sector can be advocates for safety, particularly when they stand to increase profits as a result of the programme. For example the widespread promotion of helmets will benefit helmet manufacturers and retailers, and reduce costs for insurers. Finding the "win-win" strategy between government and private sectors can result in the private sector being a partner and leading advocate for the safety initiative. To sustain the support of stakeholders and agencies, it is important that all are aware of:

- the short- and long-term objectives of the programme;
- why a given intervention or set of interventions is necessary;
- their role within the programme;
- the measures of success;
- key milestones (with a defined timeframe).

Summary

The content of this module is summarized as follows:

- Effective programme implementation requires a strategic approach, from planning to delivery, where every step is based on evidence.
- The process of strategic implementation can be summarized in five steps: defining outcome; prioritizing interventions; defining implementation capacity; developing a monitoring and evaluation plan; and summarizing this in a plan of action.
- Continuous quality improvement – using monitoring and evaluation indicators – should be embedded within PTW programme design and an associated plan of action to ensure results-based accountability by all stakeholders.

BOX 4.4: **Motorcycle Strategic Action Plan, Texas, USA**

The Texas Strategic Action Plan for Motorcycles 2013–2018 was developed over an 18-month period during which a comprehensive situational assessment was undertaken. This assessment included analysis of motorcycle crash and injury data, a statewide survey of motorcycle riders, a review of the literature on effective countermeasures, and a review of "intelligent transport systems" and other technologies for motorcycles and other vehicles. The data analysis identified the characteristics of riders and other road users involved in motorcycle crashes, the major contributing factors, as well as where and when crashes occurred. Once an understanding of the size and nature of the problem, effective countermeasures, and technological and other opportunities for prevention had been established, consultation was undertaken with key stakeholders (including experts, motorcycle riders and other members of the community) to develop the Motorcycle Strategic Action Plan.

Implementation of the plan was overseen by the Texas Motorcycle Safety Coalition (TMSC), which comprised representatives from motorcycle groups and other motorcycle riders, engineers, planning and enforcement agencies, government policy-makers, the education and emergency services sectors, as well as researchers.

Aim

The broad goal of the plan was to reduce the rate of crashes and fatal and serious motorcycle injuries.

Goals*

The goals of the Motorcycle Strategic Action Plan represented priority areas of focus, including:

- improving awareness among motorcyclists of their vulnerability in a crash and ways to increase their conspicuity;
- increasing motorists' awareness of the presence of motorcyclists on the road;
- ensuring proper licensing of all motorcycle operators riding on public roads in texas;
- providing training to all motorcyclists who need or seek it;
- reducing the total number of crashes involving motorcyclists impaired by alcohol or other drugs;
- reducing the number of speed-related motorcycle crashes and increase motorcyclists' knowledge of the dangers of excessive speed;
- increasing the use of all protective equipment by motorcyclists and passengers;
- accommodating the safety needs of motorcyclists in road design, construction and maintenance;
- encouraging and supporting legislative initiatives that promote motorcycle safety (including a specific action on reinstating universal helmet use law).

A number of other goals included ensuring legislation is adequately enforced, policies and programmes are adequately funded, and that evaluation, research and accurate data gathering are undertaken to enable data-driven decision-making.

Action steps

The priority areas identified each had specific action steps and associated timeframes to inform relevant stakeholders of the steps to be undertaken for implementation of the plan.

* The term "goals" in this Strategic Action Plan equate to "objectives" as identified above.

Source: based on *(10).*

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World Health Organization
20 Avenue Appia
1211 Geneva 27
Switzerland
E-mail: traffic@who.int
Web: www.who.int/roadsafety/en/

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