Chapter 1. Opportunities and challenges of powered two-wheelers

This chapter provides an overview to the purpose and background of this report. It reviews in brief the diversity of powered two-wheelers (PTWs) and their role within the transport system. It also outlines the risks facing users of PTWs and the various challenges for traffic safety.

Introduction

Gone are the days when powered two-wheelers (PTWs) were a marginal mode of travel reserved for a few fans of speed and adventure. PTW use has grown significantly during the last decades in most parts of the world (Haworth, 2012), resulting in the PTW gradually becoming a true mobility tool, attracting an increasingly vast and varied user population. It has now become an integral part of the traffic system, offering certain benefits over other modes of transport: what would big cities such as Rome or Paris be like now, for example, if all PTW riders were driving a car instead?

It is estimated that there are more than 300 million powered two-wheelers in the world, with a relatively uneven distribution across regions: around three quarters are found in Asia, 16% in North America and Europe, 5% in Latin America, 1% in Africa and 1% in the Middle East (Rogers, 2008). This disparity is also characterised by the uses made of this mode. Primarily recreational in North America and Australia, the two-wheeler has a much more mixed function in Europe, where it is increasingly used to escape the problems of urban traffic congestion. In other regions of the world it may serve a mainly utilitarian function.

The growing use of powered two-wheelers raises a number of road safety issues. The present report focuses on the safe integration of powered two-wheelers in the traffic system, primarily in OECD countries. However, the specific nature of motorisation in developing countries cannot be ignored. This question is raised within the different issues addressed throughout the report, and there is a chapter specifically dedicated to low- and middle-income countries (LMICs).

The issues and challenges related to the integration of PTWs within the traffic system are complex and varied. Safety and mobility issues require a comprehensive analysis to identify the means for effective action. These include taking into consideration the current risk exposures for riders when on the road network, which lead to them, being classed as "vulnerable road users", along with pedestrians and cyclists. But it is also necessary to further analyse this risk through the different facets that characterise it: the various populations involved, the types of travel concerned, the different crash-generating situations, the factors involved, etc., always keeping in mind the aim of improving the system as a whole rather than blaming a particular component. These issues were borne in mind for the establishment of the Working Group, and they constitute the spirit of this report.

The diversity of powered two-wheelers and riders

There is great diversity among PTWs and their riders and the identification of relevant issues and solutions must acknowledge this diversity.

The term PTW encompasses mopeds, scooters and motorcycles. Tricycles are also often included in this category. This report is mainly focused on the most typical PTWs found on the road, i.e.:

- Motorcycles, with an engine displacement above 50 cc;
- Mopeds, with an engine displacement equal to or below 50 cc;
- Scooters (including three-wheeler MP3s) corresponding to a shape classification ("step-through design") and an engine with automatic transmission. They can be either the "motorcycle" or "moped" type, based on engine displacement.

Electric bicycles, quads, trikes, etc., are not addressed in this report insofar as their usage is currently limited and each has its own particular characteristics. In some countries, recreational off-road riding contributes a significant proportion of the crash trauma associated with PTWs. While this report

may indirectly assist in the improvement of safety for these riders, the particular issues facing off-road riders have not been addressed separately.

The PTW environment has changed greatly in the last decades, not only in size but also in diversity. Today, the domain of the PTW covers a wide diversity of riders, motorcycles and purposes. For example, mopeds and scooters are more widely used in urban areas at moderate speeds; and motorcycles are more commonly used on roads and highways for longer journeys where higher driving speeds are common. Such diversity of vehicle types, uses and users complicates the problem of integrating PTWs within the traffic and transport system. All of this variety must be considered in order to better understand the different facets of the problem and to put forward targeted solutions.

The role of powered two-wheelers within transport systems

The use of PTWs continues to grow each year with multiple economic and social factors contributing to their expansion worldwide, such as increased traffic congestion and inner-city parking problems, increases in gasoline prices, the development of leisure, changes in lifestyle, etc. (Shinar, 2012). The result is that, in spite of a remarkable improvement in traffic safety for all road users (including motorcyclists) in OECD countries, motorcyclist exposure to road risk has increased to the point that in some countries the number of motorcyclists who died in road crashes actually increased over the past two or three decades (Shinar, 2012), while the mortality of other road users declined significantly.

Moreover, as mentioned above, the types of PTWs and the reasons for their use differ according to geographical areas and economic, social and societal factors. PTWs play a significant role in the transport or leisure of their users in different parts of the world, with diverse consequences for safety and potential countermeasures and solutions. While for some, a PTW is a direct substitute for a car, for others it fulfils quite different roles. Its compactness and manoeuvrability allows for flexible travel in congested traffic: thus, it is increasingly used to gain time. Moreover, the sensory experience linked with riding a PTW makes it an object of pleasure for a certain category of people. In the large cities of developed countries (particularly in Europe) PTWs are primarily used for travel and commuting. In other developed countries, like the United States, Canada, Australia and New Zealand, the PTW is often synonymous with “touring” or “riding for recreation”. In emerging and developing economies such as Indonesia, the Philippines and Thailand, the PTW is often a commercial vehicle used for business travel or the transport of goods. Moreover, as pointed out by Haworth (2012), in developed countries PTWs often have a high cylinder capacity and only one passenger, while in the LMICs, engine displacements are smaller and PTWs often have several passengers.

The PTW rider population differs from that of car users in the significant disparity between the use of PTWs by men and by women. However, this disparity varies according to the part of the world, and is currently changing in some countries. This is notably the case in countries with high urbanisation, where a significant increase in the proportion of female PTW riders (from a low base) can be observed. The motivation to ride to avoid traffic congestion is expected to reinforce this trend.

Another change has been noted since the late 1990s: the increasing number of riders (for recreation or transport) in the 40+ generation in certain areas of the world such as Europe, Australia and the United States. This population is partly formed of “returning riders”, who are coming back to motorcycling after a relatively long period of car use, mainly for practical reasons (transport of children, etc.), and partly composed of new riders. There is no clear evidence of higher risks for the returning riders than for experienced riders of a similar age, but a trend towards increasing trauma among this age group is

observed. For the new riders, research evidence has demonstrated an increased risk in the first year of riding.

PTWs also have a special utility and social relevance. As an example, young workers not yet old enough to hold a driving licence (depending on the OECD countries considered), may find the PTW is the only possible means of transport, particularly in rural areas.

In summary, PTWs play a major role in transport for various reasons in different locations. They represent an opportunity to improve mobility, in conjunction with public transport, in many cities suffering from significant congestion and parking challenges. They constitute an integral part of the traffic system, potentially able to meet important future needs in society. In recent years some countries have experienced a rapid growth in the variety, sales, registrations and activity of powered two-wheelers. It must be considered that this growth is likely to accelerate as the world population increases and more people recognise the potential economic, mobility and environmental benefits of PTWs. However, such a development must not be accompanied by a growth in crashes, injuries and fatalities involving PTWs. The reality is that the potential benefits of PTWs in terms of mobility are currently heavily mixed with an overly high societal cost in terms of safety. It is essential to study these safety issues both in terms of their aetiology and in terms of solutions as part of promoting powered two-wheelers as a viable transport alternative to traffic congestion.

An excessive risk

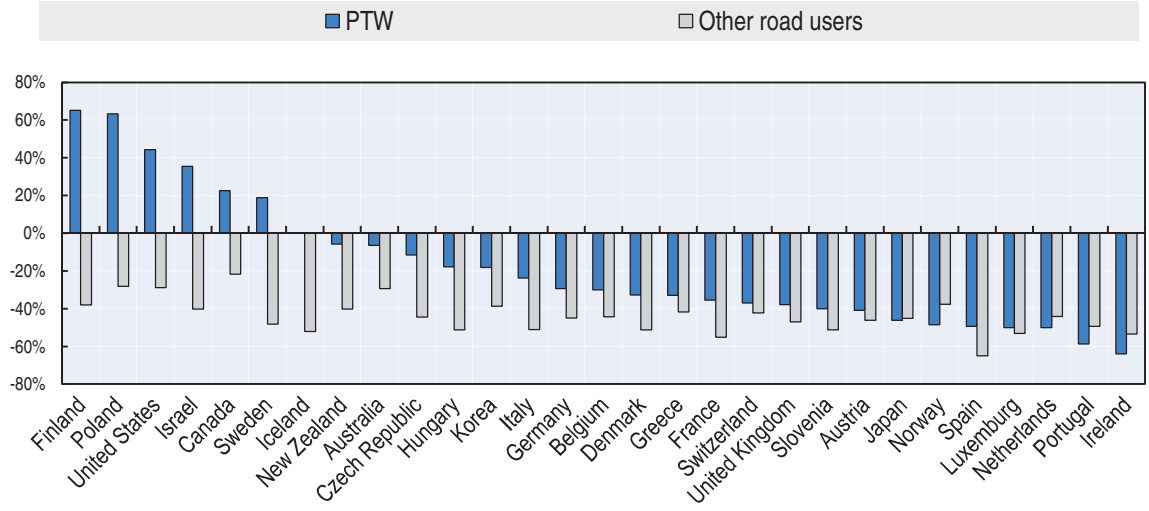
Half of the world's road traffic deaths concern "vulnerable" road users (WHO, 2013), defined as including pedestrians, cyclists and users of PTWs. This proportion is generally higher in low- and middle-income than in high-income countries. On average, PTWs represent 17% of road deaths for only 8% of the vehicle fleet in OECD countries. This proportion can reach higher levels depending on the country, notably as a secondary impact of the progress in safety for other modes.

Regardless of the countries concerned, however, PTW users are confronted with an excessive risk on the road, which has been qualified as "unfair" by Elvik (2009), insofar as for the same number of kilometres driven they have a much higher risk of being killed or severely injured than car occupants. PTW users are clearly overrepresented among road traffic casualty figures, even when they are not overrepresented in crash occurrences. When involved in a crash, PTW riders are significantly more exposed to a higher risk of severe or fatal injury, as are cyclists and pedestrians. Conversely, when involved in a crash with another road user, PTWs are less prone than a car or a truck to provoke severe injuries to others, due to their smaller mass. This is the reason why they can be considered as "vulnerable road users". While the focus is often on the risk of death, the risk of being severely injured, often handicapped for life, is also much higher for PTW users. The number of years of life lost or spent in pain and disability is considerable, with the younger population often being the most affected. This shows the necessity of basing analyses on both fatality and injury data and of integrating the different facets of safety problems.

Whereas there has been substantial progress in most OECD countries in improving road safety and reducing road mortality, PTW riders have not benefited at the same pace as car occupants from safety improvements over the last decade (see Figure 1.1). However, Figure 1.1 does not reflect the increased exposure of PTWs, due to the marked increase of the fleet and its mileage during the past decades.

Figure 1.1. **Changes in fatalities among PTW and other road users**

OECD countries, 2001-2011



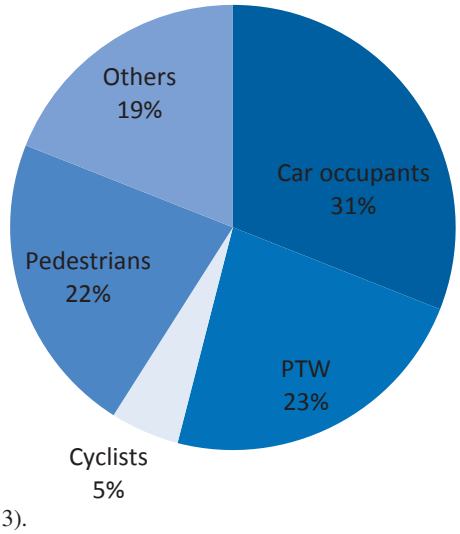
Source: IRTAD (2001-2010 data for Canada).

As we will see in Chapter 3, the risk is unequally shared by different segments of the PTW user population. There are segments of the population with very low risk but, at the opposite, young males are particularly vulnerable.

The situation in developing countries is drastically worse. While they account for only half of the world's registered vehicles, 90% of global traffic deaths occur in low- and middle-income countries. Powered two-wheelers are involved in a very high share of those casualties (see Figure 1.2). For this reason, improving the safety of vulnerable road users, including PTW riders, is among the key priorities identified by the United Nations in the framework of the UN Decade of Action for Road Safety.

Figure 1.2. **World road traffic deaths by road user type**

2010



Source: World Health Organisation (2013).

Why is it riskier to ride a powered two-wheeler?

The level of risk is influenced by many factors. A first, general factor is the intrinsic difficulty of riding a PTW, due to the necessity to balance the vehicle, its lower friction capacity and its greater sensitivity to environmental perturbations (wind, gravel, any change in road surface, etc.) which may destabilise the vehicle. Another influential risk is the domination of cars and larger vehicles in traffic – for which the traffic system has been mainly designed. As a consequence, the traffic system now requires modification to integrate the growing volume of powered two-wheelers.

Elvik (2004) has defined some basic factors which influence the level of risk of road crashes. Among these risk factors, some are considered to affect PTWs more specifically – such as low friction (as mentioned above), but also lack of visibility, failure of road-user "rationality" (such as risk-taking or human error), road-user vulnerability and system forgiveness. All these basic factors will be further discussed within the following chapters.

PTW riders have a higher risk of injury due to their greater vulnerability, resulting from a lack of protection compared to passenger cars, which can lead to very severe consequences in the event of collisions above a certain speed. Safety measures that are already well-recognised, such as helmets, protective clothes, etc., have diminished this vulnerability up to a certain point, but further progress still needs to be made.

Atypical behaviour

By its very nature, driving a PTW may induce a specific behaviour pattern on the road which is different from the drivers of four-wheeled vehicles. Such behaviour is not necessarily "deviant" according to the law, but may surprise other road users.

Even "normal" behaviour (i.e. behaviour common to PTW riders) may be atypical for other vehicle operators. For example, overtaking within a small space, overtaking on the incorrect side, filtering, positioning on one side of the lane, intense acceleration, etc., may be feasible for PTWs but are potentially startling for car drivers, disturbing their normally efficient information-seeking routines. Car drivers and PTW riders need to be aware of and trained concerning the specific driving behaviour and difficulties in perception experienced by both groups.

Atypical behaviour also refers to "deviant" conduct, including stunts, wheelies, etc. Such behaviour is not necessarily frequent, but may contribute to a negative opinion of the PTW community.

A crucial challenge for traffic safety

Road traffic injuries are among the three leading causes of death for people between 5 and 44 years of age. Unless immediate and effective action is taken, road traffic injuries are predicted to become the fifth leading cause of death in the world. May 2011 saw the launch of the worldwide UN Decade of Action for Road Safety, which includes the ambitious target to stabilise and then halve the forecasted level of road fatalities by 2020. To reflect the Decade of Action, several countries have developed strategic plans for the period 2011-2020, including the adoption of safety targets. As an example, the European Union has adopted the target of reducing the number of fatalities by 50% by the year 2020 and a longer term vision to move "close to zero fatalities" by 2050 (European Commission, 2011). The new ISO 39001 standard on road safety management within companies is also an important and ambitious initiative towards this end.

These ambitious targets will only be achievable if serious efforts are made to improve the safety of PTWs. Several countries have developed motorcycling safety strategies and integrated them into their overall safety action plans.

Improving the safety of PTWs must consider all the actors and elements at play. It is not enough to pay attention to PTW riders, one must also monitor their interactions with all other road users, the environment, the vehicles and the social, cultural and political dimensions that shape and supervise their use. Moreover, action should not be restricted to the most obvious parameters but must also take into account the background behind the problems. By acting in a coherent and integrated way on the various axes concerned, safety may be improved through progress on issues as diverse as defensive safety training, development and acceptability of appropriate protective clothing, and raising awareness among road users of the presence of PTWs and the difficulties in their interactions that each may encounter. It is necessary to integrate the specific characteristics of PTWs and their handling difficulties into the design of appropriate and tolerant ("forgiving") infrastructure. Significant progress can now be expected towards the development of devices for active and passive safety, both for PTWs and other vehicles.

But in a longer-term perspective, improving safety also implies improving knowledge of PTWs, by investing in research and in the collection of crash data (not confined to fatalities but also analysing injury crashes and even property damage crashes) and of exposure (traffic) data on which this research work can be based.

A systemic approach to powered two-wheeler safety

Road safety is a complex issue that cannot be solved by focusing only on the behaviour of the operators involved at the sharp end of the process: the road users. As stated in the 2008 OECD report, a focus on enforcement has been the dominant paradigm of traditional road safety policies over the past 30 years. These policies have provided the necessary legislative framework and control with respect to key variables such as speeds, driving under the influence of alcohol, failure to wear a seat-belt or helmet and, more generally, non-compliance with the basic safety rules. Road user compliance with the law and with regulations is a vital element in the delivery of a safe road transport system (Carsten, 2012) and these approaches have contributed to significant improvements in road fatality levels in OECD countries, complementing the improvements made in vehicles and infrastructure, notably in terms of protective devices.

However, even if police enforcement can be considered an inherent part of a sustainable safety approach (Wegman & Aarts, 2006), the focus on the road user is an insufficient paradigm today. To further improve road safety, it is necessary to broaden the spectrum of analysis and intervention. An increasing number of countries tend to think more in terms of the "Safe System approach". This is not opposed to the more classical approach to road safety; it simply provides a wider understanding of the risk factors and the spectrum of interventions which may address them efficiently.

The Safe System approach in traffic

The traffic system was designed and developed by humans but is dangerous to humans, as evidenced by the number of injuries and deaths on the roads. This raises an ethical issue for society, and motivated the Swedish "Vision Zero", directed by the credo that a road safety policy must aim to avoid fatalities and serious casualties.

Beyond ethics, the application of the systemic approach to road safety means considering crashes as anomalies to be suppressed by applying a pattern of measures, which address not only the road users but all the people involved in the traffic system, be it in its conception, equipment, maintenance, legislation,

etc. This relies on the notion of shared responsibility, which implies that everyone must act in favour of road safety instead of blaming each other. Action by all stakeholders is needed: public authorities, governments and local authorities, private companies, the car industry, transport companies, road operators and road users. The application of the systemic approach to road safety under the Safe System approach leads us to review the standards that tend to attribute full responsibility for driving difficulties to the road users only. "*This new thinking means a shift and a sharing for overall road safety, requiring a high level of political, social and community commitment, with government, other groups and individuals all having important roles to play in improving road safety* (OECD, 2008)."

A Safe System approach is based on avoiding the most severe traffic crashes by acting on the different components of the road system to 1) promote safe behaviour on the part of the road users; 2) offer the capacity to correct their eventual errors; 3) protect them when these errors cannot be corrected.

A complex problem cannot be solved by a simple intervention without wider consideration of the context. In a system, every action has consequences, and actions that are insufficiently studied from a whole perspective may result in only shifting the problem. The most effective action does not necessarily rely on where the cause (or the guilt) is the most obvious. For example, infrastructure modifications are often the most sustainable way to avoid speeding. Another important point to consider is that several forms of action are often more effective than a single action. This is what is meant by the concept of integrated safety.

The notion of integrated road safety

The notion of integrated road safety implies promoting safety by acting simultaneously on different levers, keeping in mind that each component is an important factor for the potential improvement of safety, even if it is not always identifiable as a direct contributor to crashes. The key is indeed to find, not the element to blame, but the effective and sustainable solutions using the most effective lever.

Road users

Road users directly influence traffic safety in general and therefore PTW safety. All the potential ways to promote safer riding behaviours should be developed in a coherent way with the measures addressed to infrastructure and the vehicles. Firstly, education should aim to influence the attitudes and behaviours toward other road users. Training follows, first for PTW riders, so that they obtain a good understanding of the difficulties they may encounter on the roads and the appropriate behaviours to adopt (including the use of protective equipment); secondly, for other drivers to make them aware of the potential problems in their interactions with PTWs and the right strategies to use (e.g. information-seeking strategies) to prevent these problems. Specific training is also to be promoted for road designers to sensitise them to the particular difficulties induced by riding a PTW and by being confronted with them. More broadly, the use of information campaigns (for PTWs and for other modes) is useful to make a larger audience aware of the potential problems. Finally, as a last step, enforcement is necessary to validate the other measures. No one action is complete in itself, and all have their limitations; which explains the need to integrate safety measures.

Vehicles – rider interaction

Vehicles can be seen as tools to perform the mobility task of the road users efficiently and safely. As tools, they must fit the capacity of each user and the objectives of their task. The vehicle's characteristics have a fairly direct influence on its operator's driving behaviour and they should be carefully considered to avoid potential misuse. A high acceleration capacity and a high maximum speed

may influence the drivers' behaviour depending on their objectives and personality. Dealing with PTW safety, much is to be gained from technical improvements at various levels (preventive safety, active safety, passive safety and post-crash safety), not only for the PTW itself but also the other vehicles they may interact with.

Road infrastructure

It is sometimes more effective to act indirectly on the road infrastructure than directly on the road users. Human behaviour is partly the product of the environment in which humans operate. The road layout will thus have a decisive influence on their activity, whether behavioural or cognitive (psychological). For road users, the road environment is both the physical guide to behaviour and the framework of the events that can occur. As a consequence, the design, construction, operation and maintenance of the road environment can influence the mechanisms of safety in diverse ways: first, through maladaptive behaviour (for example, unintentionally encouraging over-high speeds, hasty manoeuvres, etc.) which will make drivers more prone to error; and second, through erroneous analysis of the situation encountered (e.g. inadequate visibility, over-complicated or inconsistent layout, etc.). Finally, gaps in protection may exist that will not allow recovery from these errors (e.g. lack of a stabilised shoulder) or that may aggravate their consequences (e.g. aggressiveness of roadside objects).

Background of the Working Group

This Working Group on motorcycling safety and mobility has built on the work at Lillehammer in June 2008 (OECD/ITF, 2008b), where an international workshop brought together researchers, policymakers, industry and motorcyclists' associations. This workshop established a number of areas for improving the safety of motorcycles, which deserve further investigation. The main recommendations from the Lillehammer Workshop are described below:

Box 1.1. **Main recommendations of the Lillehammer Workshop: June 2008**

The following general principles and priority measures illustrate the key conclusions and recommendations of the Lillehammer Workshop.

General principles

- **Co-operation between the various stakeholders.** Improving safety for motorcyclists requires the establishment of a continuing dialogue and co-operation between the various stakeholders, including the motorcyclists themselves, policymakers, researchers and motorcycle manufacturers.
- **Transport and infrastructure policy.** A fundamental motorcycle safety requirement is that motorcycles should have a place in overall transport policy and infrastructure policy/management.
- **Research and evaluation:** Countermeasures need to be founded on evidence-based scientific research into driver and rider behaviour, and before-and-after evaluations should be conducted.

Priority Measures

Priority measures were classified into the following categories: human factors; social and cultural factors; vehicles; and infrastructure. The priority measures listed below are not exhaustive and the classification should not be seen as a rigid framework.

Human factors

Training programmes for motorcyclists. Countries have different training needs, based on their vehicle fleet and riding environment. Motorcycle training should therefore build on existing standards, focus on risk awareness and risk avoidance, and develop an understanding of rider/motorcycle capacities and limitations.

Box 1.1. **Main recommendations of the Lillehammer Workshop: June 2008** *(cont.)*

- **Improved training for general drivers:** A component on awareness and acceptance of motorcyclists should be included in the general training for all drivers, with a particular emphasis on the need for appropriate traffic scanning strategies.
- **Targeted integrated awareness campaigns.** There should be regular, targeted, campaigns addressing both motorcyclists and other road users, supported where necessary by other actions, e.g. enforcement, focused on mutual respect, protective equipment, speed, alcohol and drug issues.
- **Protective equipment for riders.** Where standards for protective equipment exist, these should be promoted; and where they do not, they should be developed, taking into account their safety performance, rider comfort, the ergonomics of their use, costs and the climates and regions where they will be used.

Social / cultural factors

- **Get safety messages to the riders and portrayal of responsible riding:** Safety messages to riders should be developed in partnership with rider groups, in order to use the effectiveness of peer advice in communicating key issues to riders on issues that will impact their communities.
- **Develop awareness of motorcyclists** and mutual respect between road users, education activities and campaigns should be set up from childhood, to emphasise that "road safety means road sharing".

Road environment and infrastructure

- **Guidelines for the development of road infrastructure and training for road designers.** Each level of government should include in their infrastructure guidelines measures for accommodating motorcycles, developed with input from relevant stakeholders. The guidelines should be relevant to the needs of the jurisdiction concerned and co-ordinated with other jurisdictions and levels of government. The needs of motorcycles should be included in the basic training for road designers and highway and traffic engineers.

Vehicles

- **Braking systems.** Manufacturers should continue to introduce advanced (better) **braking systems**, such as combined brake systems and anti-lock-brake systems.
- **Motorcycles in ITS.** Enhanced awareness of motorcycles should be incorporated into the development of all ITS vehicle projects.
- **Headlamps in daytime.** To improve rider/motorcycle PTW conspicuity, for new motorcycles, headlamps should come on automatically when the engine is started; for other motorcycles, riders should switch on their headlamps before they start their journey.

The objectives of the Working Group have been defined as follows:

- To further document areas that were identified in the Lillehammer Workshop as requiring more research.
- To review and synthesise the most recent knowledge dealing with PTW safety.
- Improve the understanding of PTW crash configurations and mechanisms.
- To progress toward the Safe System approach by going further than blaming weaknesses of a component of the traffic system and thinking more in terms of potential sustainably efficient solutions.
- To provide recommendations to policymakers on measures that can be implemented in the short term to improve the safety of motorcyclists.

Content of the report

This report presents state-of-the-art research conclusions and best practices dealing with the safety of PTWs within the traffic system. It is divided into eleven chapters:

- *Chapter 1*, "Opportunities and challenges of powered two-wheelers", gives an overview of the purpose, background and spirit of the report.
- *Chapter 2*, "Powered two-wheeler fleet and usage", presents the mobility patterns of PTWs as essential elements to be considered in order to thoroughly understand the different aspects of the problems in hand, as well as to assess risk exposure.
- *Chapter 3*, "Powered two-wheeler crash characteristics", introduces PTW crash patterns in a descriptive way with the purpose of defining the basis of the problems.
- *Chapter 4*, "Factors contributing to PTW crash characteristics and their severity", examines the most typical crash scenarios and their contributing factors, both at primary (i.e. crash factors) and secondary (i.e. factors related to injury severity) safety levels.
- *Chapter 5*, "Countermeasures addressing road user behaviour", describes measures targeting the road users through education, training and licensing, enforcement and communication campaigns.
- *Chapter 6*, "Countermeasures promoting the use of personal protective equipment" presents the safety value of protective equipment, including helmets, protective clothing, airbag jackets, high visibility clothing and neck braces.
- *Chapter 7*, "Countermeasures targeting vehicles", presents the current developments in vehicle technologies to improve safety of riders. Intelligent transport systems are also examined in this section.
- *Chapter 8,* "Countermeasures targeting infrastructure and traffic management", addresses the issues related to speed and traffic management, along with the necessity for infrastructure design and maintenance to take PTWs into account.
- *Chapter 9*, "Specific powered two-wheeler issues in emerging countries", presents some particular issues to acknowledge when dealing with the question of PTWs in motorising countries.
- *Chapter 10*, "Developing and implementing an integrated road safety strategy for motorcyclists", outlines the need for a strategic approach to PTW safety to integrate effort and guide the allocation of resources toward initiatives that have proven benefits.
- *Chapter 11*, "Conclusions and Recommendations" provides a summary of the main findings of this report and recommendations for the implementation of a toolbox of countermeasures are provided.

The report does not provide a priority list or best practice list of countermeasures that each country should apply. The PTW culture and safety issues differ in each country; therefore, no countermeasure fits the needs of every country. In addition, it is not always possible to evaluate the impact of different countermeasures in the same way. For some countermeasures (e.g. helmet-wearing and ABS) there is stronger scientific evidence than for others (e.g. education and communication campaigns). Countermeasures presenting less marked scientific evidence of effectiveness are nevertheless presented in this report. In this case, it is the Working Group's expert opinion that a countermeasure can be effective even if strong scientific evidence has not yet been established. It can notably be the case that

one measure (e.g. communication) will become fully efficient only when associated with another (e.g. enforcement). No single measure alone will be able to resolve the road safety problems for PTW users. Finally, the countermeasures differ in costs and time span. While some recommendations may be far into the future, others may provide more immediate results.

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