POWERED TWO WHEELERS SAFETY MEASURES: RECOMMENDATIONS AND PRIORITIES

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ABSTRACT

PTW riders are considered to be vulnerable road users as they exhibit high accident and severity rates. There is a slight reduction trend of PTW accidents in Europe over the last years; however this reduction is considerably lower than the corresponding one for car users. At the same time, PTW ownership and use is rising for several reasons including low purchase and use costs, greater movement and parking flexibility in the congested networks, increased popularity of PTW riding as a leisure activity and increasing number of returning riders. Hence, the design of suitable countermeasures that can mitigate PTW accidents is of crucial importance. The aim of this paper is to determine and test a methodological framework to assess road safety measures for PTWs as well as the assessment of existing road safety measures with the use of the proposed methodology. In addition, specific domains which ask for the design and implementation of countermeasures taking into account several effectiveness attributes including the need for such measures, their anticipated impact, acceptance and sustainability as well as the rider perspective are also identified. Research priorities and methodological recommendations are then discussed.

Keywords: motorcycle, powered two wheelers, safety, accidents, countermeasures, guidelines

INTRODUCTION

The PTW community has been experiencing a systematic growth. In the last two decades, the number of PTWs has been more than double, while projections for the next decade show that PTW sales will continue to increase both in developed and developing countries (Haworth and Nielson, 2008; Jamson & Chorlton, 2009; Morris, 2009; Paulozzi et al., 2007; and Shankar and Varghese, 2006). This is due, in part, to the re-use of the urban space, which is reducing the space available for cars. In dense urban areas, where traffic density is high, the PTW is a clear challenger for individual trips as it offers lower travel times and easier parking (Blackman and Haworth, 2010, Transport for London, 2004, Wigan 2000). Due to their small contribution to congestion compared to passenger cars, PTWs are exempted from toll charges in several implemented road pricing schemes in Europe leading to an increase of PTW sales (Duffy and Robinson, 2004). Additionally to commuting purposes, touring is another common use of powered-two-wheelers and is quite popular in Europe but also in the US and Canada (Haworth, 2012). PTW increase is also partly due to the increase of returning riders, i,e, a subgroup of motorcycle users who are returning to riding after several years of non-riding, and who, somewhat worryingly, these returning riders tend to opt for high-powered motorcycles (Jamson & Chorlton, 2009). Last, another important determinant is the low cost associated with PTWs considering purchase, use and maintenance costs; and which makes the use of PTW even more appealing especially for low income groups (Chiou et al., 2009; Kepaptsoglou, 2011).

This observed shift of preference concerning transport modes, as well as the observed increase of circulation of PTWs had resulted in an increase in the frequency and severity of accidents involving PTWs. Current data show PTWs are over-involved in fatal crashes. In particular, PTW riders (including motorcycles and mopeds) comprise a vulnerable road user category as they exhibit high risk rates compared to other drivers (European Commission 2012, Zambon & Hasselberg, 2006), as well as higher accident severity rates (DfT, 2008, Wong et al., 2010). These indicators are further increased when riding exposure is taken into account. Whilst the total number of road accidents/fatalities in EU-18 over the last decade exhibits a decreasing trend, only recently this has coincided with a reduction in accidents/fatalities for PTW riders (ERSO, 2011a; ERSO, 2011b; OECD/ITF, 2010). In addition, the size of the corresponding reduction for PTW riders, and especially motorcyclists, is substantially smaller to that of passenger cars.

Hence, the combination of increased motorcycle usage, increased number of novice (both young or older) riders and increased PTW leisure trips (in which high engine PTW's travelling at high speeds are used) together with the high PTW risk rates demand for the design of effective road safety measures.

The scope of this paper is to collect and analyse current information on countermeasure guidelines from all relevant fields (driver, environment, PTW). To achieve this, a methodological framework needs to be determined. Hence, the aim of this paper is two-fold: the design and testing of a guideline assessment methodology and the subsequent evaluation of the existing PTW road safety measures. In the next section the methodological framework is presented and discussed. Following this, significant findings related to PTW guidelines are discussed. This also involves the specification of domains in which “lack” of guidelines is identified. Last, in the concluding section priorities and recommendations on procedures related to guideline design and evaluation and research needs are elaborated and issues when designing a “new” measure are discussed.

METHODOLOGY

Collection of PTW road safety measures

Following several studies on PTW accidentology that specify several factors contributing to PTW road accidents the question is whether the already implemented countermeasures address the established risk factors. Hence, the collection of all types of possible countermeasures took place in order to design a list of PTW measures which aim at improving PTW road safety (2BESAFE, 2012). By all types of possible road safety measures not only implemented ones were considered but also policies and programmes that have been designed and suggested for implementation at a national, organisational or even broader level (for example EU) were included. These will be referred to from now on as (road safety) guidelines. The first challenging task was to be able to classify these guidelines based on specific relevant criteria, to allow qualitative analysis. This was achieved with the design of a road safety guideline template that had to be filled-in for each of the examined measures and hence provide specific information on them in a structured manner.

Structure of the road safety guideline template

The objective of the template design was to collect information on PTW guidelines in a structured and coherent manner, allowing also for the collection of information on crucial properties of the investigated guidelines. The template consists of four sections. In the 1st section, information on publication and other general guideline characteristics is requested. In particular, publication characteristics serve as a way to identify the guideline if further information is required at a later stage, and involve the guideline title, reference number, publish year and publish body. Following this, the guideline status and coverage as well as the vehicle category it addresses are requested. The status of a guideline indicates its implementation level and ranges from “under discussion” to “implemented”. In the first case, the guideline is mere a discussed countermeasure or policy that might be proposed or implemented in the future whereas in the latter case it indicates the implemented strategy involving PTWs on a particular topic. This classification is of great importance, one may distinguish between "what is done" and "what needs to be done, but still has not been done". Guideline coverage could be national or international. In the first case, this mainly involves guidelines that are developed through national bodies to meet national needs, whereas in the second case the guidelines involve rather global issues. Last, the “vehicle category addressed” mainly distinguishes between guidelines that address motorcycles, mopeds, or both categories, as different road safety issues might involve the different PTW categories.

The 2nd section of the template focuses on the specific characteristics of the guideline and provides information on what the guideline actually is. To design this section, the established risk factors were grouped under broader thematic categories, and relevant guideline domains were identified targeting the respective risk factors. Guideline domains involving horizontal actions were also included. The initial thematic categories are illustrated in Figure 1:

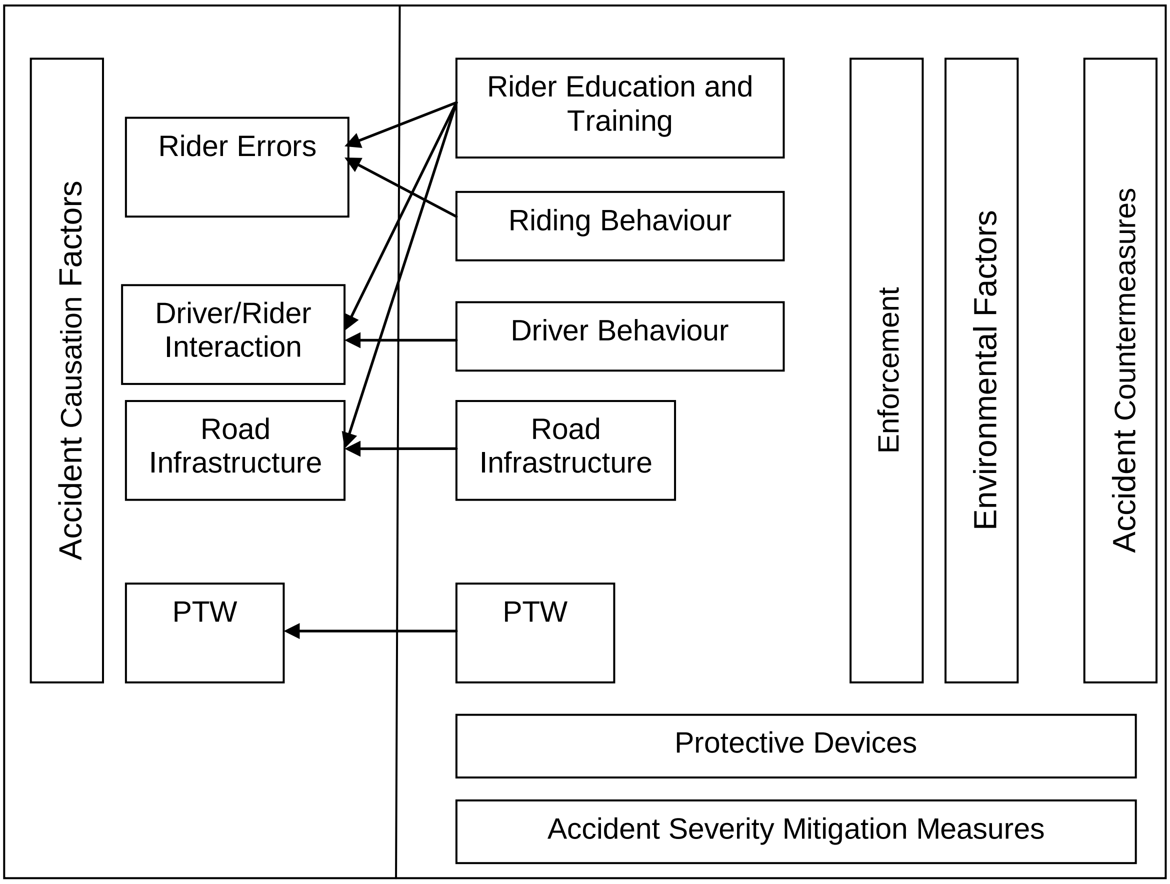

Figure 1 – Accident risk factors and targeted countermeasures

In Figure 1 the risk factors that the measures initially target are also depicted. As noted this was a broad initial classification based on the established risk factors and the existing PTW road safety countermeasures, which could be modified following guideline analysis. Rider education and training is an important element of PTW road safety especially as young and novice riders demonstrate high risk rates. This may also apply to returning riders or to specific rider populations such as violators etc. Guidelines involving riding behaviour this depicts measures not belonging in the previous category, the implementation of which can mitigate PTW accidents which are caused by specific riding behaviour elements (errors, violations etc). Examples may include specific intelligent transport systems. Driver behaviour involves measures targeting drivers, as an important proportion of PTW accidents involve collisions with other vehicles in which the other driver is at fault. Usually these involve education related guidelines. PTW have distinct characteristics from passenger cars, and road infrastructure is mainly designed taking into account passenger car needs. Hence, guidelines on infrastructure design are discussed in this category. Last, in several accidents vehicle related failures may be responsible for their occurrence. Measures targeting at such factors as well as vehicle equipment offering safer riding conditions are included under the "PTW" category. Horizontal actions involve two categories: enforcement and environmental factors. Enforcement involves strategies towards enforcing implemented guidelines and hence increasing rider/driver obedience according to proper/legal behaviour and environmental factors involves a less specific section including policy issues related to campaigns, financing PTW research etc. Last, guidelines involving rider protective devices is at a separate section as this does not reduce accidents but reduces severity rates.

The different categories serve as a way to cluster guidelines, which also allows to identify which domain involving PTW road safety is considered at a satisfactory level and which is neglected. Under each of these categories a number of possible guideline descriptions and the options of the examined guideline being “equal” (i.e. exactly the same) or “similar” to the descriptions are provided. The guideline descriptions presented in the template were extracted from several guideline reports in order for the template to include the main existing guidelines. This will allow for a more representative and hence efficient classification of the examined guidelines if the need of the modification of the guideline categories emerges. The option of describing a different guideline under each of the aforementioned categories (option “other”) was also provided. In addition, at the end of section 2, the guideline classification according to the PTW type (categories developed in respect to the PTW engine size), road category type (urban, inter-urban, rural, highway) and rider category (in respect to rider’s age or experience) was also provided, to identify whether the guideline targeted specific scenario characteristics. Such examples being the prohibition of novice drivers to ride with passengers or the lower speed limits for PTWs compared to passenger cars on specific road categories.

The 3rd section of the guideline template was aimed at collecting information on road safety specific attributes. Information on whether the guideline targets number of conflicts/accidents, crash severity or rider severity is sought. In addition, if the guideline targets reduction of number of conflicts/accidents details related to the type of accident the guideline targets are also requested.

Section 4 of the template involves the collection of the guideline abstract as an opportunity to validate the provided information. In addition, information regarding the status of evaluation, related statistical analysis that triggered the design of the guideline or that followed its implementation as well as information on the process of guideline implementation was requested.

Assessment and prioritisation methodology

Assuming a limited availability of resources, road safety measures should be efficient. Elvik and Vaa (2004) concluded that effective countermeasures to accidents in macroeconomic terms are widely not applied due to political constraints. They proposed that decision-making should more focus on sound and measureable approaches proposing cost-efficiency as the most appropriate one. Hence, an ex-ante methodology to assess road safety guidelines is required, that may also address cost-benefit related issues both directly and indirectly. EU funded project SUPREME (2007) proposed a systematic approach referred to as “best practice” to assess guidelines which could also apply to guidelines that have not been implemented. The approach involves the determination of several relevant attributes and was adopted for the assessment of the collected guidelines. The following guideline attributes were addressed:

- Beneficiaries: population categories that may benefit from the examined guideline.
- Clear definition of the problem: accident causation factor(s) that the guideline targets.

- Size of the problem: accountable risk/severity rates and other related evidence.
- Scientific background: evidence that the measure will improve road safety.
- Implementation and transferability: implementation barriers, critical issues or things to avoid when implementing the measure and raising awareness strategies.
- Expected impact: area in which the measure will have an impact, impact size and potential side effects/measure failures.
- Acceptance: acceptance of the relevant actors (riding/driving population), industry, legislative bodies and other relevant actors.
- Sustainability: behavioural adaptation and risk compensation issues.
- Transferability: possibility of the measure being implemented elsewhere and possible deviations of its implementation.
- Costs and benefits: existing data on costs and benefits.
- Priority: priority scores (0-low priority, 10-high priority).

This analysis was implemented from two different actors: road safety experts and representatives from riding associations (FEMA) in order to include both the scientific but also the rider's perspective. These experts have different backgrounds in terms of their expertise domains (psychologists, human factors specialists, engineers etc), nationality, experiences, and have also different mentality and perspectives. Hence, the scoring of the measures is quite subjective. In addition, a total score indicating the potential of each measure being a successful one was provided by FEMA to have a "formal position" from the point of view of the riders, who are also experts in the field.

ASSESSMENT OF PTW ROAD SAFETY GUIDELINES

Macroscopic Approach – "existing guidelines"

Most of the investigated guidelines were undergone both types of analysis: descriptive through the guideline template and guideline assessment using the "best practice" methodology. They were then classified under more specific categories; these emerged from the review of the collected guidelines and following the guideline descriptions that were provided in the 2nd section of the template. In Table I the modified guideline classifications are presented together with their respective proportion.

Table I – Guideline classification

Actor	Domain	Specific Topics	%
Rider	Education, Licensing and Testing	Licensing, basic training Post licensing training Behaviour	14
Rider (could also involve drivers)	Road Safety Education and Campaigns	Ways to promote motorcycle safety Improvement awareness	7
Rider	Rehabilitation and Diagnostics	Rehabilitation of severe/young violators Traffic psychological assessment	2
Other Road Users	Other Road Users	Other road users responsibilities to	3

		riders Intelligent Transport Systems	
Infrastructure	Road Infrastructure & Pavement	Self-explaining/Forgiving roads Modification of design standards Measures for urban traffic Pavement	24
Vehicle	Standard and Safety Devices	Brakes Passive Safety Devices Advanced Rider Assistance Systems	21
Vehicle & Associated Equipment	Conspicuity and Lights	Improvement of conspicuity Installation and type approval of lights	6
Associated Equipment	Protective Equipment	Standards Various components of protective equipment	7
All domains (horizontal action)	Traffic Law and Enforcement	Enforcement (strategies) Regulations concerning driving manoeuvres	7

Other categories were also considered including guidelines targeting post accident care improvement (2%; e.g. considering specificities of motorcyclist injuries in emergency and first-aid trainings) and improvement of data collection resulting in greater and more in-depth knowledge of accident risk (4%; e.g. in-depth studies, PTW exposure etc). There were specific guideline domains for which a strong focus was found and at the same time there were other domains that were underrepresented. However, to see the whole picture one should also examine which of the aforementioned topics involve implemented guidelines and which comprise merely road safety programs proposed by specific PTW relevant organisational bodies.

In particular, considering the rider element, a domain in which specific guidelines for PTWs are designed and also implemented is this of rider training and education. This might be further improved with the design of stricter licence systems or with the adoption of graduated licensing systems in all European countries, or multiphase driver training systems as is the case with passenger car licensing (Pripfl et al., 2010). Guidelines setting re-training of elderly riders, rider violators and riders involved in traffic accidents have been implemented but mainly in the US and mainly on voluntary basis. Road safety campaigns were also reported; however, a strategic plan determining such campaigns was not defined although it would be beneficial. In several countries, such campaigns (not focused on PTWs but generally on road safety) have been proven to improve young driver behaviour.

In multiple vehicle accidents, it might be the case – and it is in about 75%of the cases – that the driver of the other vehicle caused the accident (Sporner & Kramlich, 2000). In such accidents in cases where the other driver is at fault, guidelines acting as measures improving driver behaviour are relevant. It is emphasised that such guidelines were not reported. A way of developing such guidelines for drivers is mainly through driver training or targeted campaigns on specific issues concerning PTWs. Such issues may include increasing awareness of rider presence on the road, of the specificities of PTW riding; examples being the braking, accelerating and swerving capabilities, PTW “filtering” and rider vulnerability when being involved in accidents due to the absence of separation between the rider and the riding environment. Intelligent transport systems and in particular co-operative ones that consider rider-driver interactions may also be beneficial.

In respect to road infrastructure, it has been proven that certain elements of infrastructure contribute to PTW accidents. Such elements of the road environment include road design (curve radii, visibility, cross fall, gradient), road surface maintenance and road safe barriers and guardrail posts. The two latter do not increase PTW accidents but severity rates. In general, road design mainly takes into account other vehicle dynamics such as passenger cars or heavy goods vehicles (HGV's) and neglects the needs and dynamics of PTWs. In certain countries, guidelines were reported that involved road infrastructure but were merely recommendations rather than mandatory guidelines. Hence, guidelines in the infrastructure domain that consider PTW road safety need to be designed and implemented.

Vehicle relevant guidelines were also reported with a focus on specifications and standards on braking systems (including ABS) and other passive safety devices. However, except for a few basic specifications (what a braking system should comprise, what mirrors need to be installed) the majority involved non-implemented measures.

Conspicuity is an important parameter, the lack of which is a contributing factor to PTW accidents. Conspicuity involves all investigated domains i.e. the rider/driver, the infrastructure and the vehicle. In the first case, guidelines involving driver training programs or advanced systems improving driver vision or warning of the presence of a PTW could help. In the case of the infrastructure, road design allowing for greater visibility might also serve as an effective countermeasure. Last in terms of the vehicle element, the issue as to whether legislation involving having mandating the use of daytime running lights on PTWs lights on during daylight has supporters and opponents would improve conspicuity has not been resolved. In addition, the design and use of protective clothing containing fluorescent and reflective material can be an answer. Conspicuity related guidelines mainly involved mandatory use of daytime running lights, automatic headlights on and a lot of measures to improve the visibility of protective clothing and its use. Still, this is a recently established domain hence its underrepresentation in reported guidelines was anticipated.

A domain in which guidelines – mainly standards acting as guidelines – have been developed for PTW road safety and are implemented is helmet and other protection device design. On the other hand, there was a small number of guidelines involving traffic law and enforcement most of which served as recommendations rather than implemented measures.

Microscopic Approach – "guideline assessment"

The highest number of popular measures depicted from the expert evaluation (both road safety experts and FEMA) include measures that involve road infrastructure. A great number of measures scored highly and those measures were considered to be of high implementation priority in EU. For example measures including guidelines on road design, the performance of road safety audits (RSA) and road safety inspections (RSI) were largely supported. In respect to pavement conditions, road surface testing and reduction of roadway debris also received high scores. In general, the key issue that involved the high ratings of infrastructure measures is that road design, maintenance and operation is performed in a way that PTW dynamics and characteristics are not considered, resulting into making the road environment itself a contributing accident factor in a higher extent that it might be for other types of vehicles.

On the other hand, the majority of the proposed measures to improve the self-explanatory and forgiving nature of roads received either low or conflicting scores, with the exception of specific types of guardrails (under-ride barriers for guardrails and guide posts made of flexible material). This indicates the need to "discover" additional measures for these two categories, as such measures are usually less costly and better accepted by the public.

Another type of measures that got high scores involved post accident care. Measures including improving emergency and post-injury services and acquiring particular knowledge on how to deal with certain types of riders' injuries that need specific care.

In addition, almost all measures related to road safety data and data collection received great support by experts and FEMA. Such measures include improvement of data collection, road conflict investigation, in-depth analysis of PTW accidents, naturalistic riding studies and identification of accident black spots. The interaction of PTWs with other vehicles which is considered to be a contributing accident factor was also considered as the measure involving other road users' responsibilities to riders also scored high.

Measures on driver education, licensing and testing received high, medium and low scores depending on the examined measure. For example defining the legal regulations for obtaining a PTW licence providing initial rider training, organising workshops for young moped riders and providing practical training for novice riders were favoured amongst experts, whereas the graduated license scheme received diverse evaluations. The possibility of being provided access to certain PTW classes for people with a driving license for cars only was considered unbeneficial and also risky.

For several types of measures there were diverse evaluations between road safety experts and rider representatives. A category of measures which was considered promising by experts but not at all by FEMA involves PTW conspicuity; examples being the mandatory use of headlights, having automatic headlamps on (AHO) and recommendations when riding at night including reflective clothing or strips. For the majority of such measures the standpoint of FEMA is that they object to such measures because they infringe on the freedom of road user and that safety-conscious riders already rely on their judgment to decide when their comfort and safety requires actions related to conspicuity. However, the adaptive front lighting system received high scores from both "sides".

At the same time, there were several measures that were not considered to benefit PTW riders at all receiving rather poor scores from road safety experts but not from rider representatives. One reason behind this, was the small anticipated improvement on road safety or due to the high implementation costs. In the latter case, the road safety experts' assessment differed from the riders' representative one. In particular, specific measures that were classified under the road infrastructure category did not receive high scores from experts (although they did receive high scores from FEMA) mainly due to the high costs involved or the risk compensation that riders were anticipated to demonstrate which could reduce or even eliminate the anticipated improvement on PTW safety. An example of the first category is the provision of full paved shoulders and of the second the maintenance of roadway during roadwork.

Other diversions between the experts' rating and the FEMA ratings emerged in cases where mobility vs. safety issues was addressed. An example of such measures involves the traffic in urban areas and the respective regulations such as filtering and lane splitting. FEMA's score was quite high as such measures improve PTW mobility, whereas the experts gave a low scoring mainly due to safety concerns.

Last, the category of road safety education and campaigns received medium or low scores from experts in several cases but high scores from FEMA experts, as was expected, except for showing shocking films concerning motorcycle safety which according to expert and FEMA views should not be implemented. Indicatively, the measures involving educational brochures and using community collaboration to promote motorcycle safety received low scores from experts but high from FEMA.

There were several measures related to the vehicle (PTW) systems such as safety belts, adaptive cruise control (which received the lowest score) the implementation of which was not considered beneficial in any way, except for the design of future break systems which scored highly. The definition of speed limits for PTWs was also considered to be ineffective, as it was considered to be of a discriminating measure.

Generally, the evaluation results of the examined measures were different between the experts' and FEMA's point of view. This difference highlights the need for closer cooperation between researchers and riders. An issue to be further investigated is the comparison between the accident risk perceived by the rider and the actual accident risk, which could be a reason behind the diverse ratings. Still, it should be noted that further research is required in order to be able to suggest potentially successful PTW road safety measures and implement them.

PRIORITIES AND RECOMMENDATIONS

Research priorities

Generally, the design and proper implementation of such measures are not as simple and more detailed knowledge is required on the PTW accidentology domain. In most cases the calculation of risk rates does not involve the inclusion of exposure data (e.g. PTW kilometers) in the formulae, providing misleading results. Hence, actions towards the collection of reliable PTW exposure data well disaggregated for the various demographic, road environment and vehicle characteristics are necessary.

In addition, appropriate data revealing the contributing factors leading to an accident where a PTW is involved have not been extensively collected. In-depth accident studies have been performed but they are well fewer than those for passenger cars. The first main steps of PTW in-depth accident studies were made by McLean et al (1979) and Hurt et al. (1981). Still there are some recent studies where accident in-depth studies on PTW have been performed (MAIDS, 2009); however the available data is still not sufficient to provide a complete picture of the PTW accident phenomenon.

Accident in-depth studies provide identification and quantification of the human (and human machine interaction) errors and the non-adaptation of riders to adverse road environments (infrastructure, pavement), in cases where anticipatory or correctional behaviour can be achieved to avoid an accident. However, the reasons, behind these findings should also be identified. In order to achieve this, more behavioural studies on PTW riders and the interaction of PTW riders and other road users have to be carefully designed and implemented in order to collect the necessary data.

Behavioural data needs to be collected with a range of methods and tools including driving simulators where the environment includes PTWs, riding simulators, Naturalistic Riding Studies (NRS), other verbal methods including questionnaires and focus group discussions and laboratory experiments. For example there is lack of knowledge on PTW movement characteristics and dynamics; only two rather small scale NRS compared to several large scale Naturalistic Driving Studies (NDS) and Field Operational Tests (FOTs) for passenger cars have been undertaken. In addition, there is little knowledge on riders' aims, motives, risk attitudes, perception, anticipation and awareness. Methods for collecting that type of data – looking at riders at a microscopic level – have been applied mainly at a pilot level and others at a more advanced one, but still behavioural data of PTWs in order to actually identify the related causational factors is still scarce.

Methodological recommendations

When designing road safety countermeasures, and especially in cases where these address vulnerable road users it is of vital importance to produce successful road safety measures that will mitigate accident and severity rates. It is important to be able to somehow predict the effect of a measure prior to its implementation, hence to adopt an ex-ante approach. Priorities taking into account both the needs as these are illustrated through risk rates as well as the "resources" as these are demonstrated through the different attributes of a measure need to be considered. A good balance between the needs and resources needs to be established. The methodology carried out in this study can serve as a guideline for pre-assessing measures for improving PTW road safety.

The design of PTW road safety measures should consider two points of view: Both the rider and the other road users, as in accidents where more road users than the PTW are involved it could be the case that their interaction is the primary reason for increased accident probability. There are cases where not only the rider anticipates a different behaviour from the other road user than that exhibited, but also the other road users anticipate a different behaviour from the rider than the actual one. Walker et al (2011) found that drivers and PTW riders exhibit cognitive incompatibility while interpreting the same road situation differently in ways congruent with wider accident rates. Hence, not only road user behaviour, but also other prevailing characteristics of a traffic scene may interact in a different manner between riders and other road users. This should be considered carefully when designing road safety measures.

Hence, it is beneficial that ex-ante (and also post-ante assessment) is performed from at least two points of view: the road safety experts and riders representatives. This was clearly illustrated from the diverse assessment of several measures by the two different actors (road safety experts and rider association representatives). In several cases, rider needs and riding behaviour specificities are not taken into account at a satisfactory level. This is also depicted in the lack of implemented countermeasures in specific domains such as road infrastructure. In addition, the riders' perspective is essential as under specific circumstances, if a measure is not acceptable by the population it targets the possibility of its success is substantially reduced.

The need for specific measures and their effectiveness is also dependant on how and where these measures are applied. In different countries road user mentality, traffic conditions, vehicle movement characteristics, the actual problems/needs of the riding population are different and hence important factors to be taken into consideration when designing and implementing a measure may also differ. For example, in Southern European countries, although it is mandatory to wear a helmet, the proportion of the law-abiding riders is rather low, especially for the pillion passengers and during the summer months when temperatures rise. In contrast, in Northern European countries law obedience is quite high. In this case the installation of a helmet reminder system either with warning or with intervening functionalities (i.e. the engine will not start if the helmet is off) would be quite beneficial for Southern Europe and not a priority for Northern Europe. Some countries face problems with riders not at all or not properly fastening their helmets – maybe as their particular way of demonstrating resistance to mandatory helmet wearing, may be as a result of ignorance or simply sloppiness. Hence, the prevailing conditions in different countries must be taken into account when designing a measure. Transferability of countermeasures between countries is always possible however; in several cases it might be ineffective (unless other types of strategies such as enforcement are also designed to support the measure) or even unnecessary (if there are no needs for this particular measure).

Designing a “new” measure

To complete a comprehensive set of recommendation in terms of PTW measures, issues to consider within design of "new" measures, are addressed. This can provide assistance, where development and implementation of countermeasures is not sufficiently supported by experience from similar action taken before.

As indicated from the guideline assessment results that confirmed the proposed methodology, there are several factors that need to be considered when designing a measure targeting at improving road safety. The focus of a measure should be well defined; measures that target more than one focus items may also be designed, however, their complexity increases. Following this, the impact of the measure and its size should be estimated at an accurate level, and it goes without saying that the impact should be positive regarding road safety. If the measure improves road safety but at the same time reduces mobility or worsens environmental conditions the degree at which it affects each of the different items should be sought; macroeconomic cost-benefit analysis should be used to determine a useful overall efficiency. In addition to the impact itself – as safety measures are usually designed for a group of people not just individuals – the size of the impact or of the problem at which the measure targets needs also to be estimated.

Acceptance issues are of high importance as even if a measure is theoretically effective, if the riding (or driving) population at which it targets does not accept it the compliance rate will be low and hence the practical effectiveness of the measure will be low. In addition, if the measure is not accepted by the riding (or driving) population the integration of this measure with other strategies should be considered. Such strategies include enforcement strategies or providing motives to riders (drivers) such as lower insurance costs. Still if a measure is effective but not accepted by administrative bodies – mainly those who should implement it (usually such reasons may include high cost measures providing low benefits, or low acceptance rates by an important population) – then the measures will not be implemented. Hence, cost-benefit issues – although probably not so politically correct – should also be considered. Once considering the cost and benefits of a measure, one should also include "hidden" costs that will make it unattractive.

Sustainability of a measure is also important as it illustrates its effectiveness through time. If sustainability is low, certain strategies maybe considered in order to increase its sustainability with time. If no such strategies can be applied and sustainability is rather low, then it might be the case that implementing the measure is not recommendable. Another issue of sustainability is compensatory behaviour by the target population. This is most common for poorly implemented training measures, which only focus on improving manoeuvring skills. Such measure may easily result in more risky driving. Transferability is also an important element as the same measure might or might not be implemented with the same success in different places. This depends on several factors including the highway-code of the country, rider and driver training, population mentality, accident contributing factors etc. However, using the same "base" of a measure and altering specific characteristics of the measure in order to adapt it in such a way that it suits the needs of different types of populations can be a potential.

Last, it is of crucial importance to be able to estimate a measure's success. Hence, a method should be designed prior to implementation. If this measure allows for estimation of small groups and proves to be successful it can then be applied to the whole population. If such estimation is not possible, then the success of the measure should have been accurately estimated prior to implementation, as a before-and-after study might prove to be costly both in terms of actual costs but also and most importantly in terms of loss of lives.

Hence, to design a new measure from scratch all the aforementioned factors should be taken into account. Positive answers to all these factors indicate a potential successful measure; however, it might be the case that not all factors receive positive answers. It could be the case - depending on the type of factor that received negative feedback – that correctional actions or strategies are designed and implemented making the measure successful. It should be noted that for the design of these measures we must bear in mind the riding population needs and their resulting behaviour.

However, there are several other ways to design a "new" road safety measure with the aim to improve road safety without starting from scratch, but already having answers to at least some of the aforementioned elements. Previous experience is of great importance when it comes to the design of road safety measures. Failures of road safety measures for PTWs that were anticipated to be successful but were not, should be sought. Once ways to overcome those problems are adapted to this measure, this could be a "new" road safety measure with the potential to succeed.

Another way for designing a potential successful "new" measure involves best practices from other countries. As noted, transferability comprised an element that influences a measure's success. If the measure can be modified according to the specific needs of the riding/driving population it can be a successful "new" measure in several different countries.

In addition, specific road safety measures that have been proven to be successful for other types of vehicles (e.g. passenger cars) could be carefully modified if are relevant to the needs of PTW riders, considering the distinct movement and characteristics of PTWs. Two specific sectors of such measures involve graduated licensing and ITS. Graduated licensing that can be adapted for PTWs in respect to specific bans (e.g. riding with pillion passengers, riding at night, riding at high speed roads, riding specific engine size bikes) and different other characteristics (e.g. riding experience in exposure terms or time) in the different licensing phases, might be a measure that is quite effective. In addition, new technologies should be sought. Most of them have been tested extensively in passenger cars or trucks but not in PTWs. Measures that seem to have a positive effect in road safety should be examined whether they can be adapted for PTWs taking into account the PTW distinct characteristics including vehicle dynamics (mainly related to the weight, size and stability), absence of separation between the rider and the road environment, rider mentality or motives, especially the need for control that riders feel.

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