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To cite this version:

Pierre van Elslande, Rune Elvik. Powered two-wheelers within the traffic system. Editorial. Accident Analysis & Prevention, 2012, 49, pp.1-4. 10.1016/j.aap.2012.09.007 . hal-00851287

HAL Id: hal-00851287

https://hal.science/hal-00851287

Submitted on 13 Aug 2013

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Accident Analysis and Prevention 49 (2012) 1-4 / DOI: 10.1016/j.aap.2012.09.007

Powered two-wheelers within the traffic system

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ABSTRACT

The world of powered two-wheelers has changed dramatically in recent decades, along with a steady increase in the number and diversity of the fleet and uses. This evolution has led to some benefits in terms of mobility, but also some drawbacks in terms of safety. The problems involved are neither simple nor monolithic and there is a lack of knowledge about their different facets and backgrounds that require research work both in terms of risk exposure, accidents factors and impact severity. This special issue of Accident Analysis and Prevention regroups 30 papers devoted to an improvement in this knowledge, exploring the different aspects involved in the safety of powered two-wheelers by complementary methods.

1- Powered two-wheelers in a complex, moving world

Nothing is simple in the traffic world and everything in it is in constant motion. Powered two-wheelers (PTWs), including motorcycles and mopeds – whether classical or scooter models – are a good example of these complexity and evolutionary aspects, considering their recent development and the specificity of the interactions that they give rise to in traffic, sometimes revealing weaknesses in the transport system design, lacks in its protections and holes in its defenses.

PTWs constitute an individual transport mode providing travel freedom and flexibility, making it possible to travel relatively quickly due to their capacity to overtake vehicles, allowing riders to get through most traffic jams, and making it easier to find a parking place very close to the destination. There has been major growth in motorcycling the last decades in most parts of the world in relation to economic and social changes. In many developing countries, specifically in Asia, the increase in urbanization and motorization has led to an increase in PTWs in conjunction with new needs in mobility and because of their easier accessibility, lower cost of use and smaller dimensions as compared to cars (Haworth, 2012). In high income countries, the evolution of the economic and social context, including elements such as the cost of fuel, the development of traffic congestion, car traffic management policies in cities, changes in lifestyle, etc., has also led to an increase in the use of PTWs both for commuting and for touring (Shinar, 2012). The fleet of motorcycles is estimated at 313 million worldwide, most of them in Asia (77%), with Europe and North America comprising only 16% of the global fleet (Rogers, 2008). One consequence of this growth is an increase in exposure to traffic risks.

There has also been a large increase in the diversity of PTWs. Today there is a wide variety of models that cover a wide range of technical capabilities (engine capacity, power to weight ratio, size, maneuverability, etc.) corresponding to a wide variety of users and uses to which they are dedicated.

For example, a recent trend consists of an increase in use of motorcycles and scooters by women (Rogers, 2008), which leads to the adaptation of vehicles and the equipment industry toward this population. PTWs have therefore led to a twofold change in terms of the expansion and diversification that the transport system must harmoniously integrate.

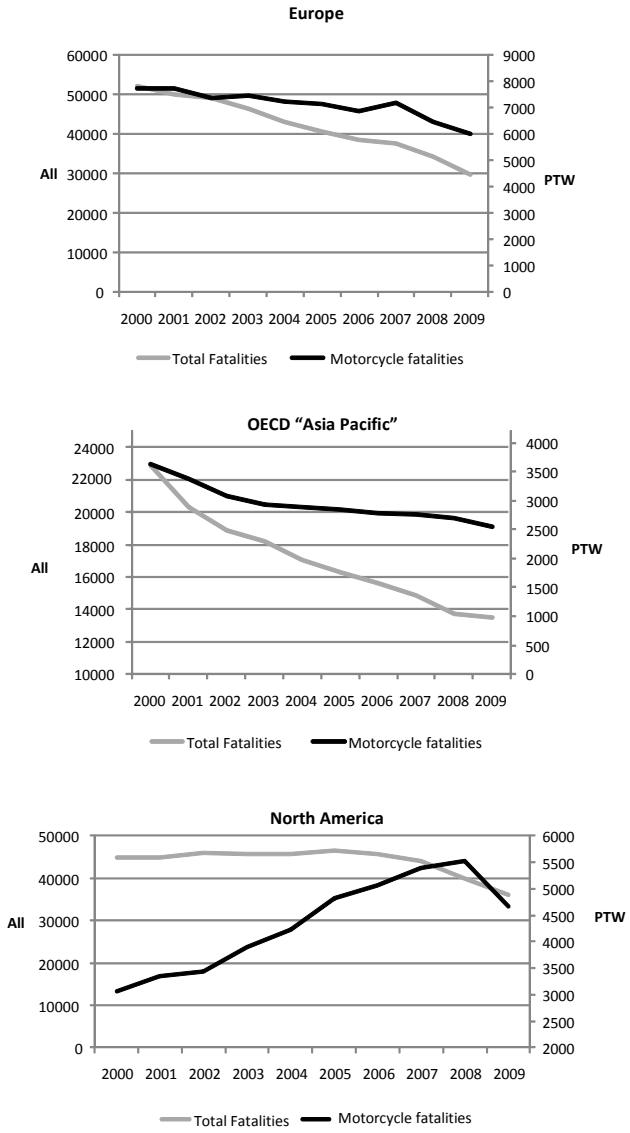
Despite the potential benefits connected to their use, PTWs suffer from some drawbacks. With only two wheels in a line, they are more difficult to control and riders are more sensitive to external disturbances (road difficulties, weather), so something that is not a problem for car drivers can become a major difficulty for them. For example, poor road surface conditions or small objects on the road (e.g. gravel) are likely to cause loss of control of a PTW. More generally, because of the technical specificity related to their small size, their high maneuverability, their acceleration capabilities and the use made of them (e.g. filtering), these vehicles generate interactions that were not originally foreseen in road design. The public transport space was primarily designed from the perspective of automobile traffic. Concerns and interventions have historically focused on the safety of four-wheel vehicles (Muzira, Chesheva, Banjo, and Marquez, 2009). It gave sidewalks to pedestrians, bike lanes to cyclists, bus lanes to buses, but no specific path was reserved for PTWs, which must fit into streets that are crowded with cars, notably in Western countries where, some decades ago, PTWs had very little incidence on traffic. It should be realized, however, that these two modes of travel entail different underlying practices and their interactions are sometimes confrontational, almost systematically to the disadvantage of riders, who are very vulnerable in case of the slightest collisions and falls.

2- Excessive risk

One indicator of the under-consideration of PTWs by the transport system is the high level of risk they are faced with. Powered two-wheeler riders are among the road users who are most vulnerable to road risks, along with pedestrians and cyclists (WHO, 2009). Statistical data show that they account for more than 15% of people killed on European roads each year. In OECD countries more generally, more than 11,000 PTW riders are killed on the roads each year, accounting on average for 14% of total fatalities, while PTWs account for around 5% of the fleet and even less if mileage is considered (IRTAD, 2011). The share of PTW fatalities can be much higher in low- and middle-income countries, with nearly 200,000 deaths worldwide according to the World Health Organization (WHO, 2009). Moreover, medical data suggest a dramatic amount of severe injuries among this population compared to their moderate share in the overall traffic.

Thus it is recognized that PTW fatality and injury rates are worse than for car occupants, with figures varying depending on the countries considered. Moreover, whereas an overall tendency toward an improvement in traffic safety for passenger cars has been noted for most countries around the world, both for fatalities and injuries (IRTAD, 2011), PTWs do not follow this trend: as indicated by Shinar (2012), progress has not been as consistent for vulnerable road users as a whole and specifically for PTW riders.

According to Haworth (2012), motorcycling itself tends to be safer and, in Figure 1, general progress in fatality rates can be seen, with some exceptions such as the USA, partly in connection with the number of returning riders and weakened mandatory helmet laws in many states (Morris, 2009). There is also a decrease in the number of seriously injured road users in nearly all OECD countries (IRTAD, 2011), although this reduction is less marked than for fatalities. But this progress is not as substantial in the light of the far greater progress in overall road safety made during the same period in the same regions, the result being a significant excess risk for PTW riders per mile ridden as compared to car drivers.



Note. OECD "Asia Pacific" includes: Australia, Japan, Korea and New Zealand

Fig. 1. Relative trends in the total number of deaths and PTW fatalities in 2000-2009 for (a) Europe; (b) OECD "Asia-Pacific"; (c) North America (Source: IRTAD)

It is often debated whether the higher risk faced by PTW riders comes from more risky behavior among riders than among other drivers of motorized vehicles or if this excess risk is attributable to the vulnerability of riders in case of a crash. From a study comparing the number of injury accidents reported by the police and the number of accidents reported by insurance providers in Norway for car drivers and PTW riders, Elvik (2009) concluded that riders were not involved in accidents more often than car drivers, so it is the outcome in terms of injury that differs between these two groups of road users. But this does not, of course, mean that there is no risk-taking in motorcycling as a whole. It just suggests that this risk-taking is, on average, no more incidental in crash occurrence than that found in car driving. All these results show that, as indicated above, the problems are not so simple. And by simplifying them too much, we risk missing the complementarity between the different levers of action. We need to understand the stakes of the core parameters involved both on the primary safety level

(the causes of crashes) and on the secondary safety level (the causes of injuries and fatalities) so that we can adequately define preventive and protective countermeasures.

3- Safe system approach to riding

As indicated above, the rate of fatalities and severe injuries among PTW riders constitutes a critical issue both in motorized and motorizing countries. This dramatically demonstrates the need to integrate PTWs into traffic more harmoniously. "Powered two-wheelers within the traffic system", the title of this special issue of the journal Accident Analysis & Prevention, comes from the conviction that PTWs are an integral part of the traffic system but at the same time constitute a specific component that deviates somewhat from car standards and needs to be better accommodated and assimilated in the system. As an actual component of the traffic system, PTWs must benefit from safety measures on the same level as others.

Development of a safe system approach in the traffic domain implies designing a road transport system that is better adapted to its users, all its users (OECD, 2008; WHO, 2009). With this in mind, the traffic system must first take into account the fact that road users are human beings and that, as human beings, they can be subject to errors when confronted with overly demanding situations (complex, unexpected, under time constraints, with long term demands in vigilance, etc.). A safe transport system should be able to accommodate the most common human errors, i.e. to prevent them by promoting the right behaviors spontaneously ("self-explaining roads") and to offer road users the capacity to master these errors so that they do not lead to dramatic consequences ("forgiving roads"). A safe system must then take into consideration the intrinsic fragility of the human body and its vulnerability when subjected to excessive energy dissipation. When errors cannot be prevented or corrected, the system's defenses should be designed so that they do not result in severe injuries or fatalities.

Prevention, correction and protection are the three main pillars of a safe transport system, and these pillars require reciprocal adaptation of all the components involved in traffic: road users, road networks and vehicles, as well as all the stakeholders who have a role to play. A safe system approach aims to make the road system intrinsically safe. It demands equity in addressing the safety needs of all motorized and non-motorized users of the system. Motorcycling can be better integrated into such a system, promoting better safety of use, instead of considering it as an unsafe means of transport as such (as would be biking and walking…). Imagine a world where all powered two-wheel vehicles are cars, and the dramatic consequences this would have in terms of mobility. Now imagine a world where all cars are PTWs - would the risk of riding be the same?

It is not enough to consider PTWs as vulnerable road users. The critical situations they encounter on the road are not the same as those encountered by cyclists or pedestrians. Considering all vulnerable users on the same level is not the best way to understand their particular difficulties and the specific solutions needed to address to each of them. In order to properly solve the problems, there is a need for a thorough understanding of the difficulties met by the different road users.

4- Needs for research and development

The state of road risks calls for a renewed corpus of research work and development on connected topics. The aim of the present special issue is to collect the most recent advances in scientific knowledge provided by researchers and practitioners dealing with the difficulties related to the integration of powered two-wheelers into the traffic system and the solutions studied to prevent and counteract these problems.

In fact, further research is needed to gain a more comprehensive understanding of the different facets of the excess risk with which PTW riders are faced. Accidents are highly complex processes that

cannot be reduced to the intervention of a single factor. To obtain operational results, their analysis should not be limited to blaming the person "responsible", but rather should consider the participation of all actors and all factors, making it possible to find solutions for each of them. And the need to address the problems with all their complexity will be emphasized, without focusing on reasoning that opposes one user group to another, but rather by working towards a harmonization of interactions. Different problems are involved in different crash configurations: loss of control, so-called “sport bike” crashes, accidents involving pedestrians, intersections with right-of-way, etc. These different problems have to be fully recognized and studied as such to find well-targeted solutions.

There is also a need for more accurate data on risk exposure (mileage, type of journey) in order to better estimate and qualify the risks associated with riding under such and such conditions, and a need for more detailed data on crash scenarios for the different kinds of PTWs. More generally speaking, a clear distinction must be made between risk exposure factors (mobility conditions), accident causation factors (causes of driving failures) and injury severity factors (lack of protection, aggressive edge), each of these categories of factors leading to completely different countermeasures.

The positive side of bad results is that they leave room for improvement and show where this improvement can be done. There is a pool of safety measures that can be implemented to prevent crashes and improve protection. Some of them have been well recognized for quite a long time and have led to reiterated research work and evaluations (helmets, protective clothing, daytime running lights, etc.). These measures not only have to be fully implemented in the countries were they are not yet in place in order to reduce the risks related to motorcycling, but they also have to be further studied for continuous improvement as attested by the papers in this issue. Other measures should lead to a more substantial corpus of research and evaluations, as they seem promising. Fully acknowledging the complexity of the problems, Narelle Haworth (2012) summed up the most important challenges to be considered for the development of safety measures. These first relate to all aspects concerning PTW users (training, licensing, coaching, enforcement, wearing appropriate protective equipment, etc.), resulting in safer riding behavior. They also relate to other road users to ensure that they are more aware of PTWs and skilled in interacting with them. Challenges are also associated with the road environment both in terms of crash causation (visibility, traffic speed, etc.) and in terms of the resulting severity of injury (side obstacles, crash barriers, etc.). Lastly, they relate to vehicles (e.g. Antilock Braking Systems) in order to promote a reduction both in accident involvement, thanks to better avoidance capacities, and in crash severity through the reduction of impact speeds (Moore and Yan, 2009; Rizzi, Strandroth, and Tingvall, 2009.). All these challenges should be considered in an integrative way in order to improve the inherent safety and protective quality of the traffic system to the benefit of all road users.

5- Overview

The idea for the present special issue of AAP came about during an international symposium held in Marseille, France, on 5-6 March 2009, one conclusion of which was to show the relative lack of research work dedicated to PTWs and the necessity to consider them specifically, not only as part of "vulnerable road users" (Van Elslande, 2009). The 30 articles comprising this issue reflect current concerns in the research field dedicated to PTWs from around the world. They illustrate the broad range of methods that could be usefully combined, including laboratory and simulation studies, queries, statistical analyses of national databases and in-depth accident studies. The questions investigated and the findings and recommendations to which they lead constitute a valuable contribution both in terms of knowledge and in terms of their application toward greater safety for PTWs within the traffic system. The papers also point out, directly or between the lines, the weaknesses in our knowledge and, therefore, the need for further research work.

The volume is organized around three main questions: accident factors, behavior and representations, and injury factors. A first group of 11 articles is devoted to the analysis of risks and factors behind

crashes based on statistical and epidemiological approaches. They notably show the importance of clearly differentiating between the different problems and the need for good quality information on accident configurations. Some of these articles give a more in-depth analysis of the influence of specific factors recognized as critical for PTWs, such as speed and conspicuity, making use of crash and experimental data. It is indeed of great interest to combine macroscopic data with more specific data in order to study problems more comprehensively. Then, a substantial set of 13 articles is devoted to the upstream analysis of behavior and representations related to PTW riding. Within that group, some papers address the question of risk awareness and risk perception by PTW riders and by other road users, showing the gap – and sometimes the misunderstanding – between user groups. Other papers more directly apprehend the behavior of PTWs and their riders. Lastly, the dramatic question of injuries related to PTW accidents is covered, with 6 articles based on complementary methods that provide a better understanding of the causes of rider injuries and how to protect them.

In conclusion, this special issue presents the state of the art in our field, but is at the same time just one step forward in our understanding of safety problems linked to PTW riding. There is still plenty of room for developing research in order to understand the difficulties connected with PTWs within the traffic system and to find solutions to promote concern for the specificity of each problem along with the particularity of each region where they occur. Identifying problems is one thing, solving them is a whole task altogether. Complementarily, there is also much work to be done in terms of applications and expertise to help these solutions to be implemented in an efficient way[1].

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[1] As an example of such actions, an on-going OECD / International Transportation Forum working group on motorcycling safety will deliver a report in early 2013 with policy recommendations on measures to improve the safety of riders (see Van Elslande, 2012, for more information).