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### ► To cite this version:

Pierre van Elslande. Motorized two-wheelers inside the traffic system. What are the key questions for enhancing road safety?. International Motorcycle Symposium 2009, Sep 2009, Germany. pp.11-13. hal-00957465

**HAL Id: hal-00957465**

**<https://hal.science/hal-00957465v1>**

Submitted on 10 Mar 2014

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## Motorized two-wheelers inside the traffic system: What are the key questions for enhancing road safety?

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### Introduction

Marginal in the past, powered-two-wheelers (PTW) have become an increasingly popular mode of travel, notably as a response to our current society difficulties, such as petrol cost, traffic jams, and the needs for mobility. As a result of this growing use, the crashes PTW drivers are victims of in terms of mortality and morbidity represent an actual problem of public health. PTW have come to the limelight of road safety and their accidents question the traffic system as a whole. The problem is not as simple as it is sometimes considered, and in order to define efficient solutions, we need to go further than an overall analysis. We have to know more about the different facets of the various difficulties that PTW meet when interacting with the road layout and with the traffic.

### An unfair risk

The motorized two-wheeled vehicles riders are, with the pedestrians and bicyclists, the users most exposed to the road risk. Statistical data show that they represent 16% of people killed on the road in Europe (SafetyNet, 2008) whereas they represent less than 2% of the quan-

tity of mobility. An eloquent indicator of their weakness is the risk to be killed as regard to the mileage. The risk per km is thus 20 times superior on a motorized two-wheeler vehicle than in the car. And perhaps even worse is the risk of being severely injured, with handicap for life (Amoros, Martin and Laumon, 2008). Furthermore, it is known that accident reporting in national databases is incomplete and there are indications that it is more incomplete for motorcycle and moped riders than for car occupants (Elvik and Vaa, 2004). It is notably the case for single vehicle accidents which are specifically underestimated for PTW.

This excess risk comes partly from the greater vulnerability of the PTW users, in the sense that, with the absence of protection, the least collision exposes them to often serious wounds. But they also come from a stronger involvement in certain types of accidents. These two characteristics of their accidentalness attest a certain inadequacy between the motorized two-wheeled vehicle and the current driving system. We must consider that, historically, this system have been essentially conceived and directed according to the problems of cars traffic flow. It requires an effort of adaptation towards the motorized two-wheeled vehicles as being an integral part of road users, to whom the traffic system should have the objective to be adapted.

### Why is it so difficult to solve the problem?

In relation with their development, the motorized two-wheelers' population constitutes an increasingly heterogeneous family, with regard to the types of vehicle (trail, sporting, scooter, etc), the very strong diversity of their characteristics, as well as the diversification of their use (from the motor bike "for fun" up to the "utilitarian" motor bike). Such a disparity of the modes, uses,

attitudes (in particular with respect to risk taking) conditions particular practices which are not without consequence on the various problems of interaction met within the traffic, and on the accidents which results from it. The different facets of the motorized two-wheelers problematic thus deserve to be apprehended in-depth from the point of view of their determinants and their consequences in terms of both primary and secondary safety. The various forms of accidents proceed from specific mechanisms which are essential to highlight so as to cover the range of the problems. One cannot speak about "the PTW" but "the PTWS". One cannot speak either about "the problem" of the motorized two-wheelers, but about the plurality of the problems which their inscription in the driving system underlies. The problems they represent being plural, they must be studied operationally in their various facets. Only under the condition of a well documented knowledge of this plurality, adapted solutions could be defined in a targeted way.

#### What are the key questions for enhancing ptw safety on the road?

Crashes can be defined as multi-factorial processes. Every single accident case involves a combination of causes, the result of which being the incapacity of the road users to compensate for the difficulties encountered. These different types of factors act along the malfunction production chain, from the "driving phase" to the "impact phase" (figure 1). Safety measures should, in the same way, be found at these different levels, whether by acting on the drivers (including "other" road users), on the vehicles or/and on the road environment.



Figure 1. Main phases within an accident sequence (from Van Elslande et al, 2008)

Among the key questions that can be drawn from research works found in the literature, we can briefly mention the followings<sup>1</sup>:

#### • PTW conspicuity

A large amount of research works insist on the fact that PTW are more difficult to perceive than other vehicles, and that this poor "conspicuity" plays an important role in accident occurring. However, such a result is governed by complex mechanisms involving perceptive, cognitive and behavioral factors. A better knowledge of these underlying factors will condition the efficiency of the measures taken.

#### • PTW users, usage, culture and risk exposure

Very few knowledge exists on the precise risk exposure of PTW users. It would thus be useful to put forward studies to know better the variety of PTW users and the variety of their mobility behavior, in order to identify well targeted strategies of prevention. Led on the European scale, this work could allow better documented comparisons of the accident risk on motorized two-wheelers between countries. Further upstream social and cultural questions should also be investigated as far as they condition driving behavior at its early stages.

#### • Training and licensing

The effect of training is complex and has sometimes proved to be counterproductive, depending on the content and the aim of the instruction. As a general point, PTW training should be more oriented toward the development of prevention abilities than recuperation skills acquisition. Training should also concern other road users, with the aim to allowing them to better interact with PTW. Besides, the introduction of a graduated driving licence for motorcyclists has been shown to be associated with a safety benefit.

<sup>1</sup> Of course, this list is non exhaustive.

#### • Technological systems

PTW is a vehicle which presents particular difficulties of driving. So it asks for the development of specific driving aids. The first works on the equipment of antilock brakes on motorcycles have been found to reduce overall accident involvement and severity. Other systems are to be developed, useful in driving situation (e.g. early detection of the situations at risk), as it in emergency situation (e.g. braking and stability improvement). Safety devices allowing the other users to better detect and interact with the PTW also are to be developed and evaluated.

#### • An infrastructure helpful, tolerant and protective for PTW users

PTW is a vehicle particularly sensitive to the characteristics of infrastructure (curve radius, friction, visibility, possibility of recuperation, fixed obstacles, etc.). A difficulty easily compensated for on four wheels can become a major drawback on two wheels. Three aspects are to be considered in order to promote a safe road layout for PTW: 1/ A "helpful" infrastructure, allowing the rider not to find himself in critical situation, 2/ A "tolerant" infrastructure, allowing this user to recover his own errors and those of the others, 3/ A "protective" infrastructure, taking into account better the PTW riders vulnerability in case of impact. Works to increase the knowledge in these domains, still too fragmented, are to be developed.

#### • Protection devices

Continuous progresses have to be done to reduce PTW riders' vulnerability. The appropriate safety devices must take into account their practicability for their user: ergonomics, cost, adaptation to weather conditions (for example summer time).

#### • Evaluation of safety measures

In a general way, the safety measures suffer from of a lack of objective evaluation of their efficiency. It would be advisable to put forward studies estimating the effects of the actions dedicated to PTW users.

#### Conclusion

Knowledge is progressing, but there is still a real need for research on the foundations underlying PTW insecurity, with a view to defining measures for addressing its specificities and meeting the needs of each participant in the driving system. Beyond the observation of the inherent vulnerability of this form of travel, it should be considered that PTWs have a specific dynamic behaviour that sometimes leads to greater difficulties of control in the same conditions. Their particular place in traffic should also be taken into account, with sizes and performances that can lead to special difficulties in interaction with other users of the road space.

In brief, we still need to progress in understanding the different mechanisms at work in this safety problems. This knowledge can be considered a necessary condition for defining more targeted, and therefore better suited, actions.

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