Deliverable 6

Traffic Management & ITS

Please refer to this report as follows:

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Deliverable Overview

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<tr>
<td>2BESAFE</td>
<td>2-Wheeler Behaviour and Safety (research project)</td>
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<tr>
<td>ABS</td>
<td>Anti-lock Braking System</td>
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<td>ACC</td>
<td>Adaptive Cruise Control</td>
</tr>
<tr>
<td>ACEM</td>
<td>The Motorcycle Industry in Europe</td>
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<td>ACN</td>
<td>Automatic crash notification</td>
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<td>ADAS</td>
<td>Advanced Driver Assistance Systems</td>
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<tr>
<td>AEBS</td>
<td>Advanced Emergency Braking Systems</td>
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<td>AHL</td>
<td>Adaptive Headlights</td>
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<tr>
<td>AMVIR</td>
<td>Association of Motor Vehicles Importers Representatives (Greece) - Σύνδεσμος Εισαγωγέων Αντιπροσώπων Αυτοκινήτων</td>
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<tr>
<td>ANCMA</td>
<td>Associazione Nazionale Ciclo Motociclo Accessori (Italy)</td>
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<td>ARAS</td>
<td>Advanced Rider Assistance System</td>
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<td>ASC</td>
<td>Automatic Stability Control</td>
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<td>AV</td>
<td>Automated Vehicle</td>
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<tr>
<td>BASi</td>
<td>The Federal Highway Research Institute (Germany) - Bundesanstalt für Straßenwesen</td>
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<tr>
<td>BMF</td>
<td>British Motorcyclists Federation (United Kingdom)</td>
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<tr>
<td>BOM</td>
<td>bill-of-materials</td>
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<tr>
<td>BSD-T</td>
<td>Blind spot detection for trucks</td>
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<tr>
<td>BU</td>
<td>Biker Union (Germany)</td>
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<tr>
<td>BVDM</td>
<td>Bundesverband der Motorradfahrer (Germany)</td>
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<tr>
<td>CBS</td>
<td>Combined braking system</td>
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<tr>
<td>C-ITS</td>
<td>Communication Information Technology Systems</td>
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<tr>
<td>COMeSafety</td>
<td>Communication for eSafety (research project)</td>
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<tr>
<td>DACOTA</td>
<td>Data Collection Transfer &amp; Analysis (research project)</td>
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<tr>
<td>DDM</td>
<td>Driver Drowsiness Monitoring and Warning</td>
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<tr>
<td>DG CONNECT</td>
<td>Directorate-General Communications Networks, Content and Technology</td>
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<td>DG ENTR</td>
<td>Directorate-General Enterprise and Industry</td>
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<tr>
<td>DG MOVE</td>
<td>Directorate-General for Mobility and Transport</td>
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<tr>
<td>DoT</td>
<td>Department of Transportation</td>
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<tr>
<td>DRL</td>
<td>Daytime Running Lamps</td>
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<td>PDS/EBR</td>
<td>Pedestrian detection systems combined with automatic emergency braking</td>
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<td>EC</td>
<td>European Commission</td>
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<td>ECOSTAND</td>
<td>Joint EU - Japan - US task force</td>
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<td>EeP</td>
<td>European eCall implementation platform</td>
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<td>ERSO</td>
<td>The European Road Safety Observatory</td>
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<td>ESC</td>
<td>Electronic Stability Control</td>
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<td>ETSC</td>
<td>European Transport Safety Council</td>
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EU European Union
EuroNCAP European New Car Assessment Program
FACTUM Traffic and Social analysis (Austria) - Verkehrs und Sozialanalysen
FEBIAC Fédération Belge de l'Automobile & du Cycle (Belgium)
FEMA Federation of European Motorcyclist's Associations
FFMC Fédération Française des Motards en Colère (France)
FIA International Automobile Federation - Federation Internationale de l'Automobile
FMI Federazione Motociclistica Italiana (Italy)
FOTNET Field Operational Test Networking and Data Sharing Support (research project)
FOTs Fields Operational Tests
GDV The German Insurance Association (Germany) - Gesamtverband der Deutschen Versicherungswirtschaft
HMI Human Machine Interface
I2V Infrastructure-to-vehicles communication
IBSR The Belgian Road Safety Institute (Belgium) - Institut Belge pour la Sécurité Routière
ICT Information and communication technologies
IFZ Institut für Zweiradsicherheit (Germany)
INS Intersection Safety
INS Intersection safety
ISA Intelligent Speed Adaptation
ITF International Transport Forum
ITS Intelligent Transport Systems
IVIS In-Vehicle Information Systems
IVM The German Motorcycle Industry Association (Germany) - Industrie-Verband Motorrad
IVSS In-Vehicle Safety Systems
KFW Austrian Road Safety Board (Austria) - Karatorium für Verkehrssicherheit
LCA Lane Change Assist
LDW Lane Departure Warning
LDWS Lane Departure Warning Systems
Lillehm. Workshop on Motorcycling Safety, Lillehammer
LMI Lëtzebuerger Moto-Initiativ (Luxembourg)
MAG Belgium Motorcycle Action Group (Belgium)
MAG Ireland Motorcyclists Action Group (Ireland)
MAG NL Motorrijders Actie Groep (the Netherlands)
MCTC MC Touring Club (Denmark)
MLIT Japanese Ministry of Land, Infrastructure, Transport and Tourism
MoC Memorandum of Cooperation
MSC Motorcycle Stability Control
NMCU The Norwegian Motorcycle Union (Norway) - Norsk Motorcykkel Union
OBIS On-Bike Information Systems
OEMs Original equipment manufacturer
<table>
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<tr>
<th>Acronym</th>
<th>Description</th>
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<tr>
<td>PCV</td>
<td>Pre-crash protection of VRU</td>
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<tr>
<td>PROMISING</td>
<td>Promotion of mobility and safety of vulnerable road users (research project)</td>
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<tr>
<td>PTW</td>
<td>Powered two-wheelers</td>
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<tr>
<td>R&amp;D</td>
<td>Research and development</td>
</tr>
<tr>
<td>RITA</td>
<td>Research and Innovative Technology Administration</td>
</tr>
<tr>
<td>ROSA</td>
<td>European Handbook on Good Practices in Safety for Motorcyclists (research project)</td>
</tr>
<tr>
<td>RTTI</td>
<td>Real-time traffic and travel information</td>
</tr>
<tr>
<td>SAFERIDER</td>
<td>Advanced Telematics for enhancing the safety and comfort of motorcycle riders (research project)</td>
</tr>
<tr>
<td>SARTRE</td>
<td>Social Attitudes to Road Traffic Risks in Europe (research project)</td>
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<tr>
<td>SIM</td>
<td>Safety In Motion (research project)</td>
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<tr>
<td>SMCR</td>
<td>European Handbook on Good Practices in Safety for Motorcyclists (research project)</td>
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<tr>
<td>SUPREME</td>
<td>Summary and publication of Best Practices in Road safety in the EU Member States (research project)</td>
</tr>
<tr>
<td>TPMS</td>
<td>Tyre Pressure Monitoring Systems</td>
</tr>
<tr>
<td>TRACE</td>
<td>Traffic Accident Causation in Europe</td>
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<tr>
<td>TRAFFI</td>
<td>Finnish Transport Safety Agency (Finland) - Liikenteen turvallisuusvirasto</td>
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<tr>
<td>TRB</td>
<td>Transport Research Board</td>
</tr>
<tr>
<td>UNECE</td>
<td>United Nations Economic Commission for Europe</td>
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<tr>
<td>UNECE</td>
<td>United Nations Economic Commission for Europe</td>
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<tr>
<td>US</td>
<td>United States</td>
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<td>USDOT</td>
<td>US Department for Transport</td>
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<tr>
<td>V2I</td>
<td>Vehicles-to-infrastructure communication</td>
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<tr>
<td>V2V</td>
<td>Vehicles-to-vehicle communication</td>
</tr>
<tr>
<td>VMS</td>
<td>Variable Message Signs</td>
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<tr>
<td>VRU</td>
<td>Vulnerable road user</td>
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<tr>
<td>VRUITS</td>
<td>Improving the Safety and Mobility of Vulnerable Road Users Through ITS Applications</td>
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<tr>
<td>VTT</td>
<td>Technical Research Centre of Finland (Finland) - Teknologian tutkimuskeskus</td>
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<tr>
<td>VTTI</td>
<td>Virginia Tech Transportation Institute (USA)</td>
</tr>
<tr>
<td>WATCHOVER</td>
<td>Vehicle-to-Vulnerable road user cooperative communication and sensing technologies to improve transport safety</td>
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<tr>
<td>WG</td>
<td>Working group</td>
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<td>WP29</td>
<td>The World Forum for Harmonization of Vehicle Regulations</td>
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Executive Summary

This deliverable reports on the work performed during the project and the main outcomes of the activities undertaken in relation to Traffic Management and ITS. It focuses mainly on:

- Setting the scene for ITS with and for motorcycling (definitions, framework)
- Gaining a clearer picture of existing ITS for motorcycling and existing system/function classifications
- Improving understanding of riders’ perception of ITS
- Identifying PTW specificities with regard to ITS developments
- Reporting on existing traffic management best practices for motorcycling

First there was a need to define traffic management and Intelligent Transport Systems in this work context. Further preliminary work involved gaining a better understanding of existing policy on the use of modern technology for transportation, and of public initiatives and other platforms where political priorities and strategic orientations are discussed.

With the objective of gathering as much expertise as possible, the project then collected feedback and information from various sources. Part of the work consisted of identifying and compiling the main outcomes of EU co-financed projects of relevance to training and licencing. These projects, available on the ERSO website, include 2-BE-SAFE, DaCoTA, PROMISING, ROSA, SAFERIDER, SARTRE1-4, SIM, SUPREME, TRACE, VRUITS, WATCHOVER.

On the basis of the available research outcomes, the project developed an overview and classification of ITS systems/functions currently discussed when addressing ITS for PTW users’ safety and comfort.

The project also summarized the outcomes of the few user acceptance surveys and focus groups from SAFERIDER, 2BESAFE, and VRUITS, before adding the ones from the RIDERSCAN ITS survey based on the previously defined ITS systems/functions list.

The project then identified priority areas for EU action according to the views of the different stakeholders. In doing so, it used:

- a review of the main relevant policy documents: Annex 14
- a questionnaire (Amplifying Questions) designed to survey the different categories of stakeholders directly involved in policymaking (Member States, the European Union, the Motorcycling Community representatives, EU stakeholders). Answers to the questionnaire were collected either via phone interviews, written answers, or face-to-face meetings. They are summarized in Annex 4/ annex 5/ annex 6/ annex 7;
- surveys targeting the riding population: Annex 1 and annex 3 (summarized in sections 6.4 and 6.5)
- LinkedIn discussions on riding vs driving differences
input from the project workshop on ITS: Annex 12

With the objective to collect as much expertise as possible and integrate as much as possible stakeholders’ priorities, the project collected input from:

- **Member States’ National Authorities**
  - Bulgaria: Road Infrastructure Agency
  - Finland: Trafi
  - France: Conseil National de Sécurité Routière
  - Ireland: National Roads Authority
  - Latvia: Latvian State roads
  - Luxembourg: Ministère du Développement durable et des Infrastructures, administration des ponts et chaussées
  - Netherlands: Ministry of Infrastructure and Environment
  - Norway: Norwegian Public Roads Administration
  - Slovenia: Slovenian Traffic Safety Agency
  - Spain: Directorate General for Traffic (DGT), Ministry of Interior
  - Sweden: Swedish Transport Administration
  - UK: Road User Licensing, Insurance and Safety

- **Research community**
  - Austria: KFV
  - Belgium: IBSR
  - Czech Republic: Transport Research Centre
  - Germany: BASt
  - Greece: National Technical University of Athens

- **Motorcycle Industry**
  - Belgium: FEBIAC
  - Germany: BMW; IVM; IFZ
  - Greece: AMVIR
  - Italy: ANCMA; Ducati
  - Netherlands: Kawasaki; Yamaha
Motorcycle Users representatives:

- Belgium: MAG Belgium
- Denmark: MCTC
- France: FFMC
- Germany: BU; BVDM
- Ireland: MAG Ireland
- Italy: FMI
- Luxembourg: LMI
- Netherlands: MAG NL
- Norway: NMCU
- Sweden: SMC
- UK: BMF

Based on these inputs, and those from a dedicated workshop on ITS organized by the project, various aspects related to PTWs and ITS deployment activities are discussed, before addressing specific PTW aspects with regard to ITS development and discussing further deployment challenges for PTW/ITS.

All in all, the project was able to deliver the following outcomes:

- an overview of the political context and stakeholders ITS systems/functions priority lists
- a summary of EU research work and main conclusions for the last decade (Annex 21)
- an overview and classification of ITS systems/functions for motorcycles, in relation to PTW safety areas
- a European map of riders’ acceptance of ITS for motorcycling (Annex 3).
- a detailed description of the specificities of the riding tasks and impact on ITS development (Annex 15)

Finally, following a comprehensive review of needs, the project team identified a List of recommendations and priority actions for European and national levels, summarized in the report on Needs for Policy Action.
The mid-term review of the EC Communication on Road Safety 2011 provides an opportunity to address specific PTW safety and ITS needs, including the urgent need to engage in strategic research activities.

This project report was reviewed by Deliverable 6 expert Aki Lumiaho from VTT for the latest comments.
1. Introduction

Powered two-wheelers (PTWs) are a popular form of transport providing mobility to millions of people worldwide. However, unlike other forms of motorised transport, PTW users, like bicycle riders, remain more vulnerable due to the intrinsic characteristics of the vehicle.

Over the past decade, collision records highlighted a substantial decrease in PTW casualties (motorcycles and mopeds). This decrease, albeit less pronounced than for other means of transport, is taking place against a substantial increase in the number of PTWs on the roads.

In 2008, the first international workshop on PTW safety\(^1\) concluded that

- it was a fundamental motorcycle safety requirement that, by default, PTWs should have a place in overall transport policy and infrastructure policy/management;

- Enhanced awareness of motorcycles should be incorporated in the development of all vehicle ITS projects

The European Commission and European Parliament are committed to the objective of accelerating and coordinating the deployment of ITS in road transport in order to achieve cleaner, more efficient and safer transport.\(^2\)

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\(^1\) [http://www.internationaltransportforum.org/jtrc/safety/Lillehammer2008/lillehammer08.html](http://www.internationaltransportforum.org/jtrc/safety/Lillehammer2008/lillehammer08.html)

Where do we go from now?

The need to integrate Powered Two-Wheelers in transport systems and ITS developments is now recognized among the road safety community. As advanced technology, especially intelligent transport systems, is now promoted for both active safety (accident prevention) and passive safety (accident protection) by a vast majority of stakeholders, the RIDERSCAN project has focused on:

- Setting the scene for ITS with and for motorcycling (definitions, framework)
- Gaining a clearer picture of existing ITS for motorcycling and existing systems/functions classifications
- Improving understanding of riders’ perception of ITS
- Identifying specific PTW aspects with regard to ITS developments
- Reporting on existing traffic management best practices for motorcycling
2. Definitions

2.1. Intelligent Transport Systems

Broadly speaking, Intelligent Transport Systems (ITS) cover all types of vehicles including motorcycles. There are many developments regarding ITS features that are completely new to the PTW sector, and which we need to clarify through additional research. The Horizon 2020 general objectives could provide the right framework for this.

ITS basically involves the application of information and communication technologies (ICT) to transport. Computers, electronics, satellites and sensors are playing an increasingly important role in transport systems. The main innovation is the interlinking of existing technologies to create new services.

![Advanced Driver Assistance Technologies - Roadmap](image_url)

Figure 2 Advanced Driver Assistance Technologies - Roadmap

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3 Stakeholder meeting on the deployment of ITS and vehicle technologies to improve road safety – Discussion Document – Brussels 8/3/2013
ITS, which combines sensors and information processing, can be applied in every transport field (road, rail, air, water) and derived services can be used by both passenger and freight transport. ITS systems process information flows from vehicles and the road network, including communication between vehicles (V) and/or infrastructure (I) (V2V, V2I, I2V).

For many, ITS systems are expected to save lives, time, money, energy and guarantee sustainable living, and should improve decision-making processes on behalf of road users and transport network managers. ITS systems as such are instruments that can be used for different purposes under different conditions, such as:

- Optimizing transport infrastructure
- Improving safety (both safety and security)
- Developing services
- Contributing to sustainable development
- Improving mobility management

According to the ITS sector (industry), it is estimated that the deployment of ITS systems could lead to:\(^4\):

- 30% reduction in the number of fatalities across Europe
- 30% reduction in the number of seriously injured persons across Europe
- 15% reduction of traffic-related road congestion
- 20% improvement in energy efficiency

\(^4\) Francesca La Torre – UNIFI/FEHRL “Safe road infrastructure: from concept to realization” Congress - Wroclaw, December
\(^5\) http://www.icarsupport.org/esafety-forum
- 50% increase in the availability of real-time traffic and travel information.

Positive safety effects can be sought in 4 different areas:

- reducing exposure to traffic, e.g. a navigation or real-time parking information service may lead to lower mileage / less time spent in traffic (active safety)
- reducing the probability of accidents (active safety)
- reducing the severity of injuries if an accident happens (passive safety)
- optimising assistance and care after an accident occurred. eCall is a well-known example of this category (passive safety)

Another way to address ITS in road safety discussions is to talk about systems requiring "cooperation" with other systems ("cooperative systems", such as navigation systems with real time information). These contrast with "stand-alone systems" such as Anti-lock Braking Systems - ABS

Stand-alone systems include In-Vehicle Safety Systems (IVSS), the objective of which is to reduce driver workload and errors, and include Advanced Driver Assistance Systems (ADAS) (e.g. Electronic Stability Control ESC) and advanced In-Vehicle Information Systems (IVIS) (e.g. speed monitoring).

For motorcycling, the corresponding terms are Advanced Rider Assistance Systems (ARAS) and On-Bike Information Systems (OBIS). These are the terms commonly used by PTW safety experts.

As in-vehicle electronics are not automatically classified as ITS, the following three conditions seem to apply with regard to ITS/IVSS:

- The system/service includes information technology
- The system/service includes an aspect of electronic data exchange with, or observation of, at least two of the following entities:
  - Vehicle
  - Road or roadside infrastructure
  - Driver or other traffic participant.
- The system/service has relevance to traffic/transport

Apart from the road safety context, other classifications can be found.
PTwoWs are officially classified by engine size (< 50 cm³ >) and by number of wheels (2 or 3). However, PTWs cover a wide variety of vehicles differing in type and usage, and hence users.

For instance:

- **riding environment** (e.g. urban, touring, adventure, track, off-road)

![Figure 4 A few examples of PTW riding environment](image_url)

- **riding purpose** (commuting, leisure, thrill, racing, holiday touring, professional)
- **journey length** (1-50 km, 51-500 km, 501-5000 km, >5000 km)
- **physical form** and seated position
- **engine capacity** (<50 cm³, 51-125 cm³, 126-500 cm³, 501-1000 cm³, 1000-1400 cm³, >1400 cm³)
- **sub-types** (standard, street, modified, sport, café racers, cruisers, custom, choppers, classics, supermoto; off-road: enduro, trial, motorcross)

- **hybrids** (sport touring, power cruisers, dual-purpose)

But one sure thing is that PTWs are not cars. Handling, manoeuvring, traffic reading and related driving tasks and patterns differ significantly. Compared to cars, PTWs are less stable, less visible and offer less protection to the rider. They are involved in a disproportionately high percentage of fatal and serious accidents, most of which are in cities and caused by human error.

### 2.2. Traffic Management

According to the European Commission,\(^6\) traffic management provides guidance to the European traveller and haulier on the condition of the road network. It detects incidents and emergencies, implements response strategies to ensure safe and efficient use of the road network and optimises the existing infrastructure, including across borders. Incidents can be unforeseeable or planned: accidents, road works, adverse weather conditions, strikes, demonstrations, major public events, holiday traffic peaks or other capacity overload.

The current instrument of strategic traffic management in Europe is a traffic management plan. This is a pre-defined set of temporary measures and procedures in response to a specific situation.

Equipping critical road sections and accident black spots (e.g. tunnels, bridges, mountain passes, large congested areas) with adequate ITS and providing ITS services at locations and areas on critical road segments will lead to quick wins in terms of safety and road efficiency.

Traffic management is a task of the public authorities and road operators and its operation is mostly handled by traffic control centres.

Another important role of traffic management is the smooth operation of urban and interurban interfaces and links between the different transport modes (e.g. road and public transport).

Core services include strategic corridor and network management, section control (especially for sensitive road segments), incident management, speed control, ramp metering and hard shoulder running.

According to the Thales group, as urban populations expand and city roads become increasingly congested, policy makers and planners need to review urban development and transport policies in order to address future needs taking into account anticipated social and demographic changes. Effective policy must meet multiple objectives:

- Strike a balance between different modes of transport: pedestrians, bicycles, motorcycles, cars and public transport
- Provide security, safety and optimum service for transport system users
- Maintain the mobility that drives economic development
- Reduce urban pollution and congestion caused by motor vehicles

Alongside longer-term solutions such as upgrading public transport systems and introducing city centre road toll systems, high-performance traffic management systems can be crucial to the success of a city planning and transportation policy.

According to Government of the Netherlands, traffic management is all about reducing traffic jams on motorways and keeping traffic moving. The government advocates a smart and flexible use of existing road capacity, for example by managing traffic. For the Dutch government, traffic management involves such practical applications as:

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- Extra lanes at rush hours (extra lane on the left- or right-hand side of the motorway which opens in busy periods)
- Entrance ramp control (a system measures how many vehicles are on the motorway and traffic lights regulate the number of trucks and private cars that can enter the motorway, ensuring that traffic can continue to flow)
- Phased traffic lights
- Incident management
- Roads to the Future innovation programme (the programme focuses primarily on finding smart solutions for traffic jams and environmental pollution)

3. Overview of the EU policy and research framework

Technology is seen by all major stakeholders (not the least by European industrialists⁹) as an important, if not essential, component of Europe’s competitiveness in the global economy.

Transporting people, goods and information in the most efficient way is definitely a critical element of this economic angle.

From a citizen perspective, technology is expected to provide more freedom (mobility/time) and a better standard of living (safety/environment). The deployment of new technologies has become one of the hottest topics on the agenda of the European institutions, closely related to mobility, safety and greening issues.

Whatever the angle, transport efficiency and freedom of movement are essential components of a competitive market focusing on consumer needs. Making the European transport network more efficient is one of Europe’s top priorities.

⁹ ERT Benchmarking report 2013 (page 34)
http://www.ert.eu/sites/default/files/ERT%20Benchmarking%20Report%202013_0.pdf
This section provides an overview of political milestones and commitments related to ITS deployment in the road transport sector.

3.1. The Green Paper on Urban Mobility

The Commission already considers ITS as a useful solution for addressing urban mobility challenges. Since urban transport is not per se a European competence, the Commission’s Action Plan on Urban Mobility is made up mainly of measures targeting research, information-sharing and the exchange of best practices. Areas addressed include research into congestion charging schemes & other pricing systems, and the use of ITS (for electronic ticketing and payment, navigation, traffic management). On the specific topic of motorcycling, the Action Plan mentions that “Alternative means of transport such as electric bicycles, scooters and motorbikes as well as taxis can also play a role [in optimizing urban mobility].”

3.2. The White Paper on Transport

In March 2011, the European Commission published its Roadmap to a Single European Transport Area – Towards a competitive and resource efficient transport system, which covers the time period up to 2050. While the content is mostly geared towards cleaner and more efficient freight and passenger transport, it admits that curtailing mobility is not an option even though oil might start running out.

Among the significant elements related to road safety and ITS, the White Paper on Transport (WPT) wants to harmonize and deploy road safety technology – such as driver assistance.

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systems, speed limiters, seat-belt reminders, eCall, cooperative systems and vehicle-infrastructure interfaces.

Although not directly related to road safety, it is relevant to note that the White Paper also refers to ITS for environmental and urban mobility issues such as the deployment of ITS applications in support of eco-driving, road-user charging and access restriction schemes.

3.3. EU Road Safety policy orientations 2011-2020

In July 2010, the Commission adopted the Policy Orientations for Road Safety 2011-2012, a governance framework containing strategic objectives for improving road safety at all levels and including the ambitious target of halving the 2010 fatality figure by 2020. The safety of Vulnerable Road Users (VRUs) is considered a priority. One of the most promising areas for improving VRU safety is new technology - in particular developments known as ITS. One of the priority areas for action identified in the Policy Orientations is the promotion of ADAS use.

The European Parliament agrees that the potential of technology should be exploited to the full. In its report on road safety concerning the Policy Orientations, it called on the Commission to take steps to deploy various ITS technologies to improve road safety, and to come up with legislative proposals in certain areas. The Commission has recently adopted its CARS 2020 Communication on an action plan for the European automotive industry, which underlines the need for the industry to keep a technological lead in order to remain competitive. The objective is to deliver vehicles that are ‘fuel-efficient, safe, quiet and connected’. The action plan states that road safety should follow an integrated approach comprising driver, infrastructure and vehicles and includes the drawing-up of a roadmap for the deployment of in-vehicle safety systems by the end of 2013.13

3.4. The ITS Directive and Action Plan

A considerable amount of work has been done, and is still being done, on implementing the Action Plan for the deployment of Intelligent Transport Systems14 and the ITS Directive (Directive 2010/40/EU), which provides the legal framework for the deployment of interoperable, compatible and continuous ITS systems and services across Europe. Action 3.1 involves ‘the promotion of deployment of advanced driver assistance systems and safety and security-related ITS systems, including their installation in new vehicles (via type-approval) and, if relevant, their retrofitting in used ones’. Priority actions c, d, e and f in the ITS Directive include ‘the provision, where possible, of road safety related minimum universal traffic information free of charge to users’, ‘the harmonised provision for an interoperable

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EU-wide eCall’ and ‘the provision of information and reservation services for safe and secure parking places for trucks and commercial vehicles’.

The 2008 "Action Plan for the Deployment of Intelligent Transport Systems in Europe", highlights the need to make the best use of driver assistance systems with proven benefits for the vehicle occupants and for other road users, especially VRUs. Unfortunately, there is little to no reliable information on which systems or applications may have proven safety benefits for VRU, hence motorcycling.

3.5. New type-approval regulations for motor vehicles

In parallel to the General Safety Regulation, other regulations for motor vehicles were finalised by the European Parliament and Council.

In 2009, Regulation (EC) 78/2009 on the type-approval of motor vehicles with regard to the protection of pedestrians and other vulnerable road users was adopted. The requirements encompassed in the legislation concern passive safety requirements which mitigate the critical injury levels in case of a vehicle colliding with persons.

In order to generalise the fitting of a number of efficient safety systems on motor vehicles through the EU type-approval legal framework, the legislator recently adopted several measures. In particular, Regulation (EC) 661/2009 of the European Parliament and Council concerning type-approval requirements for the general safety of motor vehicles has introduced Electronic Stability Control systems for cars, vans, trucks and buses and the fitting of Tyre Pressure Monitoring Systems on cars as well as the mandatory fitting in trucks and buses of Lane Departure Warning Systems (LDWS) and Advanced Emergency Braking Systems (AEBS) preventing vehicles from drifting off the road and enabling them to brake automatically if an obstacle is detected on the road ahead and the driver does not react to this imminent collision risk.15

More recently, in December 2012, the Regulation for market surveillance and approval of two- and three-wheel vehicles and quadricycles (L-category vehicles) was adopted. L-category vehicle is the generic name for such light vehicles as powered cycles, two- or three-wheel mopeds, motorcycles with and without sidecar, tricycles and quadricycles. That Regulation includes new functional safety requirements such as the mandatory fitting of

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15 Stakeholders meeting on the deployment of ITS and vehicle technologies to improve road safety – Discussion Document – Brussels 8/3/2013
advanced brake systems on powered two-wheelers and the automatic headlamp for all L-vehicle categories.

Advanced technology, especially intelligent transport systems for active safety (accident prevention) and passive safety (accident protection), along with an improved road infrastructure, is seen by the vast majority of stakeholders as a major contributor to the overall improvement of road safety in Europe. But in a society ever more focused on economic and continuous growth, technological innovation is seen by almost everyone as the only way to tackle the economic downturn faced by Europe for the last decades, with emerging markets challenging Europe’s commercial leadership.

3.6. Road safety as a market opportunity

According to the Commission\textsuperscript{16}, the rapid progress achieved in this area, particularly in the field of passive safety, may be due to the greater marketing potential, hence user acceptance, of such improvements, which are today well understood and valued by the consumer. The EU type-approval legal framework on vehicle safety\textsuperscript{17}, in particular with regard to frontal and lateral collision protection and pedestrian protection, is also considered to have positively influenced this trend. The most high-profile passive safety features include the routine installation of air-bags and brake assist systems, as well as the design of the front of cars for pedestrian protection and the mandatory fitting and use of seat belts for all passengers.

In recent years, the Commission has started looking at new in-vehicle safety technologies in terms of their impact on road safety, their effectiveness and costs. In 2006, a study\textsuperscript{18} evaluated IVSS potential to reduce accidents and fatalities, and the related benefit-to-cost ratios. More

\textsuperscript{16} Stakeholders meeting on the deployment of ITS and vehicle technologies to improve road safety – Discussion Document – Brussels 8/3/2013
\textsuperscript{17} Regulation (EC) No 78/2009 of the European Parliament and of the Council of 14 January 2009 on the type-approval of motor vehicles with regard to the protection of pedestrians and other vulnerable road users.
recently, another study\textsuperscript{19} carried out for the Commission in May 2011 on the safety and comfort of vulnerable road users included a qualitative analysis of the ITS in-vehicle safety systems that should be prioritised on the basis of their potential to improve the safety and comfort of vulnerable road users.

The latter reported on factors that have a large impact on the number and severity of injuries on the part of \textit{all or most types of VRUs} - namely speed, alcohol, non-observance of the VRU by the vehicle driver, late and insufficient braking by the vehicle driver in cases of emergency -, concluding that the following applications would be of great interest as they targeted the identified “common factors”:

\begin{itemize}
\item Intelligent Speed Adaptation/Monitoring
\item Alcohol Ignition Interlock
\item Pedestrian Detection Systems, combined with Emergency Braking, to be enhanced with VRU Beacon Systems in the future.
\end{itemize}

As comfort is also considered along with safety, the reports also listed the following applications as having considerable potential for improving VRU safety and comfort:

\begin{itemize}
\item Adaptive Headlights
\item Night Vision Warning systems
\item Blind Spot Detection, in particular for trucks
\item Cooperative Systems, in particular Intersection Safety (INS)
\item Infrastructure-based systems to reduce accidents on crossings: Intelligent Pedestrian Traffic Signals, Crossings Adaptive Lighting and Pedestrian Presence Warning systems.
\end{itemize}

In 2008, \textit{the eSafety Forum – an EC/ITS Industry platform} – identified eleven ‘eSafety’ systems (five in-vehicle systems and six cooperative systems) as priority systems whose deployment should be promoted.

\textsuperscript{19} Report on Action 3.4 — Safety and comfort of the Vulnerable Road Users. Final report May 2011
\url{http://ec.europa.eu/transport/themes/its/studies/its_en.htm}
In-vehicle safety systems | Infrastructure-related systems
---|---
ESC (Electronic Stability Control) | eCall
Blind Spot Monitoring | Extended Environmental Information
Adaptive Head Lights | Real-time Travel and Traffic Information
Obstacle & collision warning | Dynamic Traffic Management
Lane Departure Warning | Local Danger Warning
| Speed Alert

On the research side, the eIMPACT project\(^{20}\) carried out an impact assessment (from a car driver’s perspective) of twelve Intelligent Vehicle Safety Systems\(^{21}\). A list of the most promising non-cooperative and cooperative in-vehicle safety systems was prepared on the basis thereof:

1. Electronic Stability Control
2. Full Speed Range ACC
3. Emergency Braking
4. Pre-Crash Protection of Vulnerable Road User
5. Lane Change Assistant (Warning)
6. Lane Keeping Support
7. Night Vision Warning
8. Driver Drowsiness Monitoring and Warning
9. eCall
10. Intersection Safety
11. Wireless Local Danger Warning

Some manufacturers already offer advanced in-vehicle safety systems and the European New Car Assessment Programme (EuroNCAP) is gradually incorporating in-vehicle technologies in its assessment programme. Through ‘EuroNCAP Advanced’, the programme rewards the fitting of advanced safety technologies and a roadmap is being drawn up for the inclusion of emerging crash-avoidance technologies in the assessment scheme by 2015. Such a programme does not exist yet for PTWs.

\(^{20}\) eIMPACT: [www.eimpact.info](http://www.eimpact.info)

\(^{21}\) Stand-alone and cooperative Intelligent Vehicle Safety Systems — Inventory and recommendations for in-depth socio-economic impact assessment(Deliverable 2 of eIMPACT [Vollmer et al., 2006]) [http://www.eimpact.eu/download/eIMPACT_D9_D10_v2.0.pdf](http://www.eimpact.eu/download/eIMPACT_D9_D10_v2.0.pdf)
3.7. The World Forum for Harmonization of Vehicle Regulations (WP29)

In order to ensure a global level playing field, the European Union plays an active role in developing internationally harmonised rules for safety systems. International issues are discussed at the United Nations Economic Commission for Europe (UNECE), in the World forum for harmonization of Vehicle Regulations (WP29). The European Commission plays a leading role.

WP29 achievements:
- Anti-lock braking systems (ABS): 1990
- Dedicated Daytime Running Lamps (DRL): 2007
- Regenerative braking systems: 2008
- Electronic Stability Control (ESC): 2008

WP29 on-going work:
- Advanced emergency braking systems (AEBS)
- Lane departure warning systems (LDWS)
- Rear view cameras
- Child restraint system (new regulation)

22 www.unece.org/trans/main/welcwp29.htm
23 www.unece.org/trans/main/welcwp29.htm
24 Stakeholders meeting on the deployment of ITS and vehicle technologies to improve road safety – Discussion Document – Brussels 8/3/2013
- Safety of electric vehicles
- Pedestrian safety
- Hydrogen and fuel cell vehicles, pure electric vehicles,
- hybrid heavy duty vehicles, CO2 emissions
- New regulation on head restraints
- Noise of electric and hybrid vehicles
- Electric vehicle safety platform
- International e-call (expected)

3.8. **European Commission safety priorities**

In March 2013, the European Commission organised a first stakeholder meeting to discuss ITS and road safety. In its Discussion Paper compiled for the meeting on the deployment of ITS and vehicle technologies to improve road safety\textsuperscript{25}, the Commission highlighted its own priority list:

<table>
<thead>
<tr>
<th>In-vehicle safety systems with high safety potential</th>
<th>In-vehicle safety systems that require further assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cooperative in-vehicle safety systems</strong></td>
<td>• Event Data Recorders</td>
</tr>
<tr>
<td>• Intelligent speed adaptation</td>
<td>• Speed limiters for light commercial vehicles</td>
</tr>
<tr>
<td><strong>Non-cooperative in-vehicle safety systems</strong></td>
<td>• Tyre-pressure monitoring systems</td>
</tr>
<tr>
<td>• Advanced emergency braking</td>
<td>• eCall for powered two-wheelers</td>
</tr>
<tr>
<td>• Lane departure warning systems</td>
<td></td>
</tr>
<tr>
<td>• Pedestrian detection system/emergency braking</td>
<td></td>
</tr>
<tr>
<td>• Blind spot detection for trucks</td>
<td></td>
</tr>
<tr>
<td>• Alcohol interlocks</td>
<td></td>
</tr>
</tbody>
</table>

There are already ITS applications/systems on the market which are expected to positively influence safety. Some of these are already being included as minimum safety requirements for certain categories of vehicle. This is the case for:

1. Anti-lock Braking Systems (ABS) and Electronic Stability Control (ESC) in all passenger cars, vans, trucks, buses and trailer from 1 November 2011 (with a transitional period until 2016 depending on vehicle category);

\textsuperscript{25} Stakeholders meeting on the deployment of ITS and vehicle technologies to improve road safety – Discussion Document – Brussels 8/3/2013

2. Advanced Emergency Braking Systems (AEBS) and Lane Departure Warning Systems (LDWS) became mandatory for new trucks and buses in November 2012;

3. Tyre Pressure Monitoring Systems for passenger cars

4. Anti-lock Braking Systems (ABS) on bigger motorcycles as well as the fitting of Advanced Braking Systems (e.g. combined braking systems) on other motorcycles.

The Commission (DG ENTR) announced, within the framework of the report foreseen in the General Safety Regulation and the Pedestrian Protection Regulation, a comprehensive review of its active and passive safety vehicle legislation assessing, among others, the following in-vehicle technologies:

- Extension of scope of Advanced Emergency Braking Systems (AEBS)
- Extension of scope of Lane Departure Warning Systems (LDWS)
- Enhanced Pedestrian Protection Systems possibly combined with Automatic Emergency Braking (PDS/EBR)
- Blind Spot Detection for Trucks (BSD-T)
- Reversing pedestrian detection and back-up cameras
- Seat belt reminder for all seats and all vehicles

This review will constitute the basis for intervention for future initiatives on the type-approval of vehicles, which should be undertaken preferably at global level (UNECE)

The Commission (MOVE) has also launched various studies concerning different areas of analysis in view of possible future deployment:

- the safety benefits of alcohol interlocks resulting from various installation options, whose results will be available in late 2013
- the use of speed limiters in light commercial vehicles
- the fitting of Event Data Recorders

**3.9. Horizon 2020**

In December 2013, the Commission launched its new funding programme for European research. Called *Horizon 2020*, the programme has five EU objectives to be reached by 2020: on employment, the environment, education, R&D and social inclusion.

It is centred around seven flagship initiatives to pool EU and Member State actions on major policies and act as levers for growth.
Those of most interest to this debate are

- **Innovation Union** (on the objectives of which the Framework Programme for Research & Innovation has been drafted),
- the new **Industrial Policy** and
- **Resource Efficiency**.

These served as references for the White Paper on Transport, approved in 2011 and currently under mid-term review.

The **Horizon 2020 Societal Challenge: Transport** aims to achieve a European transport system that is resource-efficient, climate-and-environmentally-friendly, safe and seamless for the benefit of all citizens, the economy and society. Policy drivers are organised along two axes:

- Vehicle improvements in the four modes
- Horizontal transport system integration factors (ITS, infrastructure and logistics) + the urban dimension

It concentrates virtually all funding on innovative solutions in an attempt to provide ready-to-market solutions in the near future. In the area of road safety, next-generation ITS projects are expected to provide enhanced safety applications going beyond vehicle-based systems:

- Cooperative systems based on vehicle-to-vehicle and vehicle-to-infrastructure communications used for accident mitigation
- Automation in road transport decreasing the risk of human errors

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3.10. The iMobility Forum & the Vulnerable Road Users Working Group

The iMobility Forum superseded the eSafety Forum to further work on ICT systems for resource-efficient and clean mobility in addition to the eSafety Forum's focus on ICT-based safety technologies. Like the eSafety Forum, the iMobility Forum is a joint platform open to all road stakeholders for promoting and monitoring the implementation of the recommendations identified by the iMobility Forum Working Groups. The VRU Working Group (VRU WG) targets improvements in the safety of vulnerable road users (pedestrians, cyclists, motorcyclists), along with issuing recommendations and guidelines to achieve this target.

The iMobility Forum priority list includes

<table>
<thead>
<tr>
<th>Vehicle-based:</th>
<th>Infrastructure-based:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Adaptive headlights</td>
<td>- 112 eCall</td>
</tr>
<tr>
<td>- Blind spot monitoring</td>
<td>- Dynamic navigation systems</td>
</tr>
<tr>
<td>- Eco-driving support</td>
<td>- Dynamic traffic management</td>
</tr>
<tr>
<td>- Emergency braking</td>
<td>- Extended environmental information</td>
</tr>
<tr>
<td>- Lane keeping support</td>
<td>(extended FCD)</td>
</tr>
<tr>
<td>- Obstacle and collision warning</td>
<td>- Local danger warnings / Variable</td>
</tr>
<tr>
<td></td>
<td>Message Signs (VMS)</td>
</tr>
</tbody>
</table>

The *iMobility VRU WG* came up last year with a list of priority safety systems/functions addressing VRU safety.

In view of the fundamental difference between cyclists / pedestrians and PTWs, i.e. the *powered* aspect of the potential functions, the working group attempted to identify the specific relevance of the functions/systems to PTWs.

Note: additional aspects/items marked green are ones that were not discussed in the *iMobility VRU WG*, but need to be addressed when providing such kind of overview

<table>
<thead>
<tr>
<th>Safety Systems</th>
<th>Characteristic</th>
<th>Relevance for PTWs as VRUs</th>
<th>Group comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptive Headlights (AHL)</td>
<td>Vehicle-based</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Advanced Emergency Braking Systems (AEBS)</td>
<td>Vehicle-based</td>
<td>no</td>
<td>under research for buses, consideration for the safety of passengers in case of activation; additional hazard for PTWs</td>
</tr>
<tr>
<td>Blind Spot Detection for Trucks (BSD-T)</td>
<td>Vehicle-based</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Blind spot monitoring (same as Lane Change Assist? LCA)</td>
<td>Vehicle-based</td>
<td>yes</td>
<td>Under research within the TEAM and DESERVE projects for PTWs; group is questioning the parallelism to LCA</td>
</tr>
<tr>
<td>&gt; same as Lane Change Warning (LCW)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Driver Drowsiness Monitoring and Warning (DDM)</td>
<td>Vehicle-based</td>
<td>no</td>
<td>fatigue/tiredness (mixes function and technology)</td>
</tr>
<tr>
<td>Driver Monitoring and Warning</td>
<td>Vehicle-based</td>
<td>yes</td>
<td>DDM, human factors, inattention, distraction, alcohol, drugs consumption; no current potential for PTWs</td>
</tr>
<tr>
<td>Electronic Stability Control (ESC)</td>
<td>Vehicle-based</td>
<td>no</td>
<td>very low potential for VRUs; generally no, but potential for certain</td>
</tr>
<tr>
<td><strong>Motorcycle Stability Control (MSC)</strong></td>
<td>Vehicle-based</td>
<td>Yes</td>
<td>black box: relevant in scenarios with VRU accidents</td>
</tr>
<tr>
<td>---------------------------------------</td>
<td>---------------</td>
<td>-----</td>
<td>---------------------------------------------------</td>
</tr>
<tr>
<td>Event Data Recorder</td>
<td>Vehicle-based</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td><strong>Full Speed Range Adaptive Cruise Control (ACC)</strong></td>
<td>Vehicle-based</td>
<td>requires future research regarding the sensitivity of the system and the inclusion of PTWs =&gt; so no at this stage of development</td>
<td></td>
</tr>
<tr>
<td>Lane Change Assist (LCA)</td>
<td>Vehicle-based</td>
<td>yes</td>
<td>group is questioning the parallelism with blind spot monitoring; current research item in TEAM and DESERVE for PTWs with regard to lane change warning;</td>
</tr>
<tr>
<td>Lane Departure Warning (LDW)</td>
<td>Vehicle-based</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>Night Vision and Warning</td>
<td>Vehicle-based</td>
<td>yes</td>
<td>not yet researched; technologies to be investigated</td>
</tr>
<tr>
<td>Obstacle and collision warning</td>
<td>Vehicle-based</td>
<td>yes</td>
<td>requires further research for PTWs</td>
</tr>
<tr>
<td>Pre-crash protection of VRU (PCV)</td>
<td>Vehicle-based</td>
<td>yes</td>
<td>under research</td>
</tr>
<tr>
<td>Dynamic Traffic Management</td>
<td>Infrastructure-based</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td>eCall</td>
<td>Infrastructure-based</td>
<td>yes</td>
<td></td>
</tr>
<tr>
<td><strong>Extended environmental Information (Extended Floating Car Data)</strong></td>
<td>Infrastructure-based</td>
<td>no</td>
<td></td>
</tr>
<tr>
<td>Intelligent Speed Adaptation (ISA)</td>
<td>Vehicle-based</td>
<td>no</td>
<td>only warnings for PTWs (Speed warning (SW) and curve warning (CW)); under research within the TEAM project</td>
</tr>
<tr>
<td>Intersection safety (INS)</td>
<td>Infrastructure-based</td>
<td>yes</td>
<td>to be further researched</td>
</tr>
<tr>
<td>Real-time travel and traffic information (RTTI)</td>
<td>Infrastructure-based</td>
<td>yes</td>
<td>road conditions (and real-time friction), and black spots could be useful</td>
</tr>
<tr>
<td>Wireless local danger warning</td>
<td>Infrastructure-based</td>
<td>yes</td>
<td></td>
</tr>
</tbody>
</table>
3.11. The C-ITS Platform

In 2014, the Commission launched the C-ITS platform, composed of national authorities, relevant C-ITS stakeholders and the Commission, with a view to providing policy recommendations for the development of a roadmap and a deployment strategy for C-ITS in the EU. C-ITS systems are understood as a broad concept, not limited to V2V\(^{28}\) or to V2I\(^{29}\) communication, but also including systems applicable to vulnerable road users such as pedestrians, cyclists or motorcyclists.

This work should be followed by a Communication by the second half of 2015, presenting deployment scenarios, a gap analysis of the critical issues to be tackled, and the appropriate actors to take the lead on each of them.

3.12. European eCall implementation platform (EeIP)\(^{30}\)

eCall is an eSafety technology promoted by the European Commission. The technology brings rapid assistance to motorists involved in a collision anywhere in the European Union. Many organisations are involved in its EU-wide deployment, focusing on different aspects of eCall including in-vehicle systems, wireless data delivery and Public Safety Answering Points (PSAPs).

To harmonise the work of various stakeholders, the eCall Implementation Platform was set up in February 2009 at the initiative of the European Commission. It brings together all major stakeholders to synchronise activities accelerating the deployment of eCall at national and European level. Participants include the European Commission, the Member States, industry and other associations. The Platform is co-chaired by ERTICO – ITS Europe and a Member State.

3.13. Automation: EU-US transatlantic cooperation

In April 2015, the European Commission and the US Department of Transport (USDOT) organized, together with the Transport Research Board (TRB), the Symposium on Research for Automation, with the aim of identifying areas for research collaboration. The 2-day event brought together 70 experts from all constituencies (automotive, authorities, infra/road operators, public transport, freight transport, users/drivers/VRUs, Shared vehicles/Fleet, Insurers, Service Providers, Research, Legal/lawyers), against a background that:

- Road transport, as our primary means of transport, facilitates our mobility and lifestyle while also causing major impacts in urban areas and our daily life via air pollution, road crashes and traffic congestion;
- Experience shows that we cannot solve the issue by only building new, or extending the existing, road infrastructure.

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\(^{28}\) V2V: Vehicle to vehicle communication

\(^{29}\) V2I: Vehicle to infrastructure communication

Intelligent Transportation Systems (ITS) have proven to be effective tools for improving mobility for people and goods.

The Symposium participants discussed research issues around 3 use cases (platooning / urban city centers / urban chauffeur), and came to the conclusion that priority actions should include the following focuses (of which PTW aspects have been included in green):

**Do it now / Go ahead!**
- Test beds
- Fields Operational Tests (FOTs)
- Model deployment
- Best practice guide
- Case study for deployment
- Reuse of FOT data
- Collect data from the field after deployment

**Human factors**
- Acceptance
- Human Machine Interface (HMI) for L3 automation
- Interactions with VRU
- Behavioural norms
- Safe stops

**Legal**
- Rules of (safe) operation
- Code of practice for Automated Vehicle (AV) development
- Testing regime (Verification – Validation – Certification)
- Minimum standards / Performance
- Certification of infrastructure (Physical and Digital)
- Standards
- Liabilities
- Licencing

Figure 8 EU-US Symposium on Automation – Introductory Plenary Session
Currently there are different levels of cooperation between Europe, Japan and the US. At intergovernmental level, cooperation agreements have been signed between the US and the EU, Japan and the EU, and the US and Japan.

An EU-US agreement on cooperation in ICT for transport applications was signed in January 2009 by the Research and Innovative Technology Administration of the United States Department of Transportation (US DoT RITA) and the European Commission's Directorate-General Information Society and Media (EC DG INFSO).

A Memorandum of Cooperation (MoC) on "Cooperative Systems in the Field of Intelligent Transport Systems" was signed by the European Commission, DG Information Society and Media and the Japan Society for ITS (JST) in June 2010.

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Media (EC DG INFSO), and the Road Bureau, Japanese Ministry of Land, Infrastructure, Transport and Tourism (Road Bureau, MLIT), in Lyon (France) on 9 June 2011. The MoC focuses on cooperation in Intelligent Transport Systems (ITS), in particular cooperative systems. A similar agreement was also signed in 2010 between MLIT and the US DoT.

International cooperation activities are also supported by various FP7 support projects (except iMobility Support) such as: COMeSafety 2, ECOSTAND, FOTNET and 79GHz funded by DG CONNECT.

The Trilateral Cooperation is working on three subjects: automation, energy efficiency assessment methodologies, and probe data.

The working group on automation will identify, research, quantify, and evaluate applications improving the operation of Connected Road Vehicle Automation, with the aim of coordinating research on the development of Connected Road Vehicle Automation technologies that facilitate deployment and market uptake.

As regards energy efficiency assessment methodologies, a joint EU - Japan - US task force, ECOSTAND, was created in 2013 to further the development of a globally accepted methodology and the necessary tools enabling an accurate, cost-effective and valid evaluation of any ITS applications considered in terms of its short- and long-term energy/CO2 impact.

And finally, with regard to probe data, the Trilateral Cooperation will study three applications for further collaborative research (traffic management measures estimation, dynamic speed harmonization, and enhanced maintenance decision support systems).

4. EU Research main conclusions (Annex 21)

This section provides a selection of relevant extracts from EU-financed research projects in relation to ITS. These projects are available on the ERSO website (last consulted on 15/03/2015).

The comprehensive list of selected extracts is available in Annex 21.

- Motorcycling activity – cognitive perception/action

In the general frame, motorcycling can be defined as an activity of regulating and maintaining the status of the dynamic process as a whole (i.e. the driving situation) within the limits of acceptable and safe changes. In terms of mental activities, it requires that riders (i) select relevant information into the surrounding environment, in accordance with both their current goals and the driving task demands, (ii) understand the immediate situation (i.e. mental model elaboration) and anticipate its progression in the more or less long term, (iii) take decisions in order to interact appropriately – via the vehicle – with the road environment and the other road users, and (iv) manage their own resources (physical, perceptive and cognitive) to satisfy the time constraints of the activity inherent to the dynamic nature of the driving situation.
The selective dimension of information collection is especially important as riders cannot take in and process all the information available in the road environment. This information is not selected haphazardly, but depends on the aims the riders pursue, their short-term intentions (i.e. tactical goals, such as “turn left” at a crossroads or “overtake a car”) and long-term objectives (i.e. strategic goals, such as reaching their final destination within a given time), the knowledge they possess (stemming from their previous riding experiences) and their attentional resources available at this instant. Information selection is therefore the result of a perceptive cycle (Neisser, 1976), whose keystone is the motorcyclist’s mental representation of the driving situation. Such a representation is built in a working memory, from perceptive information extracted from the road scene on the one hand, and from permanent knowledge stored and activated in the long-term memory, on the other hand. (2BESAFE)

Figure 10 Synthetic overview of the motorcycling activity as a "perception-cognition-action" regulation loop (Source: 2BESAFE)

- **Risk/safety critical events:**
  - Based on a four-component model of responding to risk including:
    - *Hazard Detection* – being aware that a hazard may be present
    - *Threat Appraisal* – evaluating whether the hazard is sufficiently important to merit a response
    - *Action Selection* – having to select a response from one’s repertoire of skills
- Implementation – performing the necessary actions involved in the response that has been selected.

When a critical event occurs in the road environment, risk awareness is intimately linked with hazard perception as well as including a threat appraisal and a judgement concerning the driving situation criticality. Therefore, Risk Awareness is more than hazard perception, because it also includes riders’ abilities to anticipate future hazards, or the potentially dangerous progression of the current status of the driving conditions. (2BESAFE)

>- Overestimation of safety benefits can be dangerous, as users may be misled towards overcompensatory behaviour, which could reduce the safety effects of an engineering measure or even resulting an effect in a direction opposite to that intended. (2BESAFE)

>- Crash and injury risk can be heightened by: lack of basic riding skills; failure to appreciate the inherent limitations of the vehicle; failure to use special precautions or defensive riding techniques; lack of specific braking and cornering skills; poor observation and signalling; speeding and riding under the influence of alcohol. (Lin et al., 2003; NHTSA, 1999) (2BESAFE)

>- PTWs have low sensory conspicuity compared to cars and other vehicles due to their small size, their often dark colours, and their irregular contours. PTWs have low cognitive conspicuity because they are inconsistent with drivers’ expectations that other vehicles on the road will be cars and they appear in unusual locations, such as in between lanes. (2BESAFE)

>- Notwithstanding the high risks associated with motorcycle use, relatively little research on motorcycle safety design has been carried out. However, with the increasing popularity of this transport mode and increased casualty levels, new EU and national attention is currently being given to this area. (DACOTA)

![Figure 11 Accident view as a sequential event (Source: Dacota)](image)

>- If we are to significantly reduce the accident risk for PTW riders, we will have to understand what information processing is, learn to watch out for failures in that process in other drivers and riders and learn to recognise and avoid our own mistakes in that field.
For PTW riders it is of paramount importance that they stay outside the orange and red phases. A smart PTW rider always stays in the **green phase**. So, if the rider lets the traffic situation develop such that an emergency manoeuvre becomes necessary, he has lost it.

All emergency manoeuvres should be performed flawlessly during the **orange phase** to reach a perfect emergency stop or –swerve. In curves our planning and steering performance should be of such a high level that we will never end up falling or departing from our planned trajectory to the outside of the curve.

Unfortunately it turns out that, prior to accidents, PTW riders execute emergency manoeuvre very poorly. 3 groups of causes are identified:

- In case of severe fright, primitive parts of our brain go into the “fight-, flight- or freeze reaction”. This survival reflex takes command of our thinking and acting. It turns against us in by acting wrongly or by preventing us from taking sensible action.

- The dynamic properties of our single track vehicle turn against us when we execute an emergency manoeuvre,

and

- The poor level of machine control of the average PTW riders.

When no manoeuvre has been performed, or else performed wrongly, the **red phase** comes with collision and/or fall. At this point, because of the lack of passive safety features, the PTW rider will suffer relatively severe injuries or worse.

We think that we can teach this to PTW riders. Key concepts are visual scanning techniques, anticipation, risk perception, risk management and riding experience (all not only acquired by traffic exposure, but also by information, education and simulator exposure). (Source: Wouter Rijnaerts and Klaas van der Valk)
There is little evidence that moped/motorcycle training programs contribute to the safety of the riders. For that reason there is a need to do more and better research into the training of moped riders and motorcyclists. However, there is no doubt that riding a moped /motorcycle safely requires both theoretical and practical training. The development of new simulation techniques offers new opportunities for training programs. (PROMISING)

• ITS costs/benefits

General potential of ITS includes:

- **Support:** especially novice drivers, older road users and children are in need of support in certain situations in traffic which can be provided by information and warning systems.

- **Efficiency:** increasing the efficiency of motorised traffic on economic (fuel consumption) and ecological level (CO2 emissions) by a number of systems that increase traffic flow and support drivers to improve their driving behaviour in view of fuel consumption

- **Compensation:** a variety of problematic conditions (distraction, fatigue, etc.) can be improved by providing warnings and information to the road users and especially car drivers to avoid these or support the driver in these instances

- **Independency:** by providing information on trip related issues such as public transport schedules, public bike stations and alternative routes for a given trip general comfort can be raised and also lead to increased outside mobility.
- **Education and training**: by applying modern and state of the art technologies to the training and education process of novice drivers/riders can help to train them more appropriately for critical situations and coach them to how to react in specific dangerous situations by using simulation techniques. (VRUITS)

**ITS hazards & barriers include:**

- **Distraction**: due to visual and audio warnings and information provided during the driving/riding tasks. In addition interaction with interfaces of navigation systems etc. can lead to a high level of inattention.

- **Risk assessment**: due overreliance on the support by warning and intervening systems risk assessment can be negatively affected. Especially among car drivers solely relying on ITS, a risk is associated with fatigue.

- **Responsibility**: Transference of responsibility to the assistance systems is also mentioned by a number of experts relating to the overreliance of ITS in critical situations.

- **Legal/privacy issues** still need to be discussed for certain systems to be deployed on a broader scale (European level). The legal basis for ITS and especially communication systems is still very diverse in the European countries. This also relates to heightened level of awareness of potential users towards personal data and general privacy issues.(VRUITS)

- **Safety systems/functions:**

  ![Safety systems/functions](image)

  **Figure 14 The Saferider benchmarking database (2008) (Source: SAFERIDER project)**

  **Assistive systems have the potential to yield substantial road safety benefits (Regan et al., 2006; Spyropoulou et al., 2008). However, few safety systems have**
been developed for PTW riders; in 2006 there were fewer than ten ITS products commercially available for PTWs. (Bayly et al., 2006) (2BESAFE)

Few passive safety systems exist for PTWs. The only PTW-specific innovation is inflatable airbag jackets that deploy when the rider falls from the vehicle and cushion the rider from impact. Other technologies have been adapted from cars. Vehicle-mounted airbags have been shown to reduce the likelihood of being thrown from the PTW in multiple-vehicle collisions (e.g., Kuroe et al., 2005; Yamazaki et al., 2001), but may increase head and neck injuries (Ulleberg, 2003) and are difficult to adapt for PTWs due to technical design limitations. (2BESAFE)

Automatic crash notification (ACN) detects the occurrence of a crash through vehicle speed, tilt, and deceleration sensors, and automatically notifies emergency services. ACN for PTWs are in a preliminary stage of development, but studies predict that ACN may reduce serious injury and fatal crashes by 5-15%. (Abele et al., 2005; eSafety Forum, 2005) (2BESAFE)

Helmet telephone headsets and electronic toll systems are rarely used. Only 8% of motorcyclists use a helmet telephone headset often, very often or always and only 5% use electronic payment. The highest percentages of use were recorded in Serbia and Italy. Across the entire sample, the ITS systems were most frequently used by motorcyclists driving more than 10,000 km per year, those driving a touring or conventional street motorcycle. (SARTRE4)

Regarding PTW’s the potential for vehicle-to-PTW communication systems to address motorcycle conspicuity issues has been previously recognised (Bayly et al., 2006), though one issue to tackle is the need to reach the necessary penetration to achieve efficiency of cooperative systems. However, while on the one hand systems supporting visibility or communication between PTW’s and cars are considered very positive, on the other hand ITS interfering with the riding task or those perceived to take away the autonomy from the rider are seen as very sceptical. Training and education are considered to be of major importance in this group with ITS having mainly adverse effects on riding behaviour. This is in line with the research of Beanland et al. (2013), who found that riders believe that innovations should focus on protective equipment rather than systems that prevent crashes, since they believe crash prevention is better addressed through rider training. (VRUITS)

Systems aiming at infotainment, applications that are not primarily focussing on the driving, riding, or walking task, have the negative potential of distracting road users. Moreover the general usage of systems while being part of the traffic system and the mere interaction with different HMIs could increase the cognitive load of the user and negatively affect his behaviour. Therefore both usability and potential effects on different user groups need to be assessed comprehensively to develop...
and adapt ITS, which have the potential to increase VRU safety and improve general mobility and comfort. (VRUITS)

**Promising VRU Safety Applications**

<table>
<thead>
<tr>
<th>VRU Safety Applications</th>
<th>Targeted VRU group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pedestrians</td>
</tr>
<tr>
<td>Blind spot detection, BSD</td>
<td>(x)</td>
</tr>
<tr>
<td>Bicycle to car communication, B2C</td>
<td></td>
</tr>
<tr>
<td>Crossing adaptive lighting, CAL</td>
<td>X</td>
</tr>
<tr>
<td>Green wave for cyclists, GWC</td>
<td></td>
</tr>
<tr>
<td>Intelligent pedestrian traffic sign</td>
<td></td>
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<tr>
<td>Intersection safety, INS</td>
<td></td>
</tr>
<tr>
<td>Emergency braking for pedestrians/cyclists, AEB-P/ AEB-C</td>
<td>X</td>
</tr>
<tr>
<td>Oncoming vehicle warning system for PTWs, PTW2V</td>
<td></td>
</tr>
<tr>
<td>VRU beacon system, VBG</td>
<td>X</td>
</tr>
</tbody>
</table>

**Figure 15** Promising VRU safety systems/functions according to VRUITS project  
(Source: VRU WG presentation at the iMobility Forum 01/2015)

- **User acceptance:**

  ➢ In order for safety systems to successfully reduce the incidence and severity of road crashes, technologies must be deemed acceptable by the intended system users. Acceptability refers to “whether the system is good enough to satisfy all the needs and requirements of the user and other potential stakeholders” (Nielsen, 1993, p. 24). (2BESAFE)

  ➢ There are few studies addressing acceptability of assistive systems for PTWs. In Australia, Cairney and Ritzinger (2008) assessed acceptability of ISA, ACN and ABS. Riders expressed mixed views towards all three systems. Cairney and Ritzinger (2008) noted some barriers to the uptake of specific systems, most of which relate to the perceived benefits or effectiveness. This includes the “skills rather than technology” argument: some riders believe that ARAS may inhibit the development of riding skills and that equivalent (or superior) safety outcomes could be achieved by improving rider training. Cost was also a barrier, with most riders believing that retrofit systems cost too much.

  ➢ Levels of acceptance for PTW assistive systems are lower than for equivalent systems in passenger cars. Given the differences in the physical characteristics of single versus multi-track vehicles, and the unique motivations for riding, researchers should be cautious in generalising results from effectiveness and acceptence studies from passenger cars to PTWs. (2BESAFE)
• **Scientific challenges:**

   Lack of data on VRU specific accidents: in order to be able to assess the current situation in traffic especially in view of certain road user groups (pedestrians, cyclists, older road users) there still is a significant lack of data which in turn is needed to develop specifically adapted solutions on different levels. Knowledge on actually critical situations is needed for sustainable improvement. (VRUITS)

   In addition to technological advancements general developments will have a significant effect on general mobility and transport systems alike. Demographic changes (with population ageing leading to increasing numbers of older road users and the consequent need to adapt traffic systems to changing needs and forms of outdoor mobility) and changing modes of transportation (electric vehicles such as electric cars and electric bikes becoming more and more popular) need to be taken into account in view of increasing traffic safety by providing technologies and solutions specifically adapted to the needs of different road user groups. (VRUITS)

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![Socio-economic impact Safety Systems model](image)

**Figure 16 Socio-economic impact Safety Systems model (Source: TRACE project)**

• **Technology challenges:**

   Regarding technology several challenges exist for the next years:

   Make Advanced Driver Assistance more accurate. Often the scope of the safety systems mounted on vehicles is limited. In these technological limitations, come to add limitations due to the environmental conditions (meteorological, traffic, surface, etc.) and sometimes also those relative to the state of the driver. The problem of the acceptability also rises (should not the help be too intrusive) but also the one related to the trust made by the driver for the system. (DACOTA)

   Communication V2X: behind the technical problems connected to the communication protocol, to the standardization of exchange formats, to the
selection of the relevant information to deliver to the driver, to the HIM, raises the problem of the evaluation of a system so complex. (DACOTA)

่าวหมาติ: นี้ส่งผลกับการกระโดดหน้าต่างและจะมีการเปลี่ยนแปลงที่มากที่สุดในความสัมพันธ์กับรถยนต์. รถยนต์ที่จะเดินรถบนถนนอย่างมีความอิสระไม่ใช่ในวันพรุ่งนี้เพราะมันจะต้องการการจัดเก็บข้อมูลที่เกี่ยวข้องกับการเดินทาง, รถจราจรและสภาพแวดล้อมถนน. รถยนต์ต้นแบบจะเดินรถในสภาพแวดล้อมจำกัดและควบคุมหรือทำงำนที่ง่ายๆเช่นที่จอดรถ. (DACOTA)

Is the technology addressing the right problems? To answer this question, it is necessary to have available safety diagnosis (as up to date as possible) and a common methodology on accident causation to identify and quantify the stakes. => It requires mainly the implementation of an information system on the successful and accessible road accidents for every member state but also at the European level. (DACOTA)

Is the technology correctly solving the problem? It is important to check that the final product, first correspond to the initial request and because some technical limitations exist, what is its real effectiveness. (DACOTA)

Is it reliable? The challenge is to find the best compromise between the detection of all the aimed situations and the false alarms. (DACOTA)

The ISO accident configurations are diverse and no clear main scenario can be distinguished. (SIM)

An HMI aimed to an effective information exchange and interaction with the vehicle could greatly improve the rider awareness by reducing rider workload and distractions coming from non-primary riding tasks. (SIM)

Navigation instructions and phone conversations need to be managed together with the vehicle status messages. (SIM)
5. Overview and classification of ITS developments for motorcycling

Summarizing the ITS systems/functions from the Monash review\(^\text{32}\) (in blue) and the Saferider User Survey\(^\text{33}\) (in black), the RIDERSCAN project team came up with the following categorization \textit{(in orange)}. This classification was used as a basis for the \textit{RIDERSCAN ITS Survey}, the latest user acceptance survey, whose results are described in section 6.5.

Notes:

1. The majority of systems/applications/functions referred to below are far from being available on the market. Many of them are only at prototype phases. Some are indeed being investigated by the PTW industry, with some examples of implementation, but for a limited number of vehicles and with limited use. Several others have not been researched by industry, but come from researchers trying to improve road safety;

2. The latter approach requires a significant level of rider community involvement to verify any usability and user acceptance issues, and to validate the appropriate values and implementation strategies

\textit{Rider warnings and information}

<table>
<thead>
<tr>
<th>System names</th>
<th>Description</th>
<th>PTW Safety benefits</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Advanced Rider Assistance</td>
<td>Reduce rider workload</td>
<td>Prevent loss of control crashes (indirect safety benefits)</td>
<td>Active In-vehicle</td>
</tr>
<tr>
<td>Black spot warnings</td>
<td>A system able to warn the rider that he is riding in a place with a high risk of crashing or where a high number of crashes have occurred, aka a black spot</td>
<td>Prevent loss of control crashes (indirect safety benefits)</td>
<td>Active Infrastructure</td>
</tr>
<tr>
<td>Curve speed warning</td>
<td>A function able to warn the rider that he/she is negotiating a bend with an excessive speed for its curvature; Information or warnings regarding the speed or geometry of a curve ahead is delivered by a on-board unit and GPS system</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^{33}\) [http://www.fema-online.eu/riderscan/IMG/doc/saferider_certh_wp2_v3_d1.2_extract_ridersneedsandwants-2.doc]
<table>
<thead>
<tr>
<th><strong>Following distance warning</strong></th>
<th>Alerts user when distance to vehicle ahead is too short</th>
<th><strong>Forward collision warning</strong></th>
<th>Alert user when an object has been detected ahead on the roadway that is slower than the user’s vehicle</th>
<th><strong>Reduction of frontal impact crashes</strong></th>
<th><strong>Active</strong></th>
<th><strong>Infrastructure</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Heads-up display</strong></td>
<td>Projects a display of vehicle information onto the windshield</td>
<td><strong>Helmet-mounted display</strong></td>
<td>Projects a display of vehicle information onto the helmet visor</td>
<td><strong>Minimize need for riders to take eyes off road</strong></td>
<td><strong>Active</strong></td>
<td><strong>Infrastructure</strong></td>
</tr>
<tr>
<td><strong>In-vehicle tutoring systems</strong></td>
<td>Provide feedback to the user regarding vehicle performance</td>
<td><strong>Navigation systems</strong></td>
<td>Deliver information regarding vehicle position and intended path via a GPS or satellite system and on-board unit</td>
<td><strong>Reduce rider workload</strong></td>
<td><strong>Active</strong></td>
<td><strong>Infrastructure</strong></td>
</tr>
<tr>
<td><strong>Object detection systems</strong></td>
<td>Detect and alert the user to objects on the roadway (animals, pedestrians, etc.)</td>
<td><strong>Prevent collisions with objects on roadway</strong></td>
<td>Prevent loss of control crashes (indirect safety benefits)</td>
<td><strong>Active</strong></td>
<td><strong>Infrastructure</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Reverse collision warning system</strong></td>
<td>Detect and alert the user to the proximity of objects directly behind the vehicle when reversing</td>
<td><strong>Road surface condition monitoring</strong></td>
<td>Monitor the road surface ahead and alert the user to abnormalities, material or fluids on the road surface</td>
<td><strong>Reduce running off-road crashes (direct safety benefits)</strong></td>
<td><strong>Active</strong></td>
<td><strong>Infrastructure</strong></td>
</tr>
<tr>
<td><strong>Speed alert/warning</strong></td>
<td>Alert the user when a pre-set limit is exceeded</td>
<td><strong>Traffic warnings</strong></td>
<td>A system that informs the rider about traffic conditions</td>
<td><strong>Active</strong></td>
<td><strong>Infrastructure</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Weather warnings</strong></td>
<td>A system that informs the rider about weather conditions on the road he/she is riding on or planning to travel on</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

**Maintenance and diagnostic**

<table>
<thead>
<tr>
<th><strong>System names</strong></th>
<th><strong>Description</strong></th>
<th><strong>PTW Safety benefits</strong></th>
<th><strong>Characteristics</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Tyre pressure monitoring</td>
<td>Monitor the temperature and pressure of the tyres and alert user to potential problems</td>
<td>(Source Bayly et al., 2006)</td>
<td>Prevent loss of control crashes (indirect safety benefits)</td>
</tr>
<tr>
<td>Vehicle Diagnostics</td>
<td>A function that can diagnose mechanical factors of the PTW</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Lightning and visibility**

<table>
<thead>
<tr>
<th>System names</th>
<th>Description</th>
<th>PTW Safety benefits (Source Bayly et al., 2006)</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptive front lightning</td>
<td>Improve the illumination of the vehicle's path on curves by altering the direction of the light beam</td>
<td>Improve road visibility when cornering</td>
<td>Crashes occurring on curves at night or in poor visibility conditions (indirect safety benefits)</td>
</tr>
<tr>
<td>Blind spot assistance system</td>
<td>A system that can support the rider in a situation when a rider is invisible to a vehicle that is driving/approaching slightly from behind (mainly)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous strobe lighting</td>
<td>Provide a continuous flashing light which illuminates the vehicle to other road users</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daytime running lights</td>
<td>Low-luminance front-mounted lights, automatically activated when headlights are not turned on</td>
<td>Increase motorcycle conspicuity</td>
<td>All multiple vehicle crashes during daytime (direct safety benefits)</td>
</tr>
<tr>
<td>Emergency brake advisory systems</td>
<td>Activate rear brake lights when the accelerator is rapidly released</td>
<td></td>
<td>Active In-vehicle</td>
</tr>
<tr>
<td>Rear-view display / Rear-view helmet</td>
<td>Displays real-time images of the road environment direction behind</td>
<td>Prevent side-swipe and rear-end crashes (indirect safety benefits)</td>
<td></td>
</tr>
<tr>
<td>Vision enhancement</td>
<td>Provide a high contrast image of the road and road environment during low luminance or poor visibility conditions</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visibility improving helmet</td>
<td>Prevent fogging of the motorcycle helmet visor through heating or dehumidifying systems</td>
<td></td>
<td></td>
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</tbody>
</table>

**Braking**

<table>
<thead>
<tr>
<th>System names</th>
<th>Description</th>
<th>PTW Safety benefits (Source Bayly et al., 2006)</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anti-lock braking systems</td>
<td>Provide smooth and even braking pressure to all wheels, and prevent the wheels from locking</td>
<td>Prevent brakes locking</td>
<td>Most relevant to frontal and object collision crashes (direct safety benefits)</td>
</tr>
<tr>
<td>Brake assist</td>
<td>Applies maximum braking pressure in emergency stops</td>
<td></td>
<td>Most relevant to frontal and object collision Active</td>
</tr>
</tbody>
</table>
### Stability and balance

<table>
<thead>
<tr>
<th>System names</th>
<th>Description</th>
<th>PTW Safety benefits</th>
<th>Characteristics</th>
</tr>
</thead>
</table>
| Linked braking systems              | ⊳ Reduce stopping distance in emergency brakes  
|                                    | ⊳ Apply braking pressure to both wheels even when only one brake is engaged by the user  
|                                    | ⊳ Maximize braking force  
|                                    | Prevent frontal collisions and running off-road crashes (direct safety benefits)                                                                                                                                   | In-vehicle                                                          |                  |
|                                    | In-vehicle                                                                                                                                                                                                     |                                                                                   |                  |
| **Stability and balance**          |                                                                                                                                                    |                                                                                   |                  |
| **System names**                   | **Description**                                                                                                                                                                                             | **PTW Safety benefits**                                                                 | **Characteristics** |
| Automatic Stability Control        | ASC: prevents the rear wheel from spinning uncontrolled and lift-off detection of front wheel                                                                                                               | (Source Bayly et al., 2006)                                                        |                  |
|                                    | ⊳ Maintain traction of the vehicle  
|                                    | Loss of control crashes, and off-path on curve crashes (direct safety benefits)                                                                                                                                  | Active, In-vehicle                                                              |                  |
| Electronic stability program       | Detects loss of control of vehicle and intervenes on each wheel to maintain trajectory  
|                                    | ⊳ Maintain traction of the vehicle  
|                                    | Loss of control crashes, and off-path on curve crashes (direct safety benefits)                                                                                                                                  | Active, In-vehicle                                                              |                  |
| Roll stability                      | ⊳ Warn riders if tilt of motorcycle is too great  
|                                    | Off-path, on curve crashes which account for 17% of all motorcycle crashes (direct safety benefits)                                                                                                           | Active, In-vehicle                                                              |                  |
| Traction control                   | A system that gives the optimal grip level of the wheel while accelerating; Provides greater control when accelerating by applying braking pressure or altering the fuel or power supply |
|                                    |                                                                                                                                                    |                                                                                   |                  |
| **Rider fitness**                 |                                                                                                                                                    |                                                                                   |                  |
| **System names**                   | **Description**                                                                                                                                                                                             | **PTW Safety benefits**                                                                 | **Characteristics** |
| Alcohol detection and interlock    | Disable vehicle’s ignition if alcohol is detected in the breath of the user  
|                                    | ⊳ Prevent intoxicated riding  
|                                    | Any type of crash involving alcohol. 25% of fatal motorcycle crashes involve BAC over .05 (direct safety benefits)                                                                                               | Active, In-Vehicle                                                            |                  |
| Animal detection systems           | Detect and alert the user to animals on the roadway                                                                                                                                                    |                                                                                   |                  |
| Driver vigilance monitoring        | Monitor vehicle/user behaviour and/or physiology and provide alerts or intervene if the user is fatigued or inattentive  
|                                    | ⊳ Monitor alertness and fatigue in rider  
|                                    | Prevent loss of control crashes (indirect safety benefits)                                                                                                                                                    | Active, In-vehicle                                                            |                  |
| Drowsiness relieving system        | Provide alerts such as tones, haptic feedback or fragrance if users is fatigued or inattentive                                                                                                                 |                                                                                   |                  |
| Electronic licencing / Smart cards | Disable ignition unless licenced user is identified  
|                                    | ⊳ Prevent unlicensed riding  
|                                    | Should reduce alcohol and speed related crashes (direct safety benefits)                                                                                                                                     | Active, In-vehicle                                                            |                  |
Helmet reminder and interlock
Detects the presence of helmet and disables the ignition if helmet is not properly fixed

**Passive systems (post-crash)**

<table>
<thead>
<tr>
<th>System names</th>
<th>Description</th>
<th>PTW Safety benefits (Source Bayly et al., 2006)</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Airbag jackets</td>
<td>Airbags within the jacket inflate when the rider is thrown from the vehicle</td>
<td>Relevant to any single or multiple vehicle crash where the rider is thrown from the vehicle (direct safety benefits)</td>
<td>Passive</td>
</tr>
<tr>
<td></td>
<td>➔ Minimise injury to the rider when thrown from the vehicle</td>
<td></td>
<td>In-vehicle</td>
</tr>
<tr>
<td>e-call/ Automatic Crash</td>
<td>Automatically inform emergency services of vehicle’s location in the event of a crash</td>
<td>Reduce emergency response times (direct safety benefits)</td>
<td>Passive</td>
</tr>
<tr>
<td>Notification</td>
<td></td>
<td></td>
<td>In-vehicle</td>
</tr>
<tr>
<td>Emergency lighting systems</td>
<td>Illuminate the vehicle after a crash has occurred</td>
<td>Reduce emergency response times (indirect safety benefits)</td>
<td>Passive</td>
</tr>
<tr>
<td>External airbags</td>
<td>Airbags mounted externally to the front bumper and bonnet inflate upon collision with a pedestrian</td>
<td>Minimize injury in vulnerable road user collisions</td>
<td>Passive</td>
</tr>
<tr>
<td></td>
<td>➔ Cushion impact of rider with other vehicle</td>
<td></td>
<td>Other vehicle</td>
</tr>
<tr>
<td>Impact sensing cut-off systems</td>
<td>Disable electrical and/or fuel systems post-crash</td>
<td>Prevent minor injury crashes becoming serious or fatal (indirect safety benefits)</td>
<td>Passive</td>
</tr>
<tr>
<td></td>
<td>➔ Prevent electrical and fuel systems igniting in a crash</td>
<td></td>
<td>In-vehicle</td>
</tr>
<tr>
<td>Motorcycle airbag</td>
<td>Deploy upon detection of crash that exceeds a predetermined intensity level</td>
<td>Frontal impact crashes with other vehicles and objects (direct safety benefits)</td>
<td>Passive</td>
</tr>
<tr>
<td></td>
<td>➔ Prevent the rider being thrown from the vehicle in front-impact crashes</td>
<td></td>
<td>In-vehicle</td>
</tr>
<tr>
<td>Pop-up bonnet systems</td>
<td>➔ Cushion impact of upper body with car bonnet</td>
<td>Minimize injury in vulnerable road user collisions</td>
<td>Passive</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Other vehicle</td>
</tr>
</tbody>
</table>

**Communication Vehicle to Vehicle (V2V)**

| Adaptive cruise control      | A system that can automatically keep a constant distance, selected by the rider, from the preceding vehicle and can also keep a constant speed |                                                                                                              | Active         |
| Intersection collision avoidance | Vehicles approaching an intersection communicate their speed and direction to roadside beacons, which alert other vehicles of their position |                                                                                                              | In-vehicle     |
| Inter-vehicle communication systems | Vehicles communicate their speed, direction, location and vehicle type and this information is displayed to the user | Off-path, on curve crashes, which account for 17% of all MC crashes (direct safety benefits)                    | or              |
Motorcycle detection system

Motorcycles transmit the speed and location to other vehicles, alerting other drivers when motorcycles are in close proximity

**Communication Vehicle to Infrastructure (V2I)**

<table>
<thead>
<tr>
<th>System names</th>
<th>Description</th>
<th>PTW Safety benefits (Source Bayly et al., 2006)</th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intelligent speed adaptation</td>
<td>Alert and/or limit the speed of the vehicle according to the posted speed limit, using roadside beacons or GPS systems to determine this speed</td>
<td>Prevent speed-related crashes (direct safety benefits)</td>
<td>Active Cooperative</td>
</tr>
<tr>
<td>Lane changing collision avoidance</td>
<td>Monitor the vehicle’s blind spot and provide alerts when vehicles are located in this area</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lane departure warning / Lane keeping assistance</td>
<td>Monitor the vehicle’s lateral position, and either alert or intervene when the vehicle deviates from the lane</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed limiting systems</td>
<td>Alert the user and inhibit further acceleration when a pre-set limit is exceeded</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
ITS will provide many static and kinetic obstacles to riders. It is my fear that the ITS vehicles will also employ a program of predictability of near miss outcomes that will prove to be motorcyclist unfriendly/fatal. This statement is evidenced by the unsatisfactory recognition of motorcyclists and bicyclists in the roadway environment. Many motorcyclist training courses insist upon visually scanning the roadway at a distance and speed that current ITS systems do not compute.

Source: Linkedin discussion - 21/05/2013
https://www.linkedin.com/groups/What-makes-riding-different-from-2572176.S.2411771560?trk=groups_search_item_list-0-b-ttl

6. Riders ITS awareness and acceptance

In order for safety systems to successfully reduce the incidence and severity of road crashes, technologies must be deemed acceptable by the intended system users. Acceptability refers to “whether the system is good enough to satisfy all the needs and requirements of the user and other potential stakeholders” (Nielsen, 1993, p. 24). There are few studies addressing acceptability of assistive systems for PTWs. In Europe, two projects addressed the issue by means of a focus group and a pan-European survey: the SAFERIDER project and the 2BESAFE projects. Several discussions in focus groups complete this overview.

6.1. SAFERIDER Survey (2008)

The SAFERIDER survey aimed to identify the requirements (needs) to enhance the safety level of riders and to capture riders’ wants in terms of desired devices/improvements to the Powered Two-Wheeler (PTW). To achieve these different goals, the following actions were taken:

Organisation of a Focus Group with a selected group of trainers, who also represented experienced riders

The aim of the Focus Group was to identify the needs of riders, especially young ones, since its members are all professional trainers. In addition the Focus Group members were asked to provide input on the devices proposed by the consortium based on their own riders’ experience. Each member of the group had to express his opinion on each of the functions. The unabridged transcriptions of the meeting are available on the project intranet.

| Speed Warning | Half of the panel couldn't see any real benefit because accident severity does not simply depend on speed; and the best control of speed is a rider’s experience and awareness of the environment. Nevertheless, the other half felt that a passive version of this device could be mostly |

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34 2BESAFE – D9 Report On Assistive Technologies For Rider Safety

35 http://www.fema-online.eu/riderscan/IMG/doc/saferider_certh_wp2_v3_d1_2_extract_ridersneedsandwants-2.doc
beneficial for novice riders as it could help them to regulate their speed while learning to ride in compliance with speed limits or because they have the tendency to miss signs

| Curve Warning | Should adapt to different riding styles as there are several ways to enter a curve depending on a rider’s skill, experience, but also other parameters such as PTW geometry or surface or tyre condition |
| Frontal Collision Warning | This device would be better for cars than for PTWs. Its most beneficial PTW application would be for young riders on scooters and mopeds in urban traffic. It should be developed paying attention to discrimination criteria in relation to false alarms and dangerous situations; and allowing time for rider reaction and the type of braking system installed |
| Intersection Support | The device could be useful, though with certain reservations and difficulties regarding its development especially because of the enormous quantity of information needing to be taken into account. A selection of the information transferred to the rider should be done in order to avoid saturation |
| Adaptive Lights | Most likely to be useful in non-urban environments, but only with a well-developed tracking algorithm for the headlight to effectively follow the curve |
| The eCall system | Useful in scarcely populated areas, but would need a robust system to evaluate the situation, to avoid the generation of false alarms / false calls |
| Telediagnostic Services | Powerful tool to monitor certain important parameters like tyre pressure or brake functionality. But it should be affordable, based on an open format and not used for law enforcement purposes |
| Navigation system | Positively accepted, although some limits were identified with regard to overloading riders with information |
| Weather, traffic and black spot warnings | Weather information is important and useful especially if the conditions are local. Reliability of the system (updates) for safety information (e.g. black spots) was seen as crucial |
| Human Machine Interface (HMI) | Main concern regarded the “sensor overload” and the amount of information that should reach the rider. Each rider should be free to select the desired information. Vibration, but only one type, not one for each warning. Acoustic (voice) messages were considered intrusive and undesirable |

A general comment from the focus group was that each device should have the possibility to be turned off.
Conduct of a public survey

The public survey was held to gain preliminary feedback on the public acceptance of new devices from end users, based on their expectations for the future development of PTWs.

The survey was organized in the form of a voluntary poll on the internet, hosted on the FEMA website. The text was translated into the main European languages (e.g. English, French, German, Italian, Greek, and Spanish) related to key PTW markets, and advertised as widely as possible within the rider community. The webpage of the survey was accessible for over 2 months, until 31 August 2008. A total of 4256 records were finally used in the analysis of the survey.

Functions considered useful, very useful, and essential

<table>
<thead>
<tr>
<th>Function</th>
<th>Useful (%)</th>
<th>Very Useful (%)</th>
<th>Essential (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Communication System</td>
<td>23</td>
<td>24</td>
<td>15</td>
<td>61</td>
</tr>
<tr>
<td>Helmet Grip and Seat Heating</td>
<td>28</td>
<td>23</td>
<td>11</td>
<td>62</td>
</tr>
<tr>
<td>Blind Spot Assistance System</td>
<td>21</td>
<td>24</td>
<td>18</td>
<td>62</td>
</tr>
<tr>
<td>Traction Control</td>
<td>22</td>
<td>24</td>
<td>18</td>
<td>63</td>
</tr>
<tr>
<td>Cruise Control</td>
<td>27</td>
<td>25</td>
<td>13</td>
<td>64</td>
</tr>
<tr>
<td>Adaptive Suspension to the type of road</td>
<td>23</td>
<td>27</td>
<td>15</td>
<td>64</td>
</tr>
<tr>
<td>Handle Grip and Seat Heating</td>
<td>30</td>
<td>24</td>
<td>10</td>
<td>64</td>
</tr>
<tr>
<td>Adaptive Light</td>
<td>27</td>
<td>26</td>
<td>12</td>
<td>66</td>
</tr>
<tr>
<td>Black Spot Warning</td>
<td>30</td>
<td>25</td>
<td>10</td>
<td>66</td>
</tr>
<tr>
<td>Telediagnostic Services</td>
<td>25</td>
<td>29</td>
<td>18</td>
<td>72</td>
</tr>
<tr>
<td>Communication Vehicle to Infrastructure</td>
<td>19</td>
<td>24</td>
<td>10</td>
<td>78</td>
</tr>
</tbody>
</table>

Functions considered not useful or slightly useful

<table>
<thead>
<tr>
<th>Function</th>
<th>Not (%)</th>
<th>Useful (%)</th>
<th>Slightly Useful (%)</th>
<th>Total (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>System for Reduced Visibility</td>
<td>44</td>
<td>21</td>
<td></td>
<td>65</td>
</tr>
<tr>
<td>Hands Free Mobile Phone</td>
<td>53</td>
<td>16</td>
<td></td>
<td>69</td>
</tr>
<tr>
<td>Lane Departure Warning</td>
<td>44</td>
<td>21</td>
<td></td>
<td>65</td>
</tr>
<tr>
<td>Night Vision System</td>
<td>45</td>
<td>23</td>
<td></td>
<td>69</td>
</tr>
<tr>
<td>Lane Change Assistance</td>
<td>43</td>
<td>23</td>
<td></td>
<td>67</td>
</tr>
</tbody>
</table>
The survey demonstrated that there is a correlation among usefulness levels and nationality, usage, age and riding experience, but no correlation with road type, riding behaviour and accidents.

To be noted: In interpreting the results account should be taken of the fact that, at the time these activities were performed, no prototypes or demonstrators of the devices/functions were available. The opinions expressed by the survey participants and the members of the Focus Group are therefore based solely on functional descriptions made available by consortium members.

6.2. 2BESAFE Survey\(^{36}\) (2011)

The results of the 2BESAFE project revealed more system-specific indicators of acceptance, as shown in the enormous variation in levels of acceptance between specific systems.

<table>
<thead>
<tr>
<th>Perceived usability and satisfaction</th>
<th>Riders objected to systems that interfere with their responsibilities as a rider (Intelligent Speed Adaptation, Adaptive Cruise Control)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived usefulness</td>
<td>Riders showed greater acceptance of systems that provide obvious benefits in emergency situations, such as automatic crash notification (eCall)</td>
</tr>
<tr>
<td>Perceived effectiveness</td>
<td>Riders expressed a preference for established systems which are known, trusted, considered as technologically mature and have demonstrated safety benefits (ABS). Riders also expressed concern that some systems may lead to a de-skilling of riders</td>
</tr>
<tr>
<td>Affordability</td>
<td>Riders expressed concern that some assistive systems, which are increasingly available on passenger cars, may not be cost-effective for fitting on most PTWs</td>
</tr>
</tbody>
</table>

Project survey conclusions reveal that there are several barriers to the uptake of assistive systems by PTW riders; with most of them relating to the perceived effectiveness and usefulness of the systems.

Overall, the project estimates that current rider acceptance could be rated as “low to moderate” and calls for further acceptance assessment work. While recognizing that the approach should not be technology-oriented in the first place, the project also sees potential for increasing acceptance, either through changing rider attitudes towards technology or by changing the technology itself.

Nevertheless, acceptance levels for PTW assistive systems are lower than for equivalent systems in passenger cars.

6.3. VRUITS PTW focus group\(^{37}\) (2013)

Overall “tech-affinity” seems to be at a comparatively low level, especially when an ITS system interferes with the riding task or is perceived as impinging on a rider’s autonomy. Training and education are considered to be of major importance in this group of VRUs, while ITS is seen to have mainly adverse effects on riding behaviour. Systems that support PTWs in critical situations are seen as helpful only in certain situations (i.e. for novice riders).

Despite this, one technology assessed very positively is related to PTW visibility. Systems supporting visibility or communication between PTWs and cars are considered very positive.

**Potential barriers to using ITS** and the acceptance of technological solutions supporting the traffic safety of VRUs and adverse effects of these systems are in general very similar between (participating) countries:

| Fear of loss of autonomy | The fear of losing control of certain functions to ITS systems that actively interfere with the driving/riding task are discussed especially in conjunction with an underlying notion of a lack of reliability and trust in these new technologies. A lot of participants in the discussion rounds in the four countries feel that training and awareness-raising are still a more promising way of improving traffic safety. Rider groups in particular view systems that interfere with the riding task sceptically, as the pure experience of riding a motorcycle is considered as one of the reasons for owning a bike, especially when it is used for pleasure. |
| Reliability | While technology awareness and also the general knowledge of basic ITS systems are at quite a high level, there still seems to be a lack of knowledge on the specific functions and benefits of ITS systems supporting the traffic safety of the various vulnerable road user groups. Proof of the functionality, efficiency and the benefits of these systems is needed in order to establish a level of trust and reliability that would improve their acceptance. In the Dutch discussion rounds, participants even suggested introducing certificates as these would help differentiate gadgets from actual working applications. |
| Loss of responsibility | Another aspect perceived to have adverse effects on road user behaviour is attributed to the over-reliance on systems meant to support drivers/riders in critical situations. There is a fear among a number of participants from the various VRU groups in all countries of road users becoming overly accustomed to transferring responsibility for handling critical or dangerous situations to assistance and warning systems. This could lead to a decrease in a rider’s ability to handle certain situations appropriately especially when... |

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\(^{37}\) Extract from Deliverable 2.1 Technology potential of ITS addressing the needs of Vulnerable Road Users – [http://www.vruits.eu/themes/bamboo/deliverables/vruits_D21_v10_131219_draft.pdf](http://www.vruits.eu/themes/bamboo/deliverables/vruits_D21_v10_131219_draft.pdf)
a certain system fails. The question for some participants is correspondingly also related to the legal issues and liability in the case of an accident

6.4. RIDERSCAN ITS Survey (2014) (Annex 3)
The RIDERSCAN ITS survey aimed to capture the attitude of riders towards safety systems at large. More specifically, the objectives of the survey included the identification of:

- rider subgroups with different attitudes towards safety and safety systems/devices;
- systems/devices evaluation by riders;
- national differences within Europe with reference to an average European sample.

The survey was available for a period of 3 months in the following national languages: Bulgarian, Czech, Danish, Dutch, English, Estonian, Finnish, French, German, Greek, Hungarian, Italian, Lithuanian, Norwegian, Polish, Portuguese, Rumanian, Slovakian, Slovenian, Spanish and Swedish. The survey was advertised in all European countries through rider clubs and the national press.

The survey was composed of 2 parts: a first part segmenting riders according to their location, riding profile and background, and their attitude towards safety and technology; the second part offered a list of systems/functions (cf. 5.Classification of ITS Systems/Functions) for which riders were asked to rate from 0 to 4 the estimated safety potential, whereby a rating of 0 clearly underlined the identified potential danger and the implicitly recommended not pursuing such technology.

- European sample
On average, the European dataset (comprised of Belgium, Denmark, Finland, France, Germany, Greece, Italy, Luxembourg, the Netherlands, Sweden and the United Kingdom - duly corrected with park and accident rates) is mainly representative of riders 26 and older and essentially male riders.

The majority of riders (65.3%) have more than 10 years of experience, and 89.1% more than 3 years, while annual mileage with PTW(s) is pretty uniform, being above 3000 km/year.

Attitudes toward technologies
First, riders were asked to express their opinion on new technologies and the perceived relationship to safety. The largest group of riders stated that new technologies have the potential to improve road use (47.2%), though the second largest user group (28.8%) holds the opposite opinion (i.e. technology decreases safety as road users are distracted by technology; Figure 17).
When the statement on new technologies is crossed-analysed with the PTW type, results show that those with the most positive attitude towards technology are scooter and Supersport riders; Enduro/cross, on/offroad, Sport Touring and Standard follow but with a sharp drop in riders open to technology; while Supermotard riders feature a less than 10% difference between the largest and smallest group (Figure 18).

Figure 17 Distribution of the "safety statement" (European dataset)

Figure 18 Safety statement vs PTW type (European dataset)
There is also a clear correlation between the attitude towards technology and riding experience: the greater the experience the less the riders tend to have a positive attitude towards technology (Figure 18).

The same trend is visible in the correlation with annual PTW mileage (Figure 20): except for the unexplained dip for annual mileages between 1,000 and 3,000 km/year, the positive attitude towards technology decreases with increasing mileage and the group of sceptical riders increases. For those clocking up more than 15,000 km/year, the latter group becomes the largest one.
By contrast no clear relationship could be found with PTW usage. For example, Greece and Italy has the same level of technology acceptance (68.6% for Greece and 61% for Italy) and although have very opposed PTW usage. In Greece, more than 65% of the respondents use their car for commuting while more than 55% of Italian riders use their motorcycle for leisure (Figure 21).
Then, Riders were asked to rate a list of systems. The list consisted of the systems/functions identified by the Monash University review\(^{38}\) and those initially evaluated/surveyed in the SAFERIDER project\(^{39}\). A description of each system/function was provided for reference during the course of answering the questionnaire. The list was structured according to the functional/kind of support purpose of the systems/functions to facilitate understanding. The following classification scheme was used: (I) rider warnings and information systems; (II) maintenance and diagnostic; (III) lighting and visibility; (IV) braking; (V) stability and balance; (VI) rider fitness; (VII) passive (post-crash) systems; (VIII) communication between vehicles (V2V); (IX) communication between vehicles and infrastructure (V2I).

Technically speaking, the list included both systems currently available on the market and systems not available for powered two-wheelers or even not available at all for road vehicles. The latter group includes systems currently being researched and thus only general features are available to describe their performance.


In terms of safety systems best rated one is ABS, which is the only real safety device available in the market. A more general analysis in terms of typology shows that:

- 4 out of 10 systems are related to *braking*;
- 3 out of 10 systems are related to *lighting and visibility*;
- 2 out of 10 systems allow improved *maintenance* of the PTW;
- 1 out of 10 systems belongs to the *post-crash* group.

![Figure 22](image_url) 10 best safety systems/devices in decreasing order of relevance (European dataset)

A comparison of these 10 systems with the 10 best rated systems, identified through the answers of “technology negative” riders, shows that 9 out of 10 systems are identical (Figure 23 and Figure 24) This result represents a strong statement of rider expectations, independently from their position about technology.
Motivations should be investigated more broadly, since other data point to a highly fragmented scenario based on different usage patterns: in fact 67% of riders, who use PTW as main transport mean, are commuters and, on the contrary, leisure riders represent 66% of riders, who use car as main transport mean (Error! Reference source not found.). Most
probably these two subgroups have different safety requirements and have also different expectations in terms of safety systems.

Figure 25 Most often used means of transport vs PTW usage (European dataset) – data add up to 100% for the most often used means of transport

<table>
<thead>
<tr>
<th>Description</th>
<th>All</th>
<th>Sceptic</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visibility improving helmet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curve ABS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vision enhancement</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tyre pressure monitoring</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Brake assist</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Linked Braking systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Impact sensing cut off systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Vehicle diagnostics</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adaptive front lightning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Automatic Crash Notification</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 26 Comparison of top 10 best safety systems - full European dataset vs sceptic riders
Most dangerous systems

The analysis on the top 10 dangerous systems has the following results:

- 3 out of 10 systems provide warning and information systems;
- 3 out of 10 systems represent the communication between vehicles and infrastructure (V2I) group;
- 2 out of 10 systems are related to lighting and visibility;
- 2 out of 10 systems belong to the communication between vehicles (V2V).

Figure 27 10 most dangerous systems/devices for safety in decreasing order of relevance (European dataset)
The analysis on the top 10 dangerous systems has the following results:

- 3 out of 10 systems provide *warning and information* systems;
- 3 out of 10 systems represent the *communication between vehicles and infrastructure* (V2I) group;
- 2 out of 10 systems are related to *lighting and visibility*;
- 2 out of 10 systems belong to the *communication between vehicles* (V2V).
Figure 29 10 most useless systems/devices for safety vs the safety statement (systems are in decreasing order of relevance; European dataset)

The five systems in common to the useless and dangerous groups share some common traits (Figure 30), they:

- are active during riding;
- require an interaction with the rider and thus have the potential to cause a sensorial overload, especially in dangerous situations as in case of warning.
<table>
<thead>
<tr>
<th>Description</th>
<th>Dangerous</th>
<th>Useless</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helmet mounted display</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed limiting systems</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuous strobe lighting</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intelligent speed adaptation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rear view display / Rear view helmet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adaptive cruise control</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lane departure warning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Heads up display</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intersection collision avoidance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Curve speed warning</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Helmet reminder and interlock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronic licensing Smart cards</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Alcohol detection and interlock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Traffic sign recognition</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Speed alert warning</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Figure 30 Comparison of top 10 dangerous and useless safety systems (European dataset)*

In the assessment of useless systems (Figure 29 [Error! Reference source not found.]), the first three systems (i.e. *helmet reminder and interlock, electronic licensing smart cards, alcohol detection and interlock*) show amplified national differences, which range up to 45% difference. These differences tend to smooth out as the degree of uselessness decreases.

- **National analyses**
  - **Attitudes toward technologies**

  National analyses highlighted different opinions and attitudes. The distribution of riders’ attitude towards safety was summarized in the so called “safety statement”. An overview of the riders’ attitude is reported in Figure 31. Results show that in all countries but France and United Kingdom the largest subgroup is the one of technology positive riders.

  In addition, apart from Germany, the largest subgroup (positive or sceptic riders) represents at least 50% of riders (result valid in: Belgium, Greece, Italy, Netherlands, Northern countries and United Kingdom).
Figure 31 Summary of safety statement (data from national analyses)
Figure 32 10 best safety systems/devices with detail of country rating (systems are in decreasing order of relevance; European dataset)
A further comment on the ranking of best/useless/dangerous systems involves the national differences within European countries. Regarding the 10 best devices for safety (Figure 32):

- southern European countries (i.e. Greece and Italy) have usually high and very similar ratings;
- Germany, Netherlands, Sweden, and United Kingdom are always the countries with lower percentages (exceptions on specific devices are ABS and curve ABS, which received appreciation in Sweden);
- Belgium, Denmark, and France are more selective, with a changing grading on a per system basis.

The analysis of safety systems considered either definitely useful or essential for safety highlights common feeling of riders in different countries. The most relevant findings are (Figure 33):

- the most represented group of systems are: maintenance and diagnostic, and braking since all systems in the groups were at least considered once as useful for safety. Also lighting and visibility has many systems considered relevant for safety;
- only the group communication between vehicles and infrastructure (V2I) was never perceived as useful for safety. On the contrary its systems were often ranked among useless or dangerous systems;
- although different attitudes towards technology were recorded, some safety systems were considered useful for safety by all riders in all countries. Namely:
  - tyre pressure monitoring;
  - visibility improving helmet;
  - ABS;
  - curve ABS;
- in general safety systems related to braking were often considered useful in most of the countries.
### Figure 33 Summary of useful safety systems (from national analyses; percentages indicate the share of riders that, at national level, ranked the specific system as useful for safety)

**Group coding:** I – Rider warnings and information systems; II – Maintenance and diagnostic; III – Lighting and visibility; IV – Braking; V – Stability and balance; VI – Rider fitness; VII – Passive and post-crash systems; VIII – Communication between vehicles (V2V).

<table>
<thead>
<tr>
<th>Description</th>
<th>Belgium</th>
<th>France</th>
<th>Germany</th>
<th>Greece</th>
<th>Italy</th>
<th>Netherlands</th>
<th>Northern</th>
<th>United Kingdom</th>
<th>Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>Navigation systems</td>
<td>46.2%</td>
<td>39.8%</td>
<td>38.3%</td>
<td>70.3%</td>
<td>40.9%</td>
<td>28.3%</td>
<td>39.5%</td>
<td>38.1%</td>
<td>I</td>
</tr>
<tr>
<td>Road surface condition monitoring</td>
<td>51.4%</td>
<td>51.4%</td>
<td>38.3%</td>
<td>70.3%</td>
<td>59.8%</td>
<td>58.8%</td>
<td>65.5%</td>
<td>57.5%</td>
<td>II</td>
</tr>
<tr>
<td>Tire pressure monitoring</td>
<td>51.4%</td>
<td>51.4%</td>
<td>38.3%</td>
<td>70.3%</td>
<td>59.8%</td>
<td>58.8%</td>
<td>65.5%</td>
<td>57.5%</td>
<td>II</td>
</tr>
<tr>
<td>Vehicle diagnosis</td>
<td>51.4%</td>
<td>51.4%</td>
<td>38.3%</td>
<td>70.3%</td>
<td>59.8%</td>
<td>58.8%</td>
<td>65.5%</td>
<td>57.5%</td>
<td>II</td>
</tr>
<tr>
<td>Adaptive fog lighting</td>
<td>44.4%</td>
<td>52.4%</td>
<td>52.4%</td>
<td>52.4%</td>
<td>45.4%</td>
<td>38.4%</td>
<td>45.4%</td>
<td>38.4%</td>
<td>III</td>
</tr>
<tr>
<td>Blind spot assistance</td>
<td>41.4%</td>
<td>41.4%</td>
<td>52.4%</td>
<td>52.4%</td>
<td>45.4%</td>
<td>38.4%</td>
<td>45.4%</td>
<td>38.4%</td>
<td>III</td>
</tr>
<tr>
<td>Emergency brake advisory systems</td>
<td>61.9%</td>
<td>77.0%</td>
<td>61.9%</td>
<td>77.0%</td>
<td>61.9%</td>
<td>61.9%</td>
<td>61.9%</td>
<td>61.9%</td>
<td>IV</td>
</tr>
<tr>
<td>Vision enhancement</td>
<td>41.8%</td>
<td>51.7%</td>
<td>51.7%</td>
<td>51.7%</td>
<td>51.7%</td>
<td>51.7%</td>
<td>51.7%</td>
<td>51.7%</td>
<td>IV</td>
</tr>
<tr>
<td>ABS</td>
<td>41.8%</td>
<td>51.7%</td>
<td>51.7%</td>
<td>51.7%</td>
<td>51.7%</td>
<td>51.7%</td>
<td>51.7%</td>
<td>51.7%</td>
<td>IV</td>
</tr>
<tr>
<td>Brake assist</td>
<td>59.0%</td>
<td>59.0%</td>
<td>59.0%</td>
<td>59.0%</td>
<td>59.0%</td>
<td>59.0%</td>
<td>59.0%</td>
<td>59.0%</td>
<td>IV</td>
</tr>
<tr>
<td>Dynamic ABS</td>
<td>47.2%</td>
<td>51.1%</td>
<td>51.1%</td>
<td>51.1%</td>
<td>51.1%</td>
<td>51.1%</td>
<td>51.1%</td>
<td>51.1%</td>
<td>IV</td>
</tr>
<tr>
<td>Linked braking systems</td>
<td>41.1%</td>
<td>41.1%</td>
<td>41.1%</td>
<td>41.1%</td>
<td>41.1%</td>
<td>41.1%</td>
<td>41.1%</td>
<td>41.1%</td>
<td>IV</td>
</tr>
<tr>
<td>Automatic Stability / Control</td>
<td>41.1%</td>
<td>41.1%</td>
<td>41.1%</td>
<td>41.1%</td>
<td>41.1%</td>
<td>41.1%</td>
<td>41.1%</td>
<td>41.1%</td>
<td>IV</td>
</tr>
<tr>
<td>Alcohol detection and feedback</td>
<td>41.1%</td>
<td>58.9%</td>
<td>58.9%</td>
<td>58.9%</td>
<td>58.9%</td>
<td>58.9%</td>
<td>58.9%</td>
<td>58.9%</td>
<td>IV</td>
</tr>
<tr>
<td>Driver vigilance / distraction setting</td>
<td>41.1%</td>
<td>41.1%</td>
<td>41.1%</td>
<td>41.1%</td>
<td>41.1%</td>
<td>41.1%</td>
<td>41.1%</td>
<td>41.1%</td>
<td>IV</td>
</tr>
<tr>
<td>Emergency lighting systems</td>
<td>51.5%</td>
<td>51.5%</td>
<td>51.5%</td>
<td>51.5%</td>
<td>51.5%</td>
<td>51.5%</td>
<td>51.5%</td>
<td>51.5%</td>
<td>V</td>
</tr>
<tr>
<td>Impact testing support</td>
<td>54.1%</td>
<td>47.1%</td>
<td>47.1%</td>
<td>47.1%</td>
<td>47.1%</td>
<td>47.1%</td>
<td>47.1%</td>
<td>47.1%</td>
<td>VI</td>
</tr>
<tr>
<td>Motorcycle approach monitoring</td>
<td>51.5%</td>
<td>41.3%</td>
<td>41.3%</td>
<td>41.3%</td>
<td>41.3%</td>
<td>41.3%</td>
<td>41.3%</td>
<td>41.3%</td>
<td>VII</td>
</tr>
</tbody>
</table>
Most dangerous systems

Figure 34 10 most dangerous systems/devices with detail of country rating (systems are in decreasing order of relevance; European dataset)
In case of dangerous rating, Germany and United Kingdom exhibit a general outstanding negative ratings. However United Kingdom is the most critical country for continuous strobe lighting, speed limiting systems and intelligent speed adaptation, while Germany for the remaining 7 systems (Figure 34). An explanation could be linked to national campaigns against Daytime Running Lights (DRL) and/or Intelligent Speed Adaptation (ISA) in these countries, highlighting in turn the role of the media and riders’ groups campaigns for riders’ acceptance.

Observed in details for each country, 9 systems were ranked dangerous and useless by the respondents in all countries.

3 systems were ranked dangerous and useless in 6 different countries: Speed limiting systems, Intelligent speed adaptation and Lane departure warning. Rear view display / rear view helmet was and Continuous strobe lighting badly ranked respectively in 4 and 3 countries. Adaptive cruise control, Curve speed warning, Electronic licensing smart cards and In-vehicle tutoring system were ranked dangerous and useless in 2 countries.

France and the Northern countries were the most severe and ranked 6 systems each useless and dangerous, while the British riders only ranked 2 systems useless and dangerous.

<table>
<thead>
<tr>
<th>Systems installation option</th>
</tr>
</thead>
<tbody>
<tr>
<td>A summary of preferred installation option for systems reputed essential for safety shows that there is no relation to the technology attitude (Figure 35). In fact more than 60% of riders in all countries, but Greece and Italy, are in favour of a safety system available as an optional</td>
</tr>
</tbody>
</table>
installation. Reversely, in Greece and Italy respectively 58.9% and 69.2% of riders are in favour of a standard installation.

![Figure 35 Summary of preferred installation modality of essential safety functions (data from national analyses)](image)

**6.5. RIDERSCAN pan-European Motorcycling Survey (Annex 1)**

A survey targeting European riders was designed to collect information on the motorcycling community around Europe and to gain a better overview of similarities and differences in terms of riding, attitudes and safety needs.

The survey was conducted as an open participation survey, open to the general public in each participating country for 6 months. It was available in the following languages: Czech, Danish, Dutch, English, Finnish, French, German, Greek, Hungarian, Italian, Norwegian, Polish, Portuguese, Slovenian, Spanish and Swedish. The survey was advertised through rider clubs and the national press. The Pan-European survey was disseminated at national level via riders’ groups and the motorcycling press as well as via Internet. It collected over 17,000 usable answers from 18 European countries (more methodological details in Annex 1).

It consisted of 4 parts:

I. General information: this part of the survey aimed at segmenting motorcyclists per country according to basic socio-economic information.

II. Mobility habits: This part of the survey aimed at understanding what kind of journeys motorcyclists undertake in general and more specifically with their powered two-wheelers.

III. Riding habits: This part of the survey aimed at gaining more details on riding habits.
IV. Safety habits: This part of the survey aimed at gaining more details on safety habits.

The analysis of the answers included the creation of a normalised European dataset and national datasets.

Optional vehicle equipments

<table>
<thead>
<tr>
<th>What kind of equipment</th>
<th>No.</th>
<th>% obs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>[adjustable suspension]</td>
<td>9348</td>
<td>53.2%</td>
</tr>
<tr>
<td>[daytime running lights]</td>
<td>8937</td>
<td>50.9%</td>
</tr>
<tr>
<td>[hazard indicator lights]</td>
<td>8354</td>
<td>47.6%</td>
</tr>
<tr>
<td>[luggage system]</td>
<td>8316</td>
<td>47.4%</td>
</tr>
<tr>
<td>[adjustable levers]</td>
<td>7988</td>
<td>45.5%</td>
</tr>
<tr>
<td>[on-board electronic anti-theft system]</td>
<td>6047</td>
<td>34.4%</td>
</tr>
<tr>
<td>[anti-lock braking system (ABS)]</td>
<td>5625</td>
<td>32.0%</td>
</tr>
<tr>
<td>[heated grips/heated seat]</td>
<td>5289</td>
<td>30.1%</td>
</tr>
<tr>
<td>[gearshift indicator]</td>
<td>4808</td>
<td>27.4%</td>
</tr>
<tr>
<td>[navigation system]</td>
<td>4437</td>
<td>25.3%</td>
</tr>
<tr>
<td>[adjustable seat height]</td>
<td>3004</td>
<td>17.1%</td>
</tr>
<tr>
<td>[start/stop]</td>
<td>2777</td>
<td>15.8%</td>
</tr>
<tr>
<td>[fuel economy assistant]</td>
<td>2472</td>
<td>14.1%</td>
</tr>
<tr>
<td>[integral braking system (ABS +CBS)]</td>
<td>2243</td>
<td>12.8%</td>
</tr>
<tr>
<td>[traction control]</td>
<td>1841</td>
<td>10.5%</td>
</tr>
<tr>
<td>[combined braking system (CBS)]</td>
<td>1831</td>
<td>10.4%</td>
</tr>
<tr>
<td>[different riding modes]</td>
<td>1555</td>
<td>8.9%</td>
</tr>
<tr>
<td>[tyre pressure monitoring system]</td>
<td>1386</td>
<td>7.9%</td>
</tr>
<tr>
<td>[anti-fog lights]</td>
<td>1382</td>
<td>7.9%</td>
</tr>
<tr>
<td>[nothing]</td>
<td>1286</td>
<td>7.3%</td>
</tr>
<tr>
<td>[adaptive headlights]</td>
<td>919</td>
<td>5.2%</td>
</tr>
<tr>
<td>[cruise control]</td>
<td>914</td>
<td>5.2%</td>
</tr>
<tr>
<td>[launch control]</td>
<td>765</td>
<td>4.4%</td>
</tr>
<tr>
<td>[don’t know]</td>
<td>189</td>
<td>1.1%</td>
</tr>
<tr>
<td>[airbag]</td>
<td>118</td>
<td>0.7%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>17556</strong></td>
<td><strong>100%</strong></td>
</tr>
</tbody>
</table>

Figure 36 Percentage of riders with optional vehicle equipment (EU sample)

- Adjustable suspension is the most common option in Belgium, the Czech Republic, Denmark, Finland, the Netherlands, Sweden and Switzerland, and features in the top 5 options of every selected country.
Greece is the only county with anti-lock braking systems (ABS) in the top 5 of equipment options.

Launch control systems, though rare in Europe (only 4.4% of riders in our European sample has a PTW equipped with launch control), are quite common in Finland, with 35.1% of Finnish riders stating having this option.

<table>
<thead>
<tr>
<th>Equipment Option</th>
<th>The Western Europe</th>
<th>The Northern Europe</th>
<th>Southern Europe</th>
<th>Central and Eastern Europe</th>
<th>Total for Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adjustable suspension</td>
<td>56.4%</td>
<td>60.9%</td>
<td>48.8%</td>
<td>55.8%</td>
<td>55.4%</td>
</tr>
<tr>
<td>Daytime running lights</td>
<td></td>
<td>53.0%</td>
<td>63.8%</td>
<td>33.8%</td>
<td>49.9%</td>
</tr>
<tr>
<td>Luggage system</td>
<td>47.4%</td>
<td>59.7%</td>
<td>42.4%</td>
<td>58.5%</td>
<td>49.3%</td>
</tr>
<tr>
<td>Hazard indicator lights</td>
<td>52.7%</td>
<td>52.2%</td>
<td>45.0%</td>
<td>38.6%</td>
<td>46.3%</td>
</tr>
<tr>
<td>Adjustable levers</td>
<td>48.7%</td>
<td></td>
<td>45.5%</td>
<td>35.4%</td>
<td>42.8%</td>
</tr>
<tr>
<td>Heated grips/heated seat</td>
<td></td>
<td>46.0%</td>
<td></td>
<td></td>
<td>31.8%</td>
</tr>
<tr>
<td>Anti-lock braking system (ABS)</td>
<td>39.7%</td>
<td></td>
<td></td>
<td></td>
<td>31.1%</td>
</tr>
</tbody>
</table>

Figure 37 Top 5 vehicle equipment options in the different area of Europe (Area of Europe)

Legend: Western Europe: Austria, Belgium, France, Germany, Luxembourg, Netherlands, Switzerland
Northern Europe: Denmark, Finland, Ireland, Iceland, Norway, Sweden, United Kingdom
Central and Eastern Europe: Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia
Southern Europe: Cyprus, Greece, Italy, Malta, Portugal, Spain

The 5th top vehicle equipment option in Northern Europe is *heated grips/heated seat*, with 46.0% of riders having this option fitted on their main PTW. For Southern Europe, the percentage drops to 24.5%. Such equipment is obviously climate-related and can have a strong influence on safety parameters in inclement weather conditions. (Figure 37)

ITS and safety attitudes
The sentence “New technologies enable road use to be safer, greener and less congested. This is the solution to an ever-growing traffic demand” was selected as the statement best defining new technologies in the Czech Republic, Denmark, Finland, Germany, Greece, Italy, Norway, Portugal, Spain, Sweden and Switzerland. This statement was chosen by at least 50% of respondents in Spain (with the highest rate: 75.7%), Portugal, Greece, Czech Republic, Sweden, Norway and Italy (50.9%). In Germany, Finland, Denmark and Switzerland, between 44.5% (Germany) and 40.5% (Switzerland) of riders agreed with this statement (Figure 39).

Riders from France, the Netherlands, Belgium and the United Kingdom were less enthusiastic about new technologies, with the top answer for these countries being “Accidents happen because drivers are more and more distracted at the wheel by technology”: 63.7% for France, 55.6% for the
Netherlands, 51.4% for Belgium and 47.3% for the United Kingdom (Figure 39)

- Comparison with the Intelligent Transport System for PTWs User Survey: riders from Belgium and the Netherlands have a less sceptical attitude towards technologies in ITS survey panel than in the motorcycling community survey. (Figure 40)

> **The European Motorcyclists Survey**

> **Intelligent Transport System for PTWs User Survey**

> Figure 40 Comparison of attitudes towards new technologies between two RIDERSCAN surveys

### 7. Integration of PTWs in ITS deployment activities

Collecting the views of and information from the various stakeholders involved in the areas of work covered by the project belonged to the key activities for gaining a better understanding of priority actions. This collection of feedback and information took several forms:

- a literature review of the main policy documents: Annex 14
- a questionnaire (Amplifying Questions) designed to survey the different categories of stakeholders directly involved in policymaking (Member States, the European Union, the Motorcycling Community representatives, EU stakeholders). Answers to the
questionnaire were collected either via phone interviews, written answers or face-to-face meetings. They are summarized in Annex 4/ annex 5/ annex 6/ annex 7:

- surveys targeting the riding population: Annex 1 and annex 3 (summarized in sections 6.4 and 6.5)
- input from the project workshop on ITS: Annex 12

Following this structured approach, the project team identified priority areas for EU action according to the different stakeholders.

### 7.1. Key Stakeholders’ Safety Priorities – Traffic management and ITS

With the objective of gaining a preliminary overview of the key safety aspects to be considered in the PTW safety debate, and of the project safety areas in particular, the project team undertook a detailed comparison of the PTW safety policies of key PTW/road safety stakeholders.

The table below summarizes the identified key safety aspects for each key stakeholder.

It should be noted that the documents were not written at the same time, meaning that some of them are more up-to-date than others. For the complete overview of the PTW safety policies and reference details, please refer to Annex 14.

<table>
<thead>
<tr>
<th>D6 – Traffic Management/ITS</th>
<th>ETSC</th>
<th>Lillehm.</th>
<th>FEMA</th>
<th>EC</th>
<th>ACEM</th>
<th>ITF</th>
</tr>
</thead>
<tbody>
<tr>
<td>- PTWs to be integrated in transport plans/traffic management</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>- Enhanced PTW awareness in ITS projects for all vehicles</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>- Assess impact of ITS for all vehicles with regard to PTW dynamics</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Yes</td>
</tr>
</tbody>
</table>

Very few stakeholders, apart from the riders themselves, identified the need to take specific PTW aspects into account in traffic management activities. However, traffic management is an integral part of national transport strategies and directly influences traffic flows, hence impacting the safety parameters of PTW riding models.

### 7.2. Inclusion of PTWs in traffic management activities

The Amplifying Questions for Member States representatives (Annex 6) did not show otherwise, with very few examples of proper or specific integration of PTWs into intelligent transport management system.
• **Overall integration into ITS traffic management:**

<table>
<thead>
<tr>
<th>PTWs are integrated into ITS for traffic management</th>
<th>Finland</th>
<th>France</th>
<th>Latvia</th>
<th>Sweden</th>
<th>Denmark</th>
<th>Italy</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTWs are not integrated into ITS for traffic management</td>
<td>Austria</td>
<td>Czech Republic</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No ITS for traffic management</td>
<td>Belgium</td>
<td>Bulgaria</td>
<td>Germany</td>
<td>Ireland</td>
<td>Netherlands</td>
<td>Norway</td>
</tr>
</tbody>
</table>

• **Inclusion of PTWs in road tolls**

| PTW are included | Austria | Greece | Ireland | Norway | Spain | Sweden |
| PTW are not included / handled separately | Bulgaria | France | Germany | Italy |
| No toll | Belgium | Czech Republic | Finland | Latvia | Netherlands | Luxembourg |

• **Allowing PTWs in bus lanes**
- PTWs are allowed to use bus lanes
  Greece
  Ireland
  Norway
  Spain (in some cities)
  UK (local decision)

- PTWs are not allowed to use bus lanes
  Austria (allowed in rare cases)
  Belgium (it is a local decision but in practice it is not allowed)
  Bulgaria
  Czech Republic
  Finland
  France

### 7.3. Stakeholder workshop comments (Annex 12)

The project also discussed the key project findings with a range of EU stakeholders in a dedicated workshop on ITS and PTWs (Annex 12). The main outcomes / participant interventions are summarized below:

- According to ACEM, ITS systems cover all types of vehicles including motorcycles. There are many developments regarding ITS features that are unknown to the PTW sector, and which we have to clarify through additional research, for which Horizon 2020 provides the right framework. Cooperative ITS is the most promising technology as it will enable riders to communicate with other road users. But there is really no substitute for training. Technology is important, but specific training will have to be developed. Regarding ITS deployment, it should not be detrimental to motorcyclists, which means that devices should be assessed in a holistic way, not just looking at the vehicle but other road users too.

- **Priority setting**: The representative from SMC (Swedish riders’ association) underlined the fact that there are a lot of basic issues out there on the streets which are still not being addressed. It’s not rocket science to solve problems like pot-holes, diesel spill and gravel on the road, which are killing a number of riders each year and creating a lot of traffic accidents. So we have to ask whether we should solve the existing issues first and then continue, or is it a parallel process?
The representative from FFMC (French riders’ association) declared that he was hesitant towards these new technologies, especially when they seemed to be imposed on riders through legislation. While riders recognise the incredible possibilities of improving road safety, they are probably not ready to accept anything for the sake of novelty or safety. If we valued our safety more than our freedom, we probably wouldn’t be riding motorcycles. Nevertheless we still think safety is a concern. The average age of a motorcyclist is 47 so we can forget the image of a young, reckless rider. We are very concerned about road safety but ITS raises a number of questions. For example, we sometimes doubt the contribution of ABS to safety, as in some cases it could increase risk. Another issue is the vulnerability of motorcyclists with very little passive safety, and the road infrastructure has a major impact on motorcycle safety.

Data: Daniel Bell, Researcher at FACTUM, declared that the main two issues for ITS and motorcycles were the availability of data and its consistency. It will also be very interesting to compare research results from different countries. In VRUITS, they had difficulty to test recommendations in field trials because of limitations regarding the extent of the data and its detail, making it impossible to determine accident characteristics at an in-depth level. There is also a limited capability for discrimination between moped and motorcycle accidents, which makes it difficult to generalise about ITS countermeasures. So there is a need for microscopic and in-depth data to pick out the systems that can address accident-causing factors. There is still a lot of work to be done though, especially from a social science point of view.

Driver distraction: Some delegates also insisted on the issue of driver/rider distraction. We have to be aware that some vehicles will be equipped with ITS; some not. And it’s difficult and unsafe not to know which one is equipped and which is not – for example when following a vehicle that is braking on a curve. Also, if the trend is towards greater automation, we must realise that if a driver is not driving, then he will be doing other – unsafe – things.

Impact Assessment: For German insurers (GDV), further research is needed on the expected benefits of ITS, and it is essential to develop a PTW-specific impact assessment methodology. Similarly it is vital to always put the rider in the focus when designing safety applications, because riding is not the same as driving.

For FIA and FEMA, key challenges to user acceptance of ITS include liability issues, driver distraction, awareness and training, safety, vulnerable road users, and pan-European solutions.

For Shane McLaughlin, researcher at the Motorcycle Research Group at VTTI, there are issues unique to motorcyclists and these differences should be included in ITS implementation on motorcycles.

Visual conspicuity: ACEM emphasized that cooperative ITS is definitely not a short-or mid-term replacement for any conventional technology deployed today. In this
respect, in the visual conspicuity area improvements are possible, allowing riders to be seen.

- **“Look but fail to see” problem**: With regard to PTW Digital Conspicuity, one delegate raised the issue of ‘Look but fail to see’, stressing that it’s not about conspicuity, but about people seeing yet not reacting because they are distracted, for example by talking on a mobile phone.

- **Penetration rate**: A representative from the Dutch Ministry of Transport raised an important issue on cooperative systems: if you don’t get a signal, this can mean one of two things. Either there is no motorcyclist, or there is but he doesn’t have this device fitted. How can you make sure that the penetration rate reaches a level so that if you don’t hear a signal that means there is no danger ahead? ACEM responded that this is a challenge for cooperative ITS in general and that they are working on addressing it. One possibility is to combine communication technologies, adding cellular communication for instance, to speed up the penetration rate.

- **Riders & drivers training**: A lot of participants supported the idea that ITS goes hand-in-hand with proper training. In the view of FIA, ABS and CBS can support drivers in braking, help maintain motorcycle stability and reduce braking distance. Riders need to practice and learn the use of new braking technology to make the most of the capabilities of their braking systems. And it’s also important to consider and know what technology can NOT do. This is just as important as knowing what it CAN do. For ACEM, interpretation of signals is important. If you get a warning of an approaching motorcycle, what does the driver do? Accelerate, brake, turn in the opposite direction? This is something we have to take into consideration as a training issue – how to react if a driver gets certain information.

- **Effect of automation**: For Natasha Merat from the Institute of Transport Studies of the University of Leeds, the challenge is to ensure that drivers are engaged in the task, adequately trained, use the system correctly, and that designers are aware of the limitations. There are also possible long-term effects of automation on other traffic, and potential reaction/interaction with VRUs. Possible implications of automation include a loss of skill, loss of situation awareness, changes in workload (e.g. under-load followed by excessive overload in critical situations), behavioural adaptation, and misuse/abuse.

- **Data protection**: ITS also creates the issue of data protection. For the FIA, road users should in principle own all data generated by their vehicles. There is a need to get clear information about the data gathered and its potential use; and to be free to share it with service providers of one’s choice.
8. PTW specificities with regard to ITS developments

Assistive and cooperative systems are expected to have a significant impact on the safety of Vulnerable Road Users, by influencing all road users’ behaviour such as perception and decision-making, but also driving and riding tasks, without this impact being yet properly studied. In the particular case of motorcycling, state-of-the-art ITS has not been subjected to any impact assessment with regard to the positive or negative consequences for PTWs. Motorcycle accident causation factors are not fully known or understood and very little research has been done into identifying riding models/styles, patterns and specific tasks.

There are a number of ways to classify assistive systems. Active systems (pre-crash) act prior to crash occurrence and some of these can reduce the probability of a crash. Passive (pre/post-crash) systems serve to reduce the effects of the crash once it has occurred or is occurring. Alternatively, systems can be differentiated according to the level of intervention in rider behaviour. Informative systems simply provide information; warning systems transmit alerts; and intervening systems take over part of the riding task in certain situations.

Figure 8 Defining key technologies

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40 Stakeholders meeting on the deployment of ITS and vehicle technologies to improve road safety – Discussion Document – Brussels 8/3/2013
Active safety systems include crash avoidance systems, stability and braking-enhancing systems, visibility-enhancing systems, and rider-monitoring systems.

Few passive safety systems exist for PTWs. The only PTW-specific innovation is the inflatable airbag jacket that is triggered when the rider falls off the vehicle, cushioning the impact. Other technologies have been adapted from cars. Vehicle-mounted airbags have been shown to reduce the likelihood of being thrown off a PTW in multiple-vehicle collisions (e.g., Kuroe et al., 2005; Yamazaki et al., 2001), but may increase head and neck injuries (Ulleberg, 2003) and are difficult to adapt for PTWs due to technical design limitations. Automatic crash notification (ACN) and eCall systems detect the occurrence of a crash through changes in vehicle speed, tilt, and deceleration sensors, and automatically notify emergency services. ACN for PTWs are in a preliminary stage of development, but studies predict that ACN may reduce serious injury and fatal crashes by 5-15% (Abele et al., 2005; eSafety Forum, 2005).

8.1. Riding is not driving (Annex 15)

Based on a group discussion launched on LinkedIn, which gathered 180 posts from all over the world, and a one-day workshop on PTWs and ITS organised by the iMobility VRU WG, the project team was able to extract the key elements that make riding a motorcycle different from driving a car, and identify specific fields for ITS development.

In this context, it is important to make a difference between augmentation (which aims at making the driving/riding task easier – e.g. power steering, automatic gearbox) and automation (which automates the driving/riding task thanks to predictability computer programmes, taking the human out of the loop), with different impacts on mixed fleets and different requirements for single- or dual-track vehicles.

According to the answers of experienced riders, the greatest differences between riding a bike and driving a car can be found in the following areas:

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41 2BESAFE – D9 Report On Assistive Technologies For Rider Safety

8.2. Motorcyclists: Powered Vulnerable Road Users

At this stage, it is important to note that the PTW domain is very different from pedestrian and bicycle safety domains. From an ITS development perspective, it appears that these three communities of road users have very little in common with regard to hardware or software platforms supporting mobility needs, as PTWs are the only ones with on-board electricity. Besides, requirements related to usability, licencing, manoeuvrability, the environment and travelling (among many others) differ tremendously depending on which category of VRUs one is focusing on.

Due to the specific nature of uses, PTW users require a wider geographical service area and a level of service than everyday pedestrians and cyclists. While bicycles and pedestrians will most likely need to rely mainly on smartphone platforms, this is no solution for PTWs.

The bill-of-materials (BOM) – a highly scrutinized aspect at all development phases of any technical solution– does not impact bicycle and pedestrian solutions in the same way. Besides, on this specific aspect, PTW riders are perhaps the users most highly impacted by any added costs due to the relative cheap vehicle price (compared with cars).
The requirements for road structures also differ between these 3 groups. PTW riders are likely to suffer/benefit more from different factors and structures than pedestrians and cyclists.

Hence, it is highly likely that applicable solutions answering PTW safety needs will not only differ in design but may also not be applicable to pedestrians and cyclists - and vice-versa. The three categories have very limited fields of possible synergies regarding the design, specification and implementation of efficient safety measures.

8.3. Impact assessment methodologies

The current state-of-the art in ITS has not been subjected to any dedicated impact assessment with regard to positive or negative consequences for other road users, and accident causation risks are not fully known or understood, in particular with regard to PTWs and their specific characteristics, including limitations, capabilities, profiles and vulnerabilities. This all means that PTW-specific assessment methodology needs to be designed, based on a careful identification of existing differences to car use.

Driver behaviour (normative and non-normative... expected and real practices) has been studied for decades in support of the design and/or evaluation of ITS technologies in the car industry (including trucks and buses). By means of instrumented vehicles and in-depth studies, research has been able to understand car driver ergonomics and the motivation behind certain driving behaviour; impact assessment methodologies have been designed; and consequently, ITS applications have progressively equipped cars to answer their safety and comfort needs.

Compared with passenger vehicles, the limited development of ITS for PTWs has not yet enabled the necessary research into and the design of assistive technologies foreseen as yielding substantial safety benefits. The small size of the market and the high prices of the systems are not conducive to industry investment, especially in a difficult economic context. Moreover, riding activity is particularly complex, differs greatly from driving activity, and up to now has been poorly studied (compared to driving activity). As a result, most of discussed
technologies are coming from the car industry and are designed with a poor understanding of riding constraints, leading to poor rider acceptance.

As a consequence, projects targeting VRUs, such as VRUITS, have no choice but to use the only existing assessment methodology developed by eIMPACT\textsuperscript{42} to assess ITS systems. The methodology focuses on the 9 safety mechanisms described below and is based on car use, again highly different from PTW ergonomics and dynamics:

- direct in-car modification of the driving task;
- direct influence by roadside systems
- indirect modification of user behaviour
- indirect modification of non-user behaviour
- modification of interaction btw users and non-users
- modification of road user exposure;
- modification of modal choice;
- modification of route choice;
- modification of accident consequences

8.4. Automation of the transport system

Automated vehicles could, according to optimistic sources, come as early as 2018. More realistic sources talk about 2020. In all cases, automation is coming, and the only question remaining is when?

\textsuperscript{42} http://www.eimpact.eu/
9. PTW/ITS deployment challenges

The Motorcycling/ITS paradigm: *the skilled rider can manage the situation that the smart rider would never have to encounter.*

PTW Intelligent Vehicle Systems have the potential to improve riders’ safety. Indeed, compared to other VRU categories such as pedestrians and cyclists, PTWs are the only category with a permanent on-board electricity supply for powering additional safety functions, applications, features, services and devices. Hence, PTW users can benefit from far more advanced Intelligent Transport Systems (ITS) solutions, applications and services than other VRUs.

However, there are a number of obstacles that will likely lead to a lower coverage and slower uptake compared to passenger cars. Most new PTW safety functions will require major research and developments due to interference issues. The PTW Human Machine Interface (HMI) will require specific design, specification and development in order not to cause/produce any disruptive, endangering, imminent, and multiple media messages, warnings, alarms and/or requests for immediate interaction or reactions while the PTW user is riding and scanning traffic.

Available solutions as well as ongoing R&D have focused on cars and trucks, with only limited applicability to motorcycles, light PTWs, bicycles and pedestrians – in that order. This has to do primarily with technical and practical limitations, notably with regard to the user interface, available space to install equipment without hindrance to the user, exposure to outside environmental conditions and the lack of a high-quality power source. There are also economic factors: if the bill is to be paid by the road user, the cost of the ITS equipment has to be small compared to the cost of the transport means itself. Manufacturers of motorcycles, light PTW’s and bicycles do not have R&D budgets anywhere near those of car manufacturers. As a result, few ITS solutions have been developed that target traffic participants other than the car or truck drivers as the primary user.43

A better understanding of the riding activity (tasks, modelling, patterns) and the actual needs and constraints of PTW users is a prerequisite for

- the design of PTW ITS and/or efficient adaptation of car ITS to PTWs;
- the evaluation of their safety impact based on real road practices;
- rider acceptance, and in turn market and industry investment.

Indeed, the most important issue with ARAS in a PTW environment is the HMI; which is lots more than just how and where the SatNav device is attached to the PTW.

43 ITS ACTION PLAN / framework contract TREN/G4/FV-2008/475/01
http://ec.europa.eu/transport/themes/its/studies/its_en.htm
The technological challenges are numerous. All these issues are directly related to the very different **riding dynamics and handling** of a PTW compared to a 4-wheeled vehicle. Indeed, the 7 contact points between the rider and the bike - footrests, saddle, tank sides and handlebars – are not all suitable for warning strategies. The clocks (rev & speed) with the traditional (non-time-critical) warning light panels are not suitable either since they are out of sight.

The **timing of warnings** (audio, visual, haptic, tactile) is critical not only due to the desired impact of the warnings but also riding dynamics: (semi-)automatically slowing down a bike in the middle of a curve may cause a non-desired manoeuvre that the rider is unable to control; in a hazardous situation in a curve the safest action instead of decelerating might be to accelerate the bike!

All in all, riders are accustomed to listen to the satnav guidance in the earphones and monitor the oil pressure warning light on the panel. When it comes to a warning via haptic/tactile means this is all new and riders need to be considered as novices. How, when, by which means and by which of those seven contact points the warning should be delivered based on the riding situation is totally vague, whether for the administration or for the industry.

As regards the PTW industry, many OEMs are well prepared for the ARAS challenge (e.g. BMW, Honda, Yamaha; Piaggio only in R&D) but several OEMs have a model range that does not support the introduction of ARAS systems and functionalities; ABS is just not enough. However, in view of the difficult economic context, with a decline in the PTW market in the range of 47% since 200844, but also poor research investment on this transport mode, ITS systems development has not taken off as much as in the car segment. **User awareness and acceptance** are poor and the willingness to engage in a path seen to be led by car industry researchers and designers does not support rider commitment, contrary to what is witnessed among automobile clubs (e.g. FIA).

Developing ITS for PTWs will require the coordination and support of different stakeholders: authorities, researchers, manufacturers and users. Generally speaking, riders are very safety-minded and want safer infrastructures, safer vehicles and fewer accidents. In view of that, they will adopt new technologies when they are seen to improve the situation for riders and other road users. To this end, rider acceptance will be a key element to consider.

While riders recognise the incredible possibilities of improving road safety, they are probably not ready to accept anything for the sake of novelty. Road safety is a real concern for motorcyclists but ITS raises a number of questions. Key challenges for user acceptance of ITS include liability issues, driver distraction, awareness and training, safety, vulnerable road users, and pan-European solutions. Nevertheless, motorcyclists are interested in new technologies – especially the younger generation. But they also like the freedom to choose the new motorcycles with features like super advanced ABS systems. Choice remains the key.

9.1. Research needs with regards to ADAS/IVIS

The current state-of-the-art in ITS has not been subjected to any dedicated impact assessment with regard to its positive or negative consequences for other road users, and accident causation risks are not fully known or understood, in particular with regard to PTW use. Their specific characteristics, including limitations, capabilities, profiles and vulnerabilities, require the development of a specific assessment methodology based on a careful identification of the existing differences to car use.

Assistive and cooperative systems are expected to have a significant impact on the safety of motorcyclists, influencing car drivers’ perception and decision-making. With the deployment of ITS solutions, the impact of other vehicles, human behaviour, and training must therefore be studied and integrated into a specific impact assessment of intelligent transport systems with regard to PTWs.

9.2. Research needs with regards to ARAS/OBIS

Based on the functional logic of Advanced Driver Assistance Systems from CLEPA, it can easily be understood how far PTW research is from the car sector.

When looking at accident factors, the data available indicates that the most common type of accident involving motorcyclists is a collision with a passenger car, and in the majority of such cases, the car driver is at fault. With the deployment of ITS solutions, the impact of other vehicles, human behaviour, and training must therefore be studied and integrated into a specific impact assessment of intelligent transport systems.

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46 MAIDS study, ACEM, 2005
The ITS systems identified by the Monash study have been discussed in terms of critical motorcycling safety issues, namely loss-of-control crashes, multiple vehicle crashes, and additional factors such as conspicuity, alcohol and unlicensed riding. While some of these systems address specific safety issues, such as interlocks and alcohol-related crashes, other systems will show comprehensive benefits across a number of crash types. For example, advanced braking systems are relevant to any event where emergency braking is used. Importantly, this is one area of ITS development that has shown a significant amount of development. However to date there are no available studies on the effectiveness of the systems identified, with the exception of DRLs. In addition to technical development, future research should address issues such as acceptability, usability, negative behavioural adaptation, and further in-depth analysis of crash causal factors such as distraction.

Moreover, as highlighted by the report on "Safety and comfort of the Vulnerable Road User" commissioned by DG MOVE, assistive and cooperative systems are expected to have a significant impact on the safety of motorcyclists, influencing both PTW and car drivers’ perception and decision-making. Hence the safety potential and impact of new cooperative and informative applications for accident avoidance and mitigation needs to be further developed.

For more details on research needs and other actions to be undertaken, please refer to the thematic report on Needs for Policy Actions on Research, Legislation, Standardization, and Specific Actions.

10. Deliverable conclusions

ITS and cooperative rider support systems have a good potential to increase riding safety and traffic safety at large, as indicated by a number of interesting European projects. The standalone systems have led and will lead the way – ABS, combined ABS, airbags, radars, scanners etc., and they may be excellent systems in the event of a crash and just before.

Today, stability and braking power are seen by many political stakeholders as top priority. 112 eCall and intersection safety is in turn identified by some industry stakeholders as the way forward. However, again, these are assumptions not based on actual data and they will need to be properly researched and assessed in order to guarantee user acceptability, market deployment, and hence PTW industry investments.

This is confirmed by the OECD report on Motorcycle Safety which states: While Intelligent Transport Systems (ITS) offer opportunities to improve the safety of drivers as well as riders, they require more R&D on their capacity to prevent PTW crashes, as ITS applications for

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49 IMPROVED SAFETY FOR MOTORCYCLES, SCOOTERS AND MOPEDS © OECD 2015 (to be published)
cars are not directly transferable to PTWs. Any ITS application which removes, or interferes with, the longitudinal or lateral control of the vehicle could have adverse effects.

Similarly a proper integration of PTWs into intelligent traffic management activities would help reduce PTW risks within traffic flow and post-crash support in the case of an accident involving a PTW.

*Horizon 2020* could provide the right framework to enhance PTW-specific research, thus enabling the development of IVS for PTWs on the one hand, but also increased inclusion of PTW specificities in ADAS and IVIS functions/systems.

Recognition and adequate integration of PTW characteristics into ITS deployment activities, both as *vulnerable* and *powered* users of the transport system, will significantly contribute to an increased awareness of the specificities of this transport mode by all stakeholders.