RIDERSCAN
European Scanning Tour for Motorcycle Safety

Powered Two Wheelers Safety Needs

Policy Actions

Please refer to this report as follows:

Delhaye, A., Marot, L. (2015), ***Needs for Policy Actions***, Report of the EC/MOVE/C4 project RIDERSCAN.

GRANT AGREEMENT NUMBER MOVE/C4/SUB/2010-125/SI2.603201/RIDERSCAN

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Project Start date: 01/11/2011 **Duration 42 months**

Organisation name of lead contractor for this deliverable:

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Due date of deliverable:	**30/04/2015**	**Submission date:**	**30/04/2015**

Project co-funded by the European Commission

Dissemination Level: public

While the project deliverables address the 8 safety areas in detail, the goal of this report is to gather all recommendations collected in the course of the project, and structure them according to Europe's main levers for action, namely *Research*, *Legislation*, *Standardization* or *Specific Actions*.

The following section is structure two ways:

I. recommendations per safety topics

II. recommendations per policy action types

1. Recommendations per PTW Safety Topics

1.1. Knowledge on PTW safety

As highlighted by DACOTA, **aggregate road safety data** concern **road accident data**, **risk exposure data** and **road safety performance indicators**, but also **causation indicators** (such as those resulting from in-depth data) and **health indicators** (such as those resulting from epidemiological data). These indicators, combined with additional information on other important road safety aspects such as those related to behavioural, social and political aspects, enable work on an integrated approach.

Supporting road safety decision-making requires having quantitative information on **road users' attitudes and behaviour**, on **road safety measures** implemented, **rules and programmes** (including enforcement), and on their **social costs and benefits**.

As regards PTW use and safety aspects, none of these data and other statistical elements have yet been properly designed and accepted at international level to enable proper benchmarking between countries.

Based on the inputs collected during the project on *research* (D5), *data collection & statistics* (D2), and *accident reporting* (D4), the project recommendations include the following:

RESEARCH	***STANDARDIZATION***	***LEGISLATION***	***SPECIFIC ACTIONS***
Exposure studies: o develop a **methodology** to collect and analyse mobility data harmonised at EU level	Need to develop and apply relevant methods, tools and indicators to measure PTWs in traffic flows and analyse their mobility and behaviour	Prepare a legislative proposal which sets up the right framework for data collection in Member States, defining a common data collection strategy which includes improving	Promote the use of the CADaS protocol at national level to have comparable data across Europe propose and include in CADaS o common age categories;

○ mobility data (annual mileage for PTWs) to separate impact of exposure, intrinsic risk and compensatory behaviour of riders. • Development of PTW accident **prediction models** by means of accident simulations and vehicle dynamics to see which state of the road has which effect on the brake system, on the tyres, on the rider behaviour, what are the reactions of different vehicles on the same section of road, at the same speed? Etc. • Mobility research: understanding PTW use, riding models, etc. • Naturalistic/Simulation studies to identify: ○ skills, attitudes & behaviours; how to influence different types of riders to take safer decisions when riding; ○ riding models, risk patterns and the role of risk awareness ○ *safety critical events* ○ which and how information is processed by the rider	(exposure data). • Standardize the definition of "seriously injured". • Harmonize accident (macro/micro) reporting methodologies	accident reporting ○ harmonise **formats** and **headings**; ○ harmonised **classification of vehicles involved in an accident** ○ include **GPS coordinates** for accident location ○ include the following information for each vehicle involved in the accident: • Point of impact (front left, front right, etc.) • Angle of impact (0°, 45°, 90°, 135°…360°) • Impact severity (light, medium, hard) ○ include pictures of the scene and damage to each vehicle involved. and propose ○ a harmonised way to measure the vehicle fleet ○ common categories for the **type/frequency /motivation of use** for vehicles	○ common classification of the types of PTWs • complement the CADaS protocol with specific data of relevance to accidents with PTWs, such as environmental aspects or vehicle details • Cross information on injuries between Member States • Enhance exposure and mobility data collection work between Member States • Cross/compare existing knowledge between different EU countries • Set up a strategic approach to PTW research needs • Use iGLAD as the basis to set up a common European in-depth accident causation database.

○ mental failures - Road conflict investigations - Accident data collection (pre-during-post collision) and accident dynamic reconstruction - More in-depth investigations will allow a better understanding of fatal and serious injury crash patterns and causes - Assessment of injuries linked with crash types (link between crash data and hospital data); - Improvement of crash simulation and crash dummies (taking into account their particular postures to understand their specific injuries) to better understand ○ the consequences of an accident ○ how injuries work and how to prevent them; ○ - Research into the relationship between weather and accidents should be continued by including more data allowing additional factors to be considered. - PTW conspicuity and other			

perception problems - Speed: comparative study on speed differences on comparable road types within Europe. - Effectiveness of safety activities / cost-benefit analyses - Design a PTW-specific impact assessment methodology - Compile and expand key existing studies for PTW use. - Development and implementation of safety equipment adapted to countries with hot weather			

1.2. Access to PTWs

The pre-licence training curriculum should aim at teaching the necessary knowledge, skills and mental attitude to ride defensively, in full awareness of risk exposure and accident causation factors, and not simply at passing the licencing test.

The licence test should instead be a quality assurance of the candidate's competence - meaning the minimum skills, knowledge and attitude needed to safely operate a motorcycle on public roads. To this end, Category A training instructors and examiners should be experienced riders accredited by national certification programmes.

Today's EU regulatory framework only briefly describes the content of testing. Finding an adequate system enabling access to PTWs, while ensuring that novice riders & drivers have the skills, knowledge and attitudes needed to safely operate the vehicle chosen on public roads, is one of the critical issues needing to be addressed by Europe today.

Based on the inputs collected during the project on *training, testing and licencing* (D1) throughout Europe, the project recommendations include the following:

RESEARCH	*STANDARDIZATION*	*LEGISLATION*	*SPECIFC ACTIONS*
Effects of the various age limits on progressive access; ○ EU harmonisation: evaluation of the effects of the various age limits to ride a class I moped between EU countries; ○ In what way is learning to ride a moped different from learning to ride a motorcycle; or learning to ride a low performance motorcycle different from learning to ride a high performance one? ○ Risk awareness: motorcycling experience effect (including training, type of riding licence, number of year of practice and frequency of motorbike use) on motorcyclists' risk awareness. **Training:** ○ the content and effectiveness of training (including post-licence training) with the aim of improving the behaviour and safety of both drivers and riders; ○ further research should identify specific training needs	**standardizing minimum training curriculum requirements** and linking driving licence tests to this standard would significantly improve the quality of rider training programmes (need for a "quality seal"); Standardise EU rider/instructor training curricula	**addressing training content / instructors' competence in a legislative framework** becomes an essential complement to the 3rd Driving Licence Directive (for PTWs), addressing: ○ Initial rider training ○ Instructors' training ○ Advanced riding courses ○ Use of driving simulators ○ Special training and education for returning bikers Harmonize and lower the minimum age Harmonize licencing requirements to a greater extent	the type of bike chosen by riders provides a clear indication of their motives, the experience they seek and their concept of riding (when they can choose the bike). One implication is that **persuasive communications**, tailored to the motivational requirements of the average rider of each motorcycle type, could be provided when buying a motorcycle in an attempt to encourage safe riding behaviour. To train PTW users properly in the use of ABS and promote the widespread use thereof: the necessity of knowing how the Anti-lock Braking system (ABS) works: Training in ABS operation: Initial Rider Training, websites, Post-licence training programmes. The need for assistance during emergency braking: training and website informing riders on how to react in the case of emergency braking. Benchmark and exchange best practices on training methods, content, and instructors' competence;

according to experience and vehicle ○ young riders: search for effective ways to improve training for young riders/drivers ○ rider training: which skills and how should they be trained during training (e.g. manoeuvring skills, braking skills, noticing risk situations) at driving schools; and how do the skills learned work in real traffic situations? How can these be learned effectively and efficiently, in how much time and in which sequence? **New technologies:** ○ The development of new simulation techniques offers new opportunities for training programs.			

1.3. Infrastructure

PTWs have some special features which, according to the research community, directly or indirectly impact road transport research outcomes, whether for the safety of PTW users or for road safety in general. Dedicated consideration is required to gain a better understanding of PTW dynamics and interaction with traffic, and more specifically of accident causation factors, allowing risk domains and risk contributing factors to be identified.

With specific regard to the road infrastructure, the fact that PTWs are single-track vehicles, without any bodywork, means that the rider can have certain difficulty handling tasks while controlling the vehicle, in particular when cornering or braking and even more so in emergency situations, to mitigate or avoid incidents. Even with excellent brakes and tyres, controlling the vehicle in all kinds of situations requires special training and experience or specific riding assistance systems on board the PTW. The single-track character also implies that riders have greater difficulty coping with imperfect road surfaces and obstacles on the road.

Based on the inputs collected during the project on *infrastructure* (D3) throughout Europe, the project recommendations include the following:

RESEARCH	***STANDARDIZATION***	***LEGISLATION***	***SPECIFIC ACTIONS***
Better understanding of PTW/infrastructure interactions ○ Improve data collection ○ Gain an in-depth understanding of the vehicle-road interaction and its dynamics, including detailed analysis with simulation tools (vehicle-infrastructure interaction simulation) ○ Research accident scenarios and biomechanics ○ Incorporate data gathered in naturalistic riding studies ○ Study the interaction between motorcycle tyres and road surface condition ○ Safer road design: ○ Understand the effects of the	Review standards for 'PTW-friendly' road infrastructure and design	Improve the periodic maintenance of roads => The EU directive on infrastructure should include provisions on road inspections for secondary roads. Infrastructure directive: The Directive for Infrastructure and Safety Management is currently being revised, including how to cater for the needs of PTWs. A good step forward would be for any EU money given to the motorways to include specific provisions for motorcycles. This would give a good example for secondary roads. Black spot monitoring would benefit from harmonisation throughout the EU (by means of legislation or other means).	Need to find a way to motivate road engineers to use the infrastructure guidelines or make them mandatory. *Motorcyclist Protection System Database*: further political support and dissemination activities would be required to further engage MPS manufacturers to feed the database and for road authorities to make use of it. http://www.mc-roadsidebarriers.eu/search-for-mps/ A civil engineering handbook would be a practical instrument for improving road safety for PTWs by just emphasizing the engineering items to be considered during the design and maintenance of infrastructure Monitoring high-risk sites (black spots): ○ involvement of the riders' community

road environment on road users ○ Provide a more forgiving road environment ○ Make roads self-explaining for PTWs ○ Improve the environment to enhance reciprocal perception of riders and drivers ○ "Friction measuring" research ○ Re-evaluate infrastructural measures to reduce speeds (such as humps or lane narrowing) from the point of view of PTW rider safety ○ Design roadside obstacles to provide better protection for PTW riders who may collide with them **Road maintenance**: ○ Development more durable roads that will be easier to maintain in a good state ○ Develop a "holistic solution for asset management"; with the aim of making work zones safer **Black spot management**: ○ Research local accidents and			○ use of smart applications Use of the ***pan-European Road Hazard report form for PTWs http://www.fema-online.eu/riderscan/IMG/pdf/ptw_black_spots_report_form.pdf*** Promote the use of minimum safety requirements (barriers, markings, passive support structures EN 12767) though this could be done in cooperation with CEDR. Exchange best practices on the self-explaining roads concept Disseminate the guidelines on roadside barriers for motorcyclists http://www.fema-online.eu/guidelines/Guidelines.pdf Promote the infrastructure/PTWs website http://www.mc-infrastructure.eu/

suitable counter-measures. **Testing methodologies**: ○ Define a testing methodology for roadside and other infrastructure equipment which remains practicable for road equipment manufacturers			

1.4. Intelligent Transportation System

As a number of interesting European projects have indicated, ITS and cooperative rider support systems have good potential to increase riding safety and traffic safety at large. However, again, these are assumptions not based on actual data and will need to be properly researched and assessed in order to guarantee user acceptability, market deployment, hence PTW industry investments.

Similarly, the proper inclusion of PTWs in *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. 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 by all stakeholders of the specificities of this transport mode.

Based on the inputs collected during the project on *traffic management and ITS* (D6), the project recommendations include the following:

RESEARCH	***STANDARDIZATION***	***LEGISLATION***	***SPECIFIC ACTIONS***
Further research is needed regarding the expected costs/benefits of ITS on riding activity: ○ Understanding issues of automation for PTW use; ○ Interaction of PTWs with automated and non-automated vehicles	PTW tools for road safety management Integration of PTWs in automated traffic control systems Define a test protocol through which the behaviour of motorcycles (from a safety point of view) can be rated. The process would be similar to that for cars and the gaining of "stars"	Traffic management for PTW road safety. The EU should encourage and support the introduction of ITS taking specific account of PTWs (e.g. on-board collision avoidance technology in cars, vans and lorries which detect riders – V2V/V2I	It is important to spread knowledge of these new systems to stimulate demand for them. PTW users need to be trained properly in the use of ABS. Widespread adoption of ABS needs to be promoted: the necessity of knowing how the Anti-lock Braking system (ABS) works: Training in

○ User acceptance ○ ITS efficiency (estimate of the relative damage reductions associated with deploying ITS in motorcycles; the effectiveness of ITS technologies can be established through the collection and evaluation of crash data, field testing and analytical modelling of risks ○ Assess the benefits of both assistive systems and rider training, especially in direct comparison to each other ○ Prioritization of ITS for PTW safety - Fundamental: ○ Data acquisition design, implementation, and data analysis tools ○ Effects on rider performance and behaviour of human-machine interaction with new technologies covering such issues as distraction, cognitive workload, over-reliance on technology,	through crash tests defined in such test protocols as "EuroNCAP"	systems). - Effective integration of vulnerable road users into traffic management systems: these include black spot management, incident management, ITS integration, road infrastructure design	ABS operation: Initial Rider Training, websites, Post-licence training programmes. - The need of assistance during emergency braking: training and website to inform riders on how to react in case of emergency braking. - Define a test protocol through which the behaviour of the motorcycles (from a safety point of view) can be rated. The process would be similar to that for cars and the gaining of "stars" through crash tests defined in test protocols such as "EuroNCAP". (ROSA)

training requirements, situational awareness, and so on ○ Extensive on-road research examining the effects of using assistive systems on PTWs. ○ Incident, near-miss and pre-crash data ○ Modelling (riding tasks, motivation for action, accident causation factors, identification of safety critical events) ○ Specific PTW features, applications and services and their interaction with other road users ○ Perception research[1] (reliable object recognition and tracking, situation awareness, accurate road representation, detection of free space, perception architecture, etc.) ○ Development of methodologies, including PTW-specific impact assessments based on			

[1] iMobility Forum Workshop on Automation; Angelos Admitis – ECCS - .ppt

eIMPACT, 9 safety mechanisms[2] ▪ direct in-car modification of the driving task; ▪ direct influence by roadside systems ▪ indirect modification of user behavior ▪ indirect modification of non-user behavior ▪ 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 Research on vehicle technology for two-wheeler safety, including interaction of other vehicles'			

[2] http://www.eimpact.eu/

technology with PTWs ○ Large scale Field Operational Tests (FOTs) related to naturalistic driving conditions to capture VRU-related behavior and ITS requirements ○ advanced intelligent sensing ○ V2X communication platform for cooperative ITS applications ○ Research on the 112 Pan-European eCall for PTWs (drafting the minimum technical and functional specifications with identified interfaces for additional features, triggering design, tests, verification, validation, short-listed solutions, demonstrations) ○ Research on active and passive systems (incl. conspicuity technology) ○ Interaction of other vehicles' technology with PTWs			

○ Study the interaction of an automated vehicle with its environment and other (non-automated) road users; develop technology and equipment on board other vehicles (cars and trucks) that can contribute to improving motorcycle safety (blind spot) ○ post-deployment field operational tests in a real traffic environment with a full set of analyses, rider acceptance, willingness to pay In-depth identification of accident causation factors and Safety Critical Events, and prioritization of motorcycle safety problems that are amenable to ITS intervention ○ *Naturalistic riding studies* (INRS and NRS): baseline data collection with instrumented PTWs to define current practices, capabilities and issues ▪ Identify PTW-specific driving tasks, patterns and styles ▪ Understand riders'			

motivation for action ○ *Field Operational Tests and Perception research to* ▪ Validate interpretation of rider intentions ▪ Define triggering patterns Rider (and instructor) training and testing needs (e.g. coming *e-mirrors*) ○ Effects on rider performance and behaviour of human-machine interaction with new technologies that deals with issues such as distraction, cognitive workload, over-reliance on technology, training requirements, situational awareness, and so on ○ Instructor training scheme to master ITS			

1.5. Communication on PTW safety

PTW accident investigation work has highlighted the relevance of human factors, including individual behaviour, in accident causation. Awareness campaigns, broadly speaking, have the capacity to play an important role in tackling some of these factors.

This is confirmed by the OECD/ITF Motorcycle Safety Report (2015, to be published) which underlines that, although it is acknowledged that there is *little research evidence on communication campaign effectiveness, it is assumed that the media can*

- *positively influence attitudes and behaviours*;
- *provide information*
- *increase the acceptability of safety measures*

Based on the inputs collected during the project on *Awareness Campaigns* (D7), the project recommendations include the following:

RESEARCH	*STANDARDIZATION*	*LEGISLATION*	*SPECIFIC ACTIONS*
further research on **risk definition, identification, awareness** and **assessment** considering different mobility patterns and riding styles in Europe (focusing on specific rider groups at greater risk such as novice or returning riders) would enhance knowledge not only for the design of robust awareness campaigns, but also for hazard perception training purposes and ITS development; Such a study would also investigate the influence of cultural differences between European countries on road			campaigns aiming at **increasing mutual recognition and acceptance** of road traffic systems **Reaching riders in PTW dealerships**, as the type of bike chosen by riders provides clear information on their motives, the experience they seek and their concept of riding (when they can choose the bike). Such persuasive communications, tailored to the motivational requirements of the average rider of each motorcycle type, could be provided when buying a motorcycle in an attempt to

safety: behaviour, perceptions, attitudes, beliefs of road users; understand the link between different social factors (age, alcohol, riding in groups) and behaviour. - study specific risk of novice rider and design effective measure to increase their safety - **Other Vehicle drivers' perception failures,** road user distraction, and ways to increase VRU awareness (including PTWs) - **Behaviour in traffic**: to better understand all road users' behavioural patterns and their interaction (with and without technology involved); testing of / long-term analysis of rider behaviour in traffic; measures to improve the behaviour of all road users - **Extreme behaviour**: understand the causes of extreme behaviour and design effective measures to reduce it; identify the specific group of motorcyclists showing extreme behaviour and find means to reach them. - **Protective equipment**: develop and test personal safety equipment			encourage safe riding behaviour; - Increasing mutual recognition and acceptance among road users

1.6. Safe System

Road safety work needs to be based on a thorough analysis of existing safety problems, on a clear strategic view of what problems need to be tackled and by which types of measures, preferably on the basis of a vision of the long-term aims and the role of the various components of the traffic system (SUPREME).

PTW safety is a complex undertaking, as improvements in the field require an integrated, 'safe system' approach and rely on the adoption of measures by all participating disciplines and behavioural modifications by the public at large (eSUM).

Regarding the overall use of motorcycles and riding, and the behaviour and accident risk of motorcyclists, there are many differences between European countries. Safety measures for motorcyclists should be developed in accordance with country-specific circumstances (SARTRE4). Acceptance is a particular issue in terms of PTW safety measures. Riders are a rather inhomogeneous group of road users. Moreover, experience that is valid for car drivers might not be relevant to PTW riders (2BESAFE)

eSUM designed a simple methodology for designing and implementing a PTW casualty reduction programme including 6 steps:

1. Gather data required for analysing PTW casualty problems: at least collision data and contextual data (background data on PTW use)
2. Analyse data
3. Identify casualty issues: on the basis of the analysis it should be possible to identify common causation factors to assist in selecting appropriate interventions.
4. Develop targets and select interventions: match interventions to the problems defined by the analysis of data.
5. Implement interventions and monitor: A robust monitoring framework should be established in order to accurately evaluate the effectiveness of any interventions implemented.
6. Evaluate effectiveness: a named individual should be responsible for managing project implementation; interventions selected should be suitably modified to ensure that they are appropriate to national/city conditions; sufficient resources should be available (eSUM).

Based on the inputs collected during the project on *National Strategies* (D8), the project recommendations include the following:

RESEARCH	*STANDARDIZATION*	*LEGISLATION*	*SPECIFIC ACTIONS*
Fundamental research leading to proposals for PTW road safety measures: o Investigation of road conflicts o Identification of accident black spots o Riders' needs, their characteristics (riding behaviour, cognitive performance, mentality, acceptance, motives, mobility needs, etc.) o Riders' interaction with the elements comprising the road network (other road users, the road environment and their PTW) o Riders' behaviour: comparison at EU level; study of young riders; means to improve the behaviour of road users in general and of PTW users in particular. In-depth accident and naturalistic studies to better understand accidents that happened on the road	PTW tools for road safety management New definition of "seriously injured". Protective clothing (research, promotion, European standards on protective clothing)	Harmonize on-board collision avoidance technology for cars, vans and lorries Review existing transport legislative framework to integrate PTW safety elements Include PTWs in existing EU transport policy papers (e.g. White Paper on Transport policy, ITS directive, etc…)	European awareness campaigns based on shared values aiming at **increasing mutual recognition and acceptance** of road traffic systems The identification of a **general baseline for European awareness campaigns for PTWs**, to be further adapted in line with national/regional/local PTW safety patterns; **Reaching riders in PTW dealerships**, as the type of bike chosen by riders provides clear information on their motives, the experience they seek and their concept of riding (when they can choose the bike). Such persuasive communications, tailored to the motivational requirements of the average rider of each motorcycle type, could be provided when buying a motorcycle in an attempt to encourage safe riding behaviour; **Enhance stakeholders' dialogue**; increase communication between authorities and riders ; the European Union could provide

and to design effective and coherent measures to tackle the different safety issues; ○ PTW accident reconstruction - Risk perception and risk assessment work - Develop road safety management tools designed for PTW safety: - Common impact assessment and cost-benefit analysis methodologies to evaluate the impact of safety concepts (design better evaluation and better cost-benefit analyses of safety measures and their effects) - Identify relevant safety performance indicators based on an understanding of PTW riding models, risk patterns and accident causation factors; - Mobility research and design of a holistic approach to PTW safety: understanding PTW use and the motorcyclist community.			added value by stimulating positive national debates on PTW safety, fostering dialogue between the motorcycling community and national road authorities; to this end, - **Sharing best practices and benchmarking** national strategies and specific road safety actions targeting PTW safety; - Develop awareness-raising campaigns based on shared values and topics easily adaptable at national level; - Develop in-depth expertise on EU PTW safety issues - Promote the use of efficient technology - Encourage research and technological developments for PTW safety - Support standardization work and efforts that rightly integrate PTW needs (infrastructure, definition of injuries, protective clothing, conspicuity, safety management).

2. Recommendations per PTW Safety Topics

2.1. Research needs

KNOWLEDGE on PTW SAFETY	Exposure studies: o develop a **methodology** to collect and analyse mobility data harmonised at EU level o mobility data (annual mileage for PTWs) to separate impact of exposure, intrinsic risk and compensatory behaviour of riders. Development of PTW accident **prediction models** by means of accident simulations and vehicle dynamics to see which state of the road has which effect on the brake system, on the tyres, on the rider behaviour, what are the reactions of different vehicles on the same section of road, at the same speed? Etc. Mobility research: understanding PTW use, riding models, etc. Naturalistic/Simulation studies to identify: o skills, attitudes & behaviours; how to influence different types of riders to take safer decisions when riding; o riding models, risk patterns and the role of risk awareness o *safety critical events* o which and how information is processed by the rider o mental failures Road conflict investigations Accident data collection (pre-during-post collision) and accident dynamic reconstruction More in-depth investigations will allow a better understanding of fatal and serious injury crash patterns and causes Assessment of injuries linked with crash types (link between crash data and hospital data); Improvement of crash simulation and crash dummies (taking into account their particular postures to understand their specific injuries) to

	better understand ○ the consequences of an accident ○ how injuries work and how to prevent them - Research into the relationship between weather and accidents should be continued by including more data allowing additional factors to be considered. - PTW conspicuity and other perception problems - Speed: comparative study on speed differences on comparable road types within Europe. - Effectiveness of safety activities / cost-benefit analyses - Design a PTW-specific impact assessment methodology - Compile and expand key existing studies for PTW use. - Development and implementation of safety equipment adapted to countries with hot weather
ACCESS to PTWs	- **Effects of the various age limits on progressive access**; ○ EU harmonisation: evaluation of the effects of the various age limits to ride a class I moped between EU countries; ○ In what way is learning to ride a moped different from learning to ride a motorcycle; or learning to ride a low performance motorcycle different from learning to ride a high performance one? ○ Risk awareness: motorcycling experience effect (including training, type of riding licence, number of year of practice and frequency of motorbike use) on motorcyclists' risk awareness. - **Training:** ○ the content and effectiveness of training (including post-licence training) with the aim of improving the behaviour and safety of both drivers and riders; ○ further research should identify specific training needs according to experience and vehicle ○ young riders: search for effective ways to improve training for young riders/drivers ○ rider training: which skills and how should they be trained during training (e.g. manoeuvring skills, braking skills, noticing risk situations) at driving schools; and how do the skills learned work in real traffic situations? How can these be learned effectively

	and efficiently, in how much time and in which sequence? **New technologies:** o The development of new simulation techniques offers new opportunities for training programs.
INFRASTRUCTURE	**Better understanding of PTW/infrastructure interactions** o Improve data collection o Gain an in-depth understanding of the vehicle-road interaction and its dynamics, including detailed analysis with simulation tools (vehicle-infrastructure interaction simulation) o Research accident scenarios and biomechanics o Incorporate data gathered in naturalistic riding studies o Study the interaction between motorcycle tyres and road surface condition o Safer road design: o Understand the effects of the road environment on road users o Provide a more forgiving road environment o Make roads self-explaining for PTWs o Improve the environment to enhance reciprocal perception of riders and drivers o "Friction measuring" research o Re-evaluate infrastructural measures to reduce speeds (such as humps or lane narrowing) from the point of view of PTW rider safety o Design roadside obstacles to provide better protection for PTW riders who may collide with them **Road maintenance**: o Development more durable roads that will be easier to maintain in a good state o Develop a "holistic solution for asset management"; with the aim of making work zones safer **Black spot management**:

	○ Research local accidents and suitable counter-measures. **Testing methodologies**: ○ Define a testing methodology for roadside and other infrastructure equipment which remains practicable for road equipment manufacturers
INTELLIGENT TRANSPORTATION SYSTEM	Further research is needed regarding the expected costs/benefits of ITS on riding activity: ○ Understanding issues of automation for PTW use; ○ Interaction of PTWs with automated and non-automated vehicles ○ User acceptance ○ ITS efficiency (estimate of the relative damage reductions associated with deploying ITS in motorcycles; the effectiveness of ITS technologies can be established through the collection and evaluation of crash data, field testing and analytical modelling of risks ○ Assess the benefits of both assistive systems and rider training, especially in direct comparison to each other ○ Prioritization of ITS for PTW safety Fundamental: ○ Data acquisition design, implementation, and data analysis tools ○ Effects on rider performance and behaviour of human-machine interaction with new technologies covering such issues as distraction, cognitive workload, over-reliance on technology, training requirements, situational awareness, and so on ○ Extensive on-road research examining the effects of using assistive systems on PTWs. ○ Incident, near-miss and pre-crash data ○ Modelling (riding tasks, motivation for action, accident causation factors, identification of safety critical events) ○ Specific PTW features, applications and services and their interaction with other road users ○ Perception research[3] (reliable object recognition and tracking, situation awareness, accurate road representation, detection of free space, perception architecture, etc.)

[3] iMobility Forum Workshop on Automation; Angelos Admitis – ECCS - .ppt

	○ Development of methodologies, including PTW-specific impact assessments based on eIMPACT, 9 safety mechanisms[4] ▪ direct in-car modification of the driving task; ▪ direct influence by roadside systems ▪ indirect modification of user behavior ▪ indirect modification of non-user behavior ▪ 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 Research on vehicle technology for two-wheeler safety, including interaction of other vehicles' technology with PTWs ○ Large scale Field Operational Tests (FOTs) related to naturalistic driving conditions to capture VRU-related behavior and ITS requirements ○ advanced intelligent sensing ○ V2X communication platform for cooperative ITS applications ○ Research on the 112 Pan-European eCall for PTWs (drafting the minimum technical and functional specifications with identified interfaces for additional features, triggering design, tests, verification, validation, short-listed solutions, demonstrations) ○ Research on active and passive systems (incl. conspicuity technology) ○ Interaction of other vehicles' technology with PTWs ○ Study the interaction of an automated vehicle with its environment and other (non-automated) road users; develop technology and equipment on board other vehicles (cars and trucks) that can contribute to improving motorcycle safety (blind spot) ○ post-deployment field operational tests in a real traffic environment with a full set of analyses, rider acceptance, willingness to pay

[4] http://www.eimpact.eu/

	In-depth identification of accident causation factors and Safety Critical Events, and prioritization of motorcycle safety problems that are amenable to ITS intervention o *Naturalistic riding studies* (INRS and NRS): baseline data collection with instrumented PTWs to define current practices, capabilities and issues ▪ Identify PTW-specific driving tasks, patterns and styles ▪ Understand riders' motivation for action o *Field Operational Tests and Perception research to* ▪ Validate interpretation of rider intentions ▪ Define triggering patterns Rider (and instructor) training and testing needs (e.g. coming *e-mirrors*) o Effects on rider performance and behaviour of human-machine interaction with new technologies that deals with issues such as distraction, cognitive workload, over-reliance on technology, training requirements, situational awareness, and so on o Instructor training scheme to master ITS
COMMUNICATION on PTW SAFETY	Further research on **risk definition, identification, awareness** and **assessment** considering different mobility patterns and riding styles in Europe (focusing on specific rider groups at greater risk such as novice or returning riders) would enhance knowledge not only for the design of robust awareness campaigns, but also for hazard perception training purposes and ITS development; Such a study would also investigate the influence of cultural differences between European countries on road safety: behaviour, perceptions, attitudes, beliefs of road users; understand the link between different social factors (age, alcohol, riding in groups) and behaviour. study specific risk of novice rider and design effective measure to increase their safety **Other Vehicle drivers' perception failures,** road user distraction, and ways to increase VRU awareness (including PTWs) **Behaviour in traffic**: to better understand all road users' behavioural patterns and their interaction (with and without technology involved); testing of / long-term analysis of rider behaviour in traffic; measures to improve the behaviour of all road users **Extreme behaviour**: understand the causes of extreme behaviour and design effective measures to reduce it; identify the specific group of

	motorcyclists showing extreme behaviour and find means to reach them. **Protective equipment**: develop and test personal safety equipment
SAFE SYSTEM	Fundamental research leading to proposals for PTW road safety measures: o Investigation of road conflicts o Identification of accident black spots o Riders' needs, their characteristics (riding behaviour, cognitive performance, mentality, acceptance, motives, mobility needs, etc.) o Riders' interaction with the elements comprising the road network (other road users, the road environment and their PTW) o Riders' behaviour: comparison at EU level; study of young riders; means to improve the behaviour of road users in general and of PTW users in particular. In-depth accident and naturalistic studies to better understand accidents that happened on the road and to design effective and coherent measures to tackle the different safety issues; o PTW accident reconstruction Risk perception and risk assessment work Develop road safety management tools designed for PTW safety: Common impact assessment and cost-benefit analysis methodologies to evaluate the impact of safety concepts (design better evaluation and better cost-benefit analyses of safety measures and their effects) Identify relevant safety performance indicators based on an understanding of PTW riding models, risk patterns and accident causation factors; Mobility research and design of a holistic approach to PTW safety: understanding PTW use and the motorcyclist community.

2.2. Standardization needs

KNOWLEDGE on PTW SAFETY	Need to develop and apply relevant methods, tools and indicators to measure PTWs in traffic flows and analyse their mobility and behaviour (exposure data). Standardize the definition of "seriously injured". Harmonize accident (macro/micro) reporting methodologies
ACCESS to PTWs	**Standardizing minimum training curriculum requirements** and linking driving licence tests to this standard would significantly improve the quality of rider training programmes (need for a "quality seal") Standardise EU rider/instructor training curricula
INFRASTRUCTURE	Review standards for 'PTW- friendly' road infrastructure and design
INTELLIGENT TRANSPORTATION SYSTEM	PTW tools for road safety management Integration of PTWs in automated traffic control systems Define a test protocol through which the behaviour of motorcycles (from a safety point of view) can be rated. The process would be similar to that for cars and the gaining of "stars" through crash tests defined in such test protocols as "EuroNCAP"
COMMUNICATION on PTW SAFETY	
SAFE SYSTEM	PTW tools for road safety management New definition of "seriously injured" Protective clothing (research, promotion, European standards on protective clothing)

2.3. Legislation needs

KNOWLEDGE on PTW SAFETY	Prepare a legislative proposal which sets up the right framework for data collection in Member States, defining a common data collection strategy which includes improving accident reporting o harmonise **formats** and **headings**; o harmonised **classification of vehicles involved in an accident** o include **GPS coordinates** for accident location o include the following information for each vehicle involved in the accident: ▪ Point of impact (front left, front right, etc.) ▪ Angle of impact (0°, 45°, 90°, 135°…360°) ▪ Impact severity (light, medium, hard) o include pictures of the scene and damage to each vehicle involved. o and propose ▪ a harmonised way to measure the vehicle fleet ▪ common categories for the **type/frequency /motivation of use** for vehicles
ACCESS to PTWs	**Addressing training content / instructors' competence in a legislative framework** becomes an essential complement to the 3rd Driving Licence Directive (for PTWs), addressing: o Initial rider training o Instructors' training o Advanced riding courses o Use of driving simulators o Special training and education for returning bikers Harmonize and lower the minimum age Harmonize licencing requirements to a greater extent

INFRASTRUCTURE	Improve the periodic maintenance of roads => The EU directive on infrastructure should include provisions on road inspections for secondary roads. Infrastructure directive: The Directive for Infrastructure and Safety Management is currently being revised, including how to cater for the needs of PTWs. A good step forward would be for any EU money given to the motorways to include specific provisions for motorcycles. This would give a good example for secondary roads. Black spot monitoring would benefit from harmonisation throughout the EU (by means of legislation or other means).
INTELLIGENT TRANSPORTATION SYSTEM	Traffic management for PTW road safety. The EU should encourage and support the introduction of ITS taking specific account of PTWs (e.g. on-board collision avoidance technology in cars, vans and lorries which detect riders – V2V/V2I systems). Effective integration of vulnerable road users into traffic management systems: these include black spot management, incident management, ITS integration, road infrastructure design
COMMUNICATION on PTW SAFETY	
SAFE SYSTEM	Harmonize on-board collision avoidance technology for cars, vans and lorries Review existing transport legislative framework to integrate PTW safety elements Include PTWs in existing EU transport policy papers (e.g. White Paper on Transport policy, ITS directive, etc…)

2.4. Specific actions

KNOWLEDGE on PTW SAFETY	Promote the use of the CADaS protocol at national level to have comparable data across Europe propose and include in CADaS o common age categories o common classification of the types of PTWs complement the CADaS protocol with specific data of relevance to accidents with PTWs, such as environmental aspects or vehicle details Cross information on injuries between Member States Enhance exposure and mobility data collection work between Member States Cross/compare existing knowledge between different EU countries Set up a strategic approach to PTW research needs Use iGLAD as the basis to set up a common European in-depth accident causation database.
ACCESS to PTWs	The type of bike chosen by riders provides a clear indication of their motives, the experience they seek and their concept of riding (when they can choose the bike). One implication is that **persuasive communications**, tailored to the motivational requirements of the average rider of each motorcycle type, could be provided when buying a motorcycle in an attempt to encourage safe riding behaviour. To train PTW users properly in the use of ABS and promote the widespread use thereof: the necessity of knowing how the Anti-lock Braking system (ABS) works: Training in ABS operation: Initial Rider Training, websites, Post-licence training programmes. The need for assistance during emergency braking: training and website informing riders on how to react in the case of emergency braking. Benchmark and exchange best practices on training methods, content, and instructors' competence
INFRASTRUCTURE	Need to find a way to motivate road engineers to use the infrastructure guidelines or make them mandatory. *Motorcyclist Protection System Database*: further political support and dissemination activities would be required to further engage MPS manufacturers to feed the database and for road authorities to make use of it. http://www.mc-roadsidebarriers.eu/search-for-mps/ A civil engineering handbook would be a practical instrument for improving road safety for PTWs by just emphasizing the engineering items to be considered during the design and maintenance of infrastructure Monitoring high-risk sites (black spots):

	○ involvement of the riders' community ○ use of smart applications - Use of the ***pan-European Road Hazard report form for PTWs http://www.fema-online.eu/riderscan/IMG/pdf/ptw_black_spots_report_form.pdf*** - Promote the use of minimum safety requirements (barriers, markings, passive support structures EN 12767) though this could be done in cooperation with CEDR. - Exchange best practices on the self-explaining roads concept - Disseminate the guidelines on roadside barriers for motorcyclists http://www.fema-online.eu/guidelines/Guidelines.pdf - Promote the infrastructure/PTWs website http://www.mc-infrastructure.eu/
INTELLIGENT TRANSPORTATION SYSTEM	- It is important to spread knowledge of these new systems to stimulate demand for them. - PTW users need to be trained properly in the use of ABS. Widespread adoption of ABS needs to be promoted: the necessity of knowing how the Anti-lock Braking system (ABS) works: Training in ABS operation: Initial Rider Training, websites, Post-licence training programmes. - The need of assistance during emergency braking: training and website to inform riders on how to react in case of emergency braking. - Define a test protocol through which the behaviour of the motorcycles (from a safety point of view) can be rated. The process would be similar to that for cars and the gaining of "stars" through crash tests defined in test protocols such as "EuroNCAP". (ROSA)
COMMUNICATION on PTW SAFETY	- Campaigns aiming at **increasing mutual recognition and acceptance** of road traffic systems - **Reaching riders in PTW dealerships**, as the type of bike chosen by riders provides clear information on their motives, the experience they seek and their concept of riding (when they can choose the bike). Such persuasive communications, tailored to the motivational requirements of the average rider of each motorcycle type, could be provided when buying a motorcycle in an attempt to encourage safe riding behaviour; - Increasing mutual recognition and acceptance among road users
SAFE SYSTEM	- European awareness campaigns based on shared values aiming at **increasing mutual recognition and acceptance** of road traffic systems - The identification of a **general baseline for European awareness campaigns for PTWs**, to be further adapted in line with national/regional/local PTW safety patterns;

	- **Reaching riders in PTW dealerships**, as the type of bike chosen by riders provides clear information on their motives, the experience they seek and their concept of riding (when they can choose the bike). Such persuasive communications, tailored to the motivational requirements of the average rider of each motorcycle type, could be provided when buying a motorcycle in an attempt to encourage safe riding behaviour; - **Enhance stakeholders' dialogue**; increase communication between authorities and riders ; the European Union could provide added value by stimulating positive national debates on PTW safety, fostering dialogue between the motorcycling community and national road authorities; to this end, - **Sharing best practices and benchmarking** national strategies and specific road safety actions targeting PTW safety; - Develop awareness-raising campaigns based on shared values and topics easily adaptable at national level; - Develop in-depth expertise on EU PTW safety issues - Promote the use of efficient technology - Encourage research and technological developments for PTW safety - Support standardization work and efforts that rightly integrate PTW needs (infrastructure, definition of injuries, protective clothing, conspicuity, safety management, etc.)