RIDERSCAN

European Scanning Tour for Motorcycle Safety

Annex 21

PTW Safety and EU Research Work

Review of PTW-related research work from ERSO portal

Please refer to this report as follows: Delhaye, A., Marot, L. (2015), ***PTW Safety and EU Research Work – Review of PTW-related research work from ERSO portal***, Annex 21 of the EC/MOVE/C4 project RIDERSCAN.

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Dissemination Level: public

Projects Overview[1]

Ending date	Project/website	Full name of the project	Official description	Related Project Deliverables
ongoing	**SAFERWHEEL**	Study on Accident Causation for traffic accidents involving PTWs and bicycles in the EU		D2
31/02/2018	**MOTORIST**	MOTOrcycle Rider Integrated SafeTy	http://cordis.europa.eu/project/rcn/111466_en.html	D1, D6
ongoing	**VRUITS**	Improving the Safety and Mobility of Vulnerable Road Users Through ITS Applications		D2, D6
30/09/2013	**MOSAFIM**	Motorcyclists road safety improvement through better performance of the protective equipment and first aid devices	http://ec.europa.eu/transport/road_safety/pdf/projects/mosafim.pdf	D6, D7, D8
31/10/2012	**WHITEROADS**	White spots in the Trans-European road network: a positive approach to road safety	http://ec.europa.eu/transport/road_safety/pdf/projects/whiteroads.pdf	D3
30/06/2012	**DaCoTA**	Data Collection, Transfer & Analysis	http://ec.europa.eu/transport/road_safety/pdf/projects/dacota.pdf	D1, D2, D3, D6, D7, D8,
30/06/2012	**ROSYPE**	ROadSafety for Young People in Europe	http://ec.europa.eu/transport/road_safety/pdf/projects/rosype.pdf	D7
31/05/2012	**PILOT4SAFETY**	Pilot project for common EU Curriculum for Road Safety experts: training and application on Secondary Roads	http://ec.europa.eu/transport/road_safety/pdf/projects/pilot4safety.pdf	D3
1/12/2011	**Smart RRS**	Innovative Concepts for smart road restraint systems to provide greater safety for vulnerable road users	http://ec.europa.eu/transport/road_safety/pdf/projects/smart_rrs.pdf	D2, D3
1/09/2011	**2-BE-SAFE**	2-Wheeler Behaviour and Safety	http://ec.europa.eu/transport/road_	D1, D2, D3, D4, D5, D6, D7, D8,

[1] http://ec.europa.eu/transport/road_safety/specialist/projects/sorted-by-keywords/index_en.htm#0801262487ec0540

			safety/pdf/projects/2-be-safe.pdf	D9
31/03/2011	**ROSA**	Dissemination of European handbook on best-practice related to two-wheeled motor vehicles' safety	http://ec.europa.eu/transport/road_safety/pdf/projects/rosa.pdf	D1, D3, D6, D7, D8
1991 - 2010	**SARTRE 1-4**	Social Attitudes to Road Traffic Risks in Europe	http://ec.europa.eu/transport/road_safety/pdf/projects/sartre.pdf	D2, D6 D7, D8, D9
30/11/2010	**eSum**	European Safer Urban Motorcycling	http://ec.europa.eu/transport/road_safety/pdf/projects/esum.pdf	D2, D7, D8
30/09/2010	**MYMOSA**	Motorcycle and Motorcyclist Safety	http://ec.europa.eu/transport/road_safety/pdf/projects/mymosa.pdf	
1/12/2009	**APROSYS**	Advanced Protection Systems	http://ec.europa.eu/transport/road_safety/pdf/projects/aprosys.pdf	D2, D3
30/11/2009	**PISA**	Powered Two Wheeler Integrated Safety	http://ec.europa.eu/transport/road_safety/pdf/projects/pisa.pdf	D2
31/01/2009	**CAST**	Campaigns and Awareness-raising Strategies in Traffic Safety	http://ec.europa.eu/transport/road_safety/pdf/projects/cast.pdf	D7
1/12/2010	**SAFERIDER**	Advanced Telematics for enhancing the safety and comfort of motorcycle riders	http://ec.europa.eu/transport/road_safety/pdf/projects/saferider.pdf	D6
31/08/2009	**SIM**	Safety In Motion	http://ec.europa.eu/transport/road_safety/pdf/projects/sim.pdf	D1, D2, D6
1/12/2008	**SAFETYNET**	SafetyNet	http://ec.europa.eu/transport/road_safety/pdf/projects/safetynet.pdf	D1, D2, D3
30/06/2008	**TRACE**	Traffic Accident Causation in Europe	http://ec.europa.eu/transport/road_safety/pdf/projects/trace.pdf	D2, D6
1/06/2007	**SUPREME**	Summary and publication of best Practices in Road safety in the Eu Member States	http://ec.europa.eu/transport/road_safety/pdf/projects/supreme.pdf	D1, D2, D3, D4, D6, D7, D8

30/04/2007	**IRT**	Initial Rider Training	http://ec.europa.eu/transport/road_safety/pdf/projects/irt.pdf	
30/04/2007	**IRT**	Initial Rider Training	http://ec.europa.eu/transport/road_safety/pdf/projects/irt.pdf	D1
1/12/2005	**RISER**	Roadside Infrastructure for Safer European Roads	http://ec.europa.eu/transport/road_safety/pdf/projects/riser.pdf	D3
1/12/2005	**SUNFLOWER+6**	A comparative study of the development of road safety in 9 European countries	http://ec.europa.eu/transport/road_safety/pdf/projects/sunflower_6.pdf	D1, D2, D3, D9
1/01/2001	**PROMISING**	Promotion of mobility and safety of vulnerable road users	http://ec.europa.eu/transport/road_safety/pdf/projects/promising.pdf	D1, D2, D3, D5, D6, D8, D9
31/10/2009	**TRAIN-ALL**	Integrated System for driver TRaining and Assessment using Interactive education tools and New training curricula for ALL modes of road transport	http://ec.europa.eu/transport/road_safety/pdf/projects/train-all.pdf	D1
31/12/2008	**WATCH-OVER**	Vehicle-to-Vulnerable roAd user cooperaTive communication and sensing teCHnologies to imprOVE transpoRt safety	http://ec.europa.eu/transport/road_safety/pdf/projects/watch-over.pdf	D4, D6
1/12/2003	**EURORAP I and II**	Road Assessment Programme	http://ec.europa.eu/transport/road_safety/pdf/projects/eurorap.pdf	D3
1/03/2003	**TRAINER**	System for driver Training and Assessment using Interactive Evaluation tools and Reliable Methodologies	http://ec.europa.eu/transport/road_safety/pdf/projects/trainer.pdf	D1
1/12/2002	**MAIDS**	Motorcycle Accidents In Depth Study	http://ec.europa.eu/transport/road_safety/pdf/projects/maids.pdf	D1, D2, D3
31/12/1998	**STAIRS**	Standardisation of Accident and Injury Registration Systems	http://ec.europa.eu/transport/road_safety/pdf/projects/stairs.pdf	D2

D1: Training, testing and licensing

Project/website	Ending date	Final report	Relevant Deliverables
2-BE-SAFE	1/09/2011	http://www.2besafe.eu/sites/default/files/deliverables/2BES_D35_FinalReport.pdf	• D3.1 Social, cognitive and behavioural differences of PTW riders with reference to their attitudes towards risk and safety • D3.2 Risk Perception, its contextual parameters, and its influence on PTW rider choices and riding behaviour
DaCoTA	30/06/2012	http://www.dacota-project.eu/Deliverables/DaCoTA_Final_Report.pdf	• Powered Two Wheeler report (ERSO)
IRT	30/04/2007	http://www.initialridertraining.eu/docs/2007_IRTFinalReport.pdf	• The Initial Rider Training Manual • e-Coaching evaluation report • Hazard perception, attitudes and behaviour in riding
MAIDS	1/12/2002	Final report : http://www.fema-online.eu/riderscan/IMG/pdf/maids2-2.pdf	• MAIDS & Initial Rider Training
MOTORIST	31/02/2018		• WP1 outcomes
PROMISING	1/01/2001	http://www.transport-research.info/Upload/Documents/200310/promisingrep.pdf	• Deliverable 3
ROSA	31/03/2011	http://ec.europa.eu/transport/road_safety/pdf/projects/rosa_handbook_en.pdf	• European Handbook on Good Practices in Safety for Motorcyclists - Epigraph: HUMAN FACTOR – • European Handbook on Good Practices in Safety for Motorcyclists - Epigraph: TRAINING -
SAFETYNET	1/12/2008	http://erso.swov.nl/knowledge/Fixed/45_PoweredTwoWheelers/powered%20two%20wheelers.pdf	• Learning, Testing and Licensing
SIM	31/08/2009		• In-depth Accident analysis

SARTRE 1-4		http://www.attitudes-roadsafety.eu/index.php?eID=tx_nawsecuredl&u=0&file=fileadmin/Results/SARTRE%203%20results/S3_reports/Part%201_Report%20on%20principal%20results.pdf&t=1426947005&hash=37ce58463fddcf23253e64977ec9e93f	• Sartre 4 - European road users' risk perception and mobility
SUNFLOWER+6	1/12/2005	http://www.20splentyforus.co.uk/UsefulReports/SUNflower%2B6_Final_Report.pdf	• Final report (Pp.343, 344)
SUPREME	1/06/2007		• Best Practices Handbook
TRAIN-ALL	31/10/2009	http://www.transport-research.info/Upload/Documents/201208/20120814_161813_84170_TRAIN%20ALL%20D8.3%20-%20FINAL%20REPORT%20COMPLETE_v3_060910.pdf	• D1.2 Training Needs, Scenario and Curricula Definition and Specification of Tools and Curricula • D1.1 Benchmarking and classification of CBT tools for driver training • D5.3 Impact analysis and towards an integrated training curriculum
TRAINER	1/03/2003		• Del. 1 Survey of existing training methodologies and driving instructors' needs • Del.2.1 Inventory of driver training needs and major gaps in the relevant training procedures

- **2BESAFE project (2011) – Deliverable 3.1**
  - Risk Awareness corresponds to a rider's subjective assessment of the situational criticality as it is perceived, understood and anticipated by the motorcyclists.

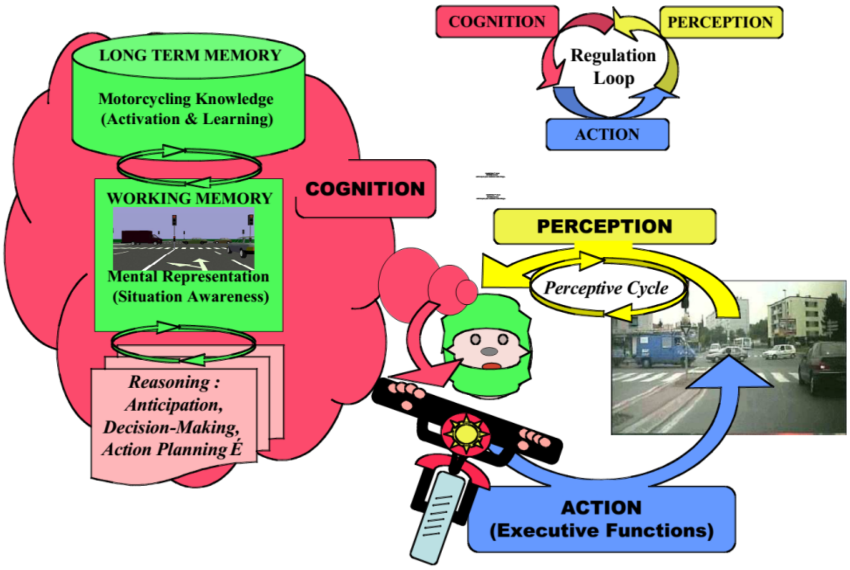


Figure 4: Synthetic overview of the motorcycling activity as a "Perception-Cognition-Action" regulation loop (adapted from COSMODRIVE model; Bellet and al., 2007)

- The figure provides a synthetic overview of this activity considered as an iterative "Perception-Cognition-Action" loop of regulation, between the human rider and the road environment. Indeed, as with any dynamic environment, the road environment requires constant adaptation from the driver. 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. Indeed, from their interaction with the road environment, riders build mental models of the events and objects that surround them (Johnson-Laird, 1983, Norman, 1983). 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. This mental representation provides a meaningful and self-oriented interpretation of the reality, including anticipations of potential evolutions in the current driving situation. They are not copies of objective reality but they potentially diverge from it quite considerably. On the one side, they only contain a tiny amount of the information available in the environment: they focus in priority on useful information in order to act efficiently in current traffic conditions, as a function of the goals pursued by the rider. On the other side, they can also convey much more information than that available in perceptible reality (e.g. keeping in memory information perceived previously but henceforth hidden, formulating inferences of potential future events based on precursive clues, or anticipating the expected effects of an action in progress). From this point of view, it corresponds to the driver's Situation Awareness, according to Endsley (1995) definition of this concept: the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future. Moreover, this mental representation is "action-oriented" (i.e. the rider doesn't passively observe the road scene as a "spectator", but as an "actor"). It constitutes an operative image (i.e. a functionally deformed view of the reality; cf. Ochanine, 1977), a "goal driven" model of the road environment. They are formulated "by" and "for" the action. Therefore they provide interiorised models of the task (Leplat, 2004) constructed for the current activity, but which can be stored in Long Term Memory (LTM) and reactivated later in new situations, for future performances of the same task. Mental representations form the kernel of complex sequences of cognitive processes, ranging from the perception of events to driving behaviours, through intermediate steps of decision-making and activity planning. However, care is required to avoid taking an over-linear and sequential view of this processing string. Although the perception of an unexpected or critical event sometimes triggers the processing sequence, it is more often the action in progress and/or the riders' intention (the aim they seek to attain in the current situation) that directs their perceptive exploration and information processing. More than a linear sequence of perceptive-cognitive processes, riders' mental activities should be described as an iterative "perception cognition action" cycle of regulation, organized around the mental representation of the driving situation. In this control loop, perception is constantly fuelled by mental representation, which in turn constantly fuels perception. Once built, these mental models generate perceptive expectations, guide the road environment exploration and the new information processing, and are also the central components of cognitive cycles involving decision-taking and anticipating functions (i.e. via mental simulation based on the current state of the world). When an appropriate action to the current driving context has been identified, selected, or cognitively planned, it is implemented by the rider on the motorbike (i.e. executive functions) for progressing into the dynamic road environment. From this point of view, mental representations are key elements of the rider's cognition; and an erroneous representation means, potentially, decision-making errors and unsafe driving actions.

- 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.
- *Risk awareness* could be considered as judgment of criticality close to the Threat Appraisal stage.

When a critical event occurs in the road environment, risk awareness is intimately linked with hazard perception (Horswill and McKenna, 2004), as well as including a threat appraisal (Grayson et al., 2003) and a judgment concerning the driving situation criticality (Banet and Bellet, 2008). From this approach, 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.

- Factors influencing *Risk Awareness* at the cognitive level: A number of contributing factors have been identified in the literature on car driving activities as impacting cognitive abilities of situational awareness and risk perception (like gender or age, for example). Several past studies have demonstrated that the risk of motorcyclists having a crash decreases with age and riding experience. Other surveys clearly indicate that the risk of having anaccident is higher for inexperienced than for experienced motorcyclists. Moreover, the risks of motorcycle injury and death were found to be higher for young riders, which may be partly due to inexperience, unfamiliarity, or lack of ridingexposure. The number of available empirical data concerning riding experience effect on risk awareness is more limited, and primarily focused on hazard perception issues. Recent simulator experiment showed that experienced motorcyclists – in comparison with novice riders - crashed less often, received better performance evaluations, and approached hazards at more appropriate speeds. They also found that some novice riders were overconfident in their riding ability. In another recent paper, Hosking et al (2010) showed that experienced motorcyclists respond to hazards earlier than inexperienced riders, and have more flexible and efficient visual search patterns. Furthermore, motorcycling practice can impact cognitive abilities relevant to risk awareness. For example, a motorcyclist riding a motorbike in urban area for commuting may have different knowledge, expertise inrisk awareness and / or riding skills than a sport rider mainly using the motorbike on rural roads, or than a "rambler" using the motorbike during holidays for long trips travel on motorways.
- To improve road safety, engineering measures (which change the physical safety conditions) are introduced. One way of doing this is to minimise the severity of an accident if and when it occurs, for example introducing helmet laws for motorcyclists. However, a problem with this is that motorbike riders may overestimate the safety benefit of the helmet and overcompensate for it by riding in a more risky manner. It has previously been found that motorcycle riders who wore helmets perceived their risk of death as lower and responded with greater risk taking in the form of increased speed (Peltzman 1973; Underwood et al., 1993). Asogwa

(1980) investigated motorcyclist fatalities in Anabra State, Nigeria, before and after the introduction of a law mandating the wearing of helmets. Despite high wearing rate (96%), a substantial increase in both fatality rate (17.1%) and injury rate (55%) occurred in a two-year period after the legislation, compared with a two-year period before the legislation. The major reason why this measure had effects in a direction opposite to that intended was that the motorcyclists overestimated the protection afforded by wearing helmets, and then increased their risk taking when wearing them. Wearing a helmet has a safety effect of reducing accident severity in some crashes. However, it has no effect on reducing accident number. This case study indicates that 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 resultin an effect in a direction opposite to that intended.

- Once an individual rider evaluates the level of risk of a situation, a variety of factors will influence the level of risk he/she is comfortable with. The level of risk accepted will be based in part on the riders' beliefs about their own level of skill in successfully avoiding the hazard. Mannering and Grodsky (1995) noted the factors that may tend to bias an individual's perception of risk. These were:
  - *Unwarranted optimism*: those who are more optimistic of their skills and likelihood of accident involvement are more likely to perceive a lower risk.
  - *Anchoring bias*: this refers to tendencies to anchor risk estimates around the notion of overall risk based on experiences and general knowledge of overall accident risk. Therefore, involvement in training courses or previous accidents may be likely to affect estimates of perceived risk.
  - *Availability bias*: this refers to the assessment of risk based upon disproportionate information. As a result, appropriate probabilities of risk may not be assigned to events which have been disproportionately experienced or recalled.
  - *Deliberate under-estimates of risk*: this is the tendency to justify risk-taking behaviour by underestimating risk deliberately.
  - *Under-estimate the variance in accident risk*: this is the over-estimation of lower probability events and the under-estimation of higher probability events.
- There is need to improve motorcycling training, with more specific targeting of new (or returning) leisure riders, but there is also potential for improving the training of car driversor developing campaigns that focus on the responsibility of the driver to actively search for motorcyclists. There is evidence that the nature of motorcycling appears to be changing. More riders are taking up motorcycling at an older age and engaging in motorcycling as a leisure pursuit. In order to increase motorcycle safety it is therefore necessary to take account of these changing habits and target interventions in the form of specialised training to the appropriate riders, their choice of machine and the situations in which they ride.
- Research question: further research should investigate whether the ''licence for life" model is appropriate, or whether retraining could help to increase motorcycle safety

- **2BESAFE project (2011) – Deliverable 3.2**
  - ✓ A potential future interesting topic to be investigated across Europe could be the motorcycling experience effect (including training, type of riding license, number of year of practices and frequency of motorbike use) on motorcyclists' Risk Awareness. Such a comparative research, dedicated to novice motorcyclists' Risk Awareness across Europe, could be an interesting comparative challenge for a future project liable to be implemented in future EU Framework programme
- **DACOTA (2012) – PTWs report**
  - Licensing, testing and training are related measures directed at the riders as well as defining access to categories of PTW. Little evidence exists of the effect of current licensing systems in improving safety. One future option is to introduce a more graduated system
  - Learning, testing and licensing of PTW riders are related subjects. Together they form a system to make sure that all riders have an acceptable level of competency. This competency requires sufficient mental maturity and has to be learned by training and experience.
  - Although there is no concrete results to support a crash reduction effect for rider training (not within a graduated licensing system with other restrictions), given the characteristics of a PTW and their high crash rate, it is obvious that riders need a high level of competence both in terms of vehicle control and in terms of safe interaction with other road users
  - The aim of training programs is to improve the competency of riders in order to reduce their crash rate. But a program may have adverse effects depending on the motivation of the applicants. More experienced riders may willingly start actions (like overtaking, cornering at high speed) which are close to their limit of losing control
  - There is no evidence or indication which of the presently existing systems is better, supervised training by a qualified instructor or unsupervised practising on a low performance PTW. There is little doubt, however, that a better system in terms of crash prevention is a graduated system with:
    - High minimum age limit (at least as high as for a car license)
    - At least two stages of riding under low risk conditions on a low performance motorcycle with a combination of compulsory training and unsupervised practising
    - Testing before and at the end of each stage
    - No option of direct access
  - According to the Australian review (Haworth & Mulvihill, 2005) the present tests and training programs do not adequately address rider motivation and riding style or hazard perception and response. A traffic hazard is an element of a traffic situation with the potential of initiating a collision and therefore requiring special attention. It may be related to the road (a change in road surface, a curve) or related to the presence and behaviour of other road users. Hazard perception and responding is the behaviour in between normal and timely actions (to avoid a

situation with little or no time to avoid a crash) and emergency actions (with little or no time left).

- Many private organisations offer voluntary, advanced training programs. Their aim may differ e.g. improving the detection and avoidance of (potential) emergency situations or improving vehicle control in difficult situations. The effects will depend on the motivation of the participants. With riders who are safety minded these programs can be expected to improve their behaviour and prevent accidents. With performance-oriented riders the result may be the opposite

- **IRT (2007) – The Initial Rider Training Manual**

AM	1a, 2a, 3, 4a, 4b, 6a, 7, 8	AM	1a, 2, 3a, 3d, 4, 5	AM	1a, 2, 4a, 4b
A1	1a, 2a, 3, 4a, 4b, 5, 6a, 6b, 7, 8	A1	1b, 2, 3b, 3c, 4, 5, 6a, 6b	A1	1b, 2, 3a, 3b, 4a, 4b, 5, 6
A1/B	3, 4a, 4b, 5, 6a	A1/B	1b, 2, 3b, 3c, 4, 5, 6a, 6b	A1/B	1b, 3a, 3b, 4b
A2	1a, 1b, 2a, 2b, 3, 4a, 4b, 5, 6a, 6b, 7, 8	A2	1b, 1c, 2, 3b, 3c, 3d, 4, 5, 6a, 6b	A2	1b, 2, 3a, 3b, 4a, 4b, 5, 6, 7, 8, 9
A	1a, 1b, 2a, 2b, 3, 4a, 4b, 5, 6a, 6b, 7, 8	A	1b, 1c, 2, 3b, 3c, 3d, 4, 5, 6a, 6b	A	1b, 2, 3a, 3b, 4a, 4b, 5, 6, 7, 8, 9

Theoretical	Machine control	Traffic interface
1 Road regulations	1 Machine familiarity	1 Positioning in traffic
a general rules and regulations	a automatic controls	a slower than traffic
b motorway rules and regulations	b manual controls	b at traffic speed
2 Signs and markings	c advanced braking systems	2 Distance
a general signs and markings	2 First movements	3 Curves and bends
b motorway signs and markings	3 Gears, brakes and direction	a right hand
3 Machine dynamics	a automatic gears	b left hand
4 Hazard awareness	b manual gears	4 Anticipation
a other road users	c separate braking systems	a other road users
b environment and infrastructure	d advanced braking systems	b environment and infrastructure
5 Helmets and appropriate clothing	4 Steering and counter-steering	5 Junctions
6 Social responsibilities	5 Low speed manoeuvring	6 Overtaking
a noise	6 Hazard management	7 Motorways
b first aid and accidents	a swerving	8 Group riding
7 Impairment	b emergency braking	9 Journey planning
8 Attitude and behaviour		

1a, 1b, 2a, 2b, 3, 4a, 4b, 5, 7, 8	4, 5, 6a, 6b	1a, 1b, 2, 3a, 3b, 4a, 4b, 5, 6, 7, 8, 9
e-Coaching. Virtual no-risk exposure to hazards and consequences of attitude and behaviour.		

Figure 1: the initial structure matrix of the IRT model European programme showing the relevance of its modular based approach to a progressive licensing system.

- **IRT (2007) – eCoaching evaluation report**
  - eCoaching programme can be seen as particularly attractive training method for young trainees of age 15-35;
  - e-Coaching programme is ideal for training hazard perception and avoidance and correct attitude and behaviour in traffic; Observing the performance of the trainee and giving feedback is easier and more illustrative within the programme than it would be in real life
  - PCs and video game consoles as platforms were studied, as well as the possibilities of internet-based solutions. PC hardware seems more suitable for the IRT e-Coaching programme than the video game consoles due to wider availability and adequate calculation power. They also provide an easy access to the Internet, which can be used to create communal collaboration among the users of the programme, thus reinforcing the learning process.
  - It is recommended that the programme is distributed via a website since this is an ideal way to distribute the software to the initial rider trainees all around Europe
  - the IRT eCoaching programme itself consist of two ”modes”: In a level-based mode the trainee completes a series of levels with randomly generated traffic situations with increasing difficulty. In the exercise-based mode the user can select an interesting aspect of riding, and the exercise then contains traffic situations related to this aspect. Before and after every level or exercise a briefing and debriefing is held.
  - Sun Microsystem's Java is assessed to be the most suitable implementation technology due to its suitability for web development, cross-platform support, capability tocope with complex projects and the wide range of premade APIs and integrated development environments available. The creation of dynamic models is most efficient with Mathwork's Matlab and Simulink software. JBoss Rules is a appropriate solution for creating the required rule bases.
  - The cost estimate for this project, executed as recommended in this document, is 1,512,000€.
- **IRT (2007) – Hazard perception, attitude and behaviour**
  - Motivations behind riding:
    - Hedonism
    - Escapism
    - Dynamic aspects of biking
    - Performance aspects of biking
    - Exhibition riding
    - Rivalry
    - Thrill and adventure seeking
    - Flow effects
    - Identifying with the bike

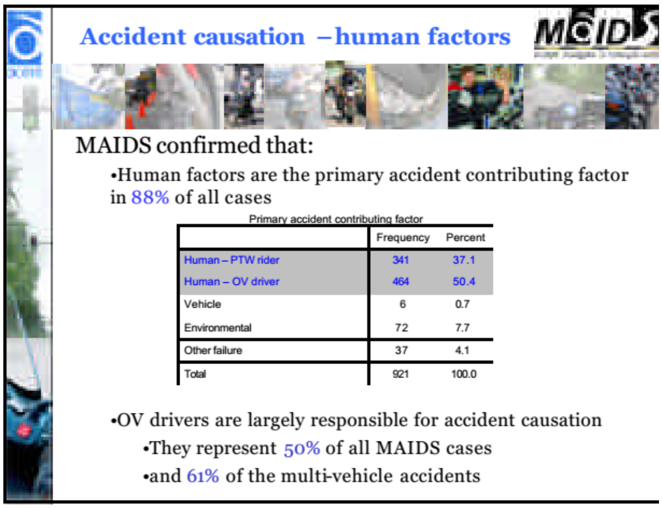
- Safety behavior
- Control beliefs
- Social aspects
- Economic aspects
- Independence
- Convenience

- These 12 motivational aspects can be further grouped into 3 broad categories:
  - Biking for pleasure
  - Biking as a fast competitive sport
  - Control over the motorbike
- Another classification could be made which grouped
  - *Those who use a motorcycle for practical reasons*: perceive the main advantage to be economical to run and convenient to use and park (most of female riders, tendency towards smaller bikes, short journeys); dislike the level of arousal generated by the course of riding and tendency towards being cautious in their approach to riding in terms of their handling and use of speed
  - *Those who were enthousiasts*: likely to be younger riders, using their bike for work and pleasure, and older riders, who had ridden a motorcycle for a long period of time and typically owned a car as an alternative mode of transport; found to accept the risk involved in riding, but unlike practical riders, tend to perceive it as a challenge rather than a deterrent; motivated by the excitement, exhilaration, and sense of freedom and control which they believed could not be obtained from driving a car; tend to be confident in their ability to handle the motorcycle correctly
  - *Those who are considered as irresponsible* and whose behavior is considered as immature and irresponsible by others: found to have a lack of awareness of the risk in motorcycling, were overconfident, and perceived themselves as 'invincible"; gaining attention, excitement and independence were cited as motivations to behave in such a manner; such riders were young, typically 17-18 years old;
- Age influence:
  - Younger riders were more influenced by riding pleasure, exhibition riding, and thrill seeking motives compared to older age groups;
- Influence by vehicle type:
  - Riders with specialized motorcycles (choppers, sport bikes, endures) were more motivated in driving for pleasure;
  - Riders of sport bikes were more influenced by dynamic aspects and exhibition motives

- Riders of sport bikes and endures were more influenced by performance aspects and thrill and adventure seeking

✓ The type of bike chosen by riders provides clear information on the bikers' motives, the experience they seek and their concept of riding (when they can choose the bike). On implication is that persuasive communications, tailored to the motivational requirements of the general rider of each motorcycle type, could be provided when buying a motorcycle in an attempt to encourage safe riding behaviour

- **MAIDS (2004) – The Initial Rider Training and MAIDS**

    - 

    - 

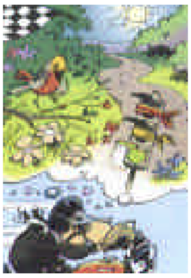
Accident causation – human factors

The most relevant secondary contributing factors are:

- Traffic-scan errors in:
  - 28% of cases for PTW riders
  - 63% of cases for OV drivers
- Faulty traffic strategies in:
  - 32% of cases for PTW riders
  - 41% of cases for OV drivers

Accident causation – human factors

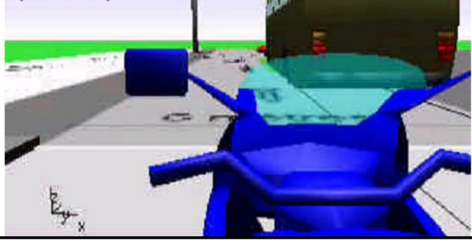
- Loss of concentration reduces the reaction time of the vehicle operator and thus reduces the amount of time available for collision avoidance



- Attention failure was present and contributed to accident causation in 11% of cases (PTW riders) and 18% (OV drivers)

Accident causation – human factors

- The neglect of the visual obstruction contributed to accident causation in 18% of cases (PTW riders) and 23% (OV drivers)



Selected results – human factors

- 5% of riders had no licence even though one was required
- 13% were found to have a licence, but for vehicles other than a PTW
- There were 104 accident cases in which a licence was not required to operate the vehicle involved in the accident.

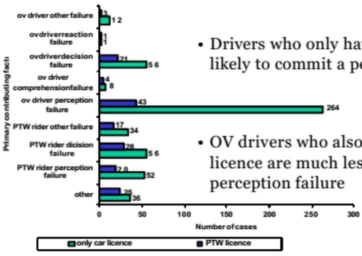
PTW licence qualification

	Accident data		Exposure data	
	Frequency	Percent	Frequency	Percent
None, but licence was required	47	5.1	13	1.4
Learner's permit only	4	0.4	1	0.1
PTW licence	608	66.0	697	75.6
Only licence for OVs other than PTW	125	13.6	125	13.5
Not required	104	11.3	86	9.3
Unknown	33	3.6	1	0.1
Total	921	100.0	923	100.0

The data clearly indicates that riders without licences are over-represented in the accident population

Selected results - human factors

Other Vehicle licence

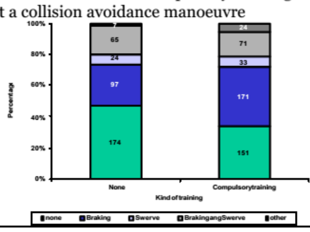


- Drivers who only have a car licence are likely to commit a perception failure
- OV drivers who also have a PTW licence are much less likely to commit a perception failure

Selected results - human factors

PTW collision avoidance manoeuvre by PTW training

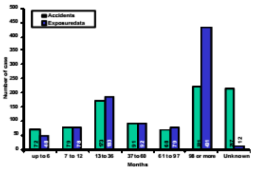
- 47% of the riders without any type of training failed to attempt a collision avoidance manoeuvre
- 33% of the riders who had compulsory training also failed to attempt a collision avoidance manoeuvre



Selected results - human factors

Experience on any PTW

- Riders who have less than 6 months experience on any PTW are more likely to be in an accident when compared to the riding population (8% of accident cases and 5% of exposure cases)



- Riders with a great experience on PTWs(i.e. over 98 months) are under represented (24% of accident cases and 47% of exposure cases)

Selected results - human factors

Alcohol and Drug

- Alcohol use by the PTW riders represents 4% of all cases
- 18 cases of alcohol use by the OV driver was reported (2%)

Alcohol/ drug use by PTW rider

	Accident data		Exposure data	
	Frequency	Percent	Frequency	Percent
None	853	92.6	902	97.8
Alcohol	36	3.9	14	1.5
Drug	5	0.5	2	0.2
Alcohol+drug	2	0.2	2	0.2
Unknown	25	2.7	3	0.3
Total	921	100.0	923	100.0

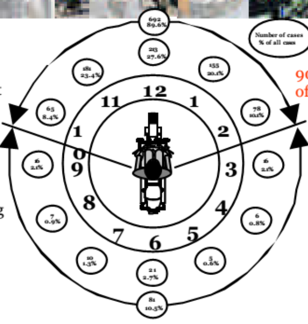
Note: drug use is defined as the use of illegal, non-prescription drugs (e.g., cocaine).

Alcohol/drug use by the OV driver

	Frequency	Percent
None	712	91.5
Alcohol	18	2.3
Drug	4	0.5
Unknown	44	5.7
Total	778	100.0

Selected results – collision dynamics

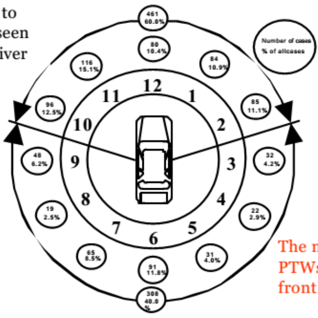
Line of sight to the OV as seen from the PTW rider at the time of the precipitating event



90% of OVs in front of the PTW rider

Selected results – collision dynamics

Line of sight to the PTW as seen by the OV driver



The majority of PTWs appears in front of the OV

Selected results – collision dynamics

Collision avoidance

- In almost one-third of all cases, the PTW rider did not attempt to perform any collision avoidance manoeuvre

Collision avoidance performed by PTW rider	Frequency	Percent
No collision avoidance attempted	362	26.9
Braking	664	49.3
Swerve	218	16.2
Accelerating	17	1.3
Use of horn, flashing headlamp	18	1.3
Drag feet, jump from PTW	9	0.7
Other	32	2.4
Unknown	26	1.9
Total	1346	100.0

Selected results – collision dynamics

Loss of control

- No loss of control reported in 68% of all cases
- loss of control was mostly related to braking 13% of all cases (41% of all cases involving loss of control).

Loss of control mode	Frequency	Percent
No loss of control	626	68.1
Capsize, or fall over	49	5.3
Braking slide-out, low side	94	10.2
Braking slide-out, high side	27	2.9
Cornering slide out, low side	27	2.9
Cornering slide out, high side	2	0.2
Ran wide on turn, ran off road, under cornering	45	4.9
Lost wheelie	1	0.1
Low speed wobble	4	0.4
High speed wobble	5	0.5
Weave, no pitch	1	0.1
Pitch weave, low speed	3	0.3
Pitch weave, high speed cornering	1	0.1
End-over, endo, reverse wheelie	6	0.7
Continuation, no control actions	7	0.8
Other	15	1.6
Unknown	8	0.9
Total	921	100.0

Selected results – collision dynamics

Loss of control Single accidents

- Running off the roadway was the most frequently reported loss of control mode: 34 cases, 23%

Loss of control mode	Frequency	Percent
No loss of control	25	17.2
Capsize, or fall over	15	10.3
Braking slide-out, low side	21	14.5
Braking slide-out, high side	4	2.8
Cornering slide out, low side	16	11.0
Cornering slide out, high side	2	1.4
Ran wide on turn, ran off road, under cornering	34	23.4
Lost wheelie	1	0.7
Low speed wobble	2	1.4
High speed wobble	3	2.1
Weave, no pitch	1	0.7
Pitch weave, low speed	2	1.4
Pitch weave, high speed cornering	1	0.7
End-over, endo, reverse wheelie	4	2.8
Continuation, no control actions	2	1.4
Other	8	5.5
Unknown	4	2.8
Total	145	100.0

Selected results – collision dynamics

Reason for failed collision avoidance action

- In 32% of the PTW cases and in 21.1 of the OV cases, there was failed collision avoidance due to inadequate time available to complete the collision avoidance action

Reason for failed collision avoidance	PTW rider		OV driver	
	Frequency	Percent	Frequency	Percent
Decision failure, wrong choice of evasive action	69	7.5	26	3.4
Reaction failure, poor execution of evasive action	41	4.5	9	1.2
Inadequate time available to complete avoidance action	297	32.2	164	21.1
Loss of control in attempting collision avoidance	129	14.0	3	0.4
Other	6	0.7	6	0.8
Not applicable, no OV or no evasive action taken	362	39.3	545	70.1
Unknown	17	1.8	25	3.2
Total	921	100.0	778	100.0

Environmental factors – Weather

- The weather conditions at the time of the accident were most frequently dry (90%)
- Rain at the time of the accident was noted in 8% of all cases

Weather conditions at time of accident

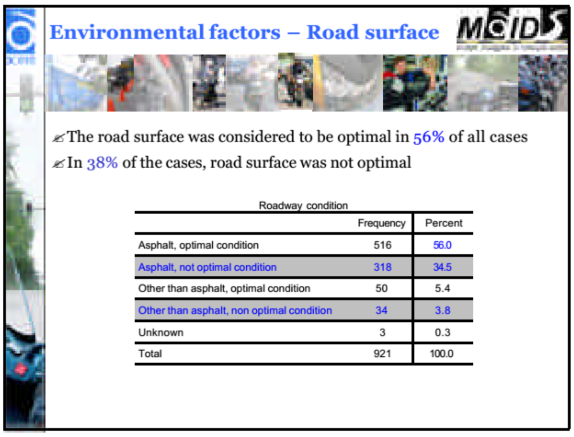
	Frequency	Percent
No precipitation	828	89.9
Rain	73	7.9
Ice rain/snow	2	0.2
Other	2	0.2
Unknown	16	1.8
Total	921	100.0

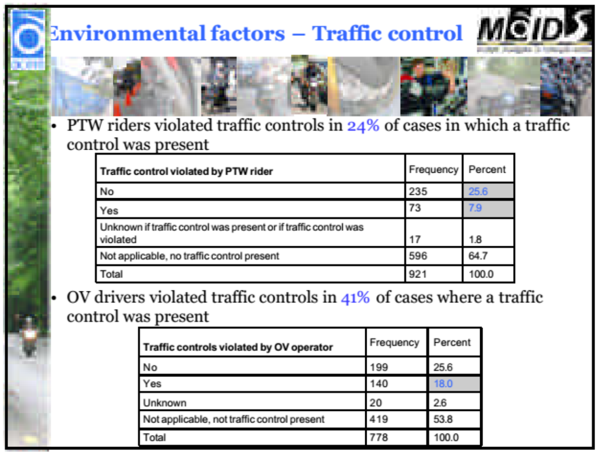
Environmental factors – Roadway contamination

- Dry and free of contamination in 85% of all accidents
- Wet in 8% of all collected cases
- Ice, snow and mud were in 5 cases
- Gravel or sand was reported in 23 cases, 2.5% of all cases
- Oil in 7 cases

Roadway contamination

	Frequency	Percent
Dry	780	84.7
Wet	73	7.9
Snow	2	0.2
Mud	3	0.3
Ice	5	0.5
Gravel sand	23	2.5
Oil	7	0.8
Other	26	2.9
Unknown	2	0.2
Total	921	100.0





- **PROMISING (2001) – Deliverable 3**
    - In most European countries mopeds now have a speed limit of 45 km/h and an engine of less than 50cc. The minimum age for riding a moped varies between 14 and 18 years. Some countries have special sub-categories of mopeds with lower speed limits
    - Many countries, but not all, require the passing of a special test. This is usually a theoretical and practical test, but some countries only have a theory test. Several countries allow riding a moped at a lower age after passing a test, resp. at a higher age without a test, or with a car or motorcycle license instead of a special test. Countries with low speed mopeds usually have a lower age limit for riding these mopeds and/or a simpler test or no test at all. Some countries allow riders of (slow) mopeds to use bicycle facilities; some countries do not allow passengers on mopeds; in some countries the wearing of a helmet is not compulsory for all moped riders.
    - Both mopeds and motorcycles have some special characteristics which directly or indirectly contribute to their relatively high number of accidents
        - They are **single track vehicles**, without a bodywork. The fact that they are single track vehicles means that the rider has difficulty controlling the vehicle, in particular when cornering or braking and even more so in emergency situations. Even though modern mopeds/motorcycles have good brakes and tyres, the control of the vehicle in all kinds of situations requires special training and experience. The single track character also implies that riders have more difficulty coping with imperfect road surfaces and obstacles on the road. This does not seem to be fully recognised by road authorities.
        - A **small frontal area** contributes to the problems of the perception of mopeds/motorcycles by other road users. Small numbers of mopeds/motorcycles on the road also contribute to this problem as does the behaviour of the riders insofar as it is different from car driver behaviour. Because of the small numbers, other road users may not realise that mopeds/motorcycles are relevant objects for them, i.e. they have to search for their presence and take action to avoid a collision. This means that riders of a moped/motorcycle need training and experience in recognising situations in which other road users may not react adequately to their presence.

- The **small size of a moped/motorcycle** and their **low weight in relation** to their engine performance provide opportunities to their riders for behavior which is different from car drivers. They can overtake where cars cannot, they can accelerate faster. Other road users may not expect this behavior and riders who behave like this will have to realise this and learn how other road users will (not) react to this.

All this serves to explain why **age and experience** are important for the safety of riding a moped or motorcycle.

- **Motivation** or the **style of riding** is important as well. Most riders will enjoy the direct sensation of speed (offered by the absence of a bodywork) and the control of the vehicle with the whole body. Other riders are more attracted to use a moped/motorcycle because of the opportunities to overtake, to accelerate and go fast. To a certain extent a rider will chose a moped/motorcycle model which reflects or actually allows the kind of behaviour to which the rider is attracted. This explains why a statistical relation may be found between moped/motorcycle characteristics and accident rate. But it is the rider motivation or riding style, rather than the vehicle characteristics which can explain this relation.
- The **absence of a bodywork** means that riders of a moped/motorcycle have little or no protection against collision impact. It is this same vehicle characteristic which adds to the sensation of (fast) riding, which is one of the attractions of riding a motorcycle.
- Training and experience of riders are important to control the moped/motorcycle in all kinds of situations, to cope with imperfect road surfaces and obstacles on the road, to recognise situations in which other road users may not react adequately to their presence and to learn the consequences of behaviour which is different from that of car drivers and how to cope with these consequences. This is all in addition to what all road users or car drivers have to learn about safe behaviour. In other words, learning to ride a motorcycle safely may take longer and to a certain extent is different from learning to drive a car. Since mopeds have a lower speed, this is only partly true for learning to ride a moped.

✓ From research into learning to ride a moped/motorcycle, there is no clear answer to such obvious questions as:

- What should a learner rider learn as a minimum to be able to safely ride a moped/motorcycle?
- How can this be learned effectively and efficiently, in how much time and in which sequence?
- In what way is learning to ride a moped different from learning to ride a motorcycle or is learning to ride a low performance motorcycle different from learning to ride a high performance one?

In fact 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.

- Legislation concerning mopeds and motorcycles shows differences in minimum age and training/testing requirements for different categories of moped and motorcycle. These differences seem to be based on the notion that riding a high performance motorcycle requires more maturity and more and special training; less maturity or less (special) training may be compensated by lower engine performance or speed. Apart from the recently introduced higher age limit for riding an unlimited motorcycle, the requirements for motorcyclists are roughly similar to those for car drivers. The same age limit applies to both cars and motorcycles and the duration and content of compulsory training programs and/or testing are roughly the same.
- The effects of this legislation have not been thoroughly evaluated. It is obvious, however, that legislation only gives minimal requirements and that training on a voluntary basis is highly desirable.
- Training programs should teach which actions and conditions are potentially dangerous.
- There is a special problem for other road users. This can only be partly solved by the use of daytime headlights by riders of mopeds/motorcycles. Another part of the problem is that other road users are not prepared to search for mopeds/motorcycles and to take action to avoid a collision. Car drivers have to be made aware of this and learn to change their behaviour for the safety of riders of mopeds/motorcycles.

- **ROSA (2011) – European Handbook - TRAINING**
  - Identified problems related to training:
    - Lack of training to ride a motorcycle
    - The motorcyclists´ awareness and education
    - First aid for motorcyclists
    - The other users´ awareness
  - Collected good practices include
    - Rider Skills Day: An initiative: http://www.bikesafe-london.co.uk/
    - The Motorcycle Training Programme: Jonah, B. A., Dawson, N. E., and Bragg, B. W. E. (1982) Are formally trained motorcyclists safer? Accident Analysis and Prevention, 14 (4), 247-255
    - Pre-licence Scooter Rider Scheme: http://www.northamptonshire.gov.uk/en/Pages/HomePage.aspx
    - Rules for motorcyclists: MUST/MUST NOT: http://www.direct.gov.uk/en/TravelAndTransport/Highwaycode/Motorcyclists/index.htm

        - Course for the “Born again or recycled bikers”: http://www.msa-ireland.com/courses.htm#bmwcourse
        - Riding courses at national level: http://www.enmotomasseguro.com/
        - Rider Training (Campaign, 2011-2012): http://www.motorcyclesafety.state.mn.us/latest/MMSCHomeSecondary.asp?cid=4&mid=384&scat=105
    - ✓ Project recommendations include
        - Training for those riders who obtained the license previously but they have not been riding for a long time is considered as a good practice which will help to refresh their memory and they can ride any type of motorcycle.

- **ROSA (2011) – European Handbook – HUMAN FACTOR**
    - Identified problems related to human factors:
        - Socio-demographic aspects of riders: age, gender and experience
            - The tendency of the young riders to violate the rules of safe riding and towards negligence of potential risk. The same way as the lack of superior cognitive skills for riding due to the lack of experience
        - Perception of riders/human errors
            - The tendency to ever-rate their own abilities and chances of positive outcomes due to the psychological construction of unrealistic optimism.
            - Low hazard perception skills to detect dangerous traffic situations and a lack of abilities to respond appropriately in the face of the hazard.
        - Riding/ Driving Attitudes and Patterns
            - Risky attitudes carried out by motorcyclists in group riding at weekends and holidays
            - Risky behaviour associated to personality features, sensation seeking, and risk-taking decisions of some riders
            - Attitudes and risky behaviours associated to riders with aggressive personality or anti-social features
        - Psycho-physiological state of the motorcyclist
            - The effects of fatigue on motorcyclists reaction time and decision making ability
            - Alcohol consumption in motorcycling rallies and weekends
        - Perception of drivers/human errors
            - Fail to detect the motorcycle by the other road users, despite its presence in the driver’s field of view, referred to this as the conspicuity hypothesis

- Attitudes and sociological consideration
  - The motorcyclist's image among the other road users

- Collected good practices include:
  - Graduated Licensing System for Motorcyclist (GLS)
  - European standard for initial training. Initial Rider Training programme (2007): http://www.initialridertraining.eu/
  - "Scootsafe" training: http://www.local-transportprojects.co.uk/files/BP1%20016%20ScootSafe%20Leeds%20%28v1%29.pdf
  - Norwegian Rider Training Curriculum
  - Take Control training: http://www.takecontroltraining.co.uk/
  - Best training methods for teaching hazard perception and responding by motorcyclists: http://www.monash.edu.au/muarc/reports/muarc236.pdf
  - Enhancing hazard avoidance in teen-novice riders: Vidotto, G.; Bastianelli, A.; Spoto, A. And Sergeys, F. (2011) *Enhancing hazard avoidance in teen-novice riders Accident Analysis and Prevention*, 43, Issue, 1, January 2011
  - Using a riding trainer as a tool to improve hazard perception and awareness in teenagers: http://host.uniroma3.it/riviste/ats/sixteenth%20issue/Vidotto%2051-60%20A.pdf
  - Advanced Rider training / Post Test training: http://www.cooperbiketraining.org.uk/news/articles/ukadvanced.htm
  - Rider Risk Reduction Course: http://www.devon.gov.uk/index/transport/roads/road_safety/biker_safety/rider_training/rider_risk_reduction_course.htm

- ✓ Project recommendations include:
  - The inclusion of modules aimed at promoting risk-aware and responsible riding would increase the potential effectiveness of the training
  - While more research is needed regarding hazard perception and responding by motorcycle riders, specific deficiencies in current training methods were identified and potential remedies suggested. In particular, there is potential to improve existing Training Range rider training through provision of written materials. PC-based part-task training appears to offer a cost-effective means of addressing hazard perception and responding training in the near term.

- **SAFETYNET (2008) –Learning, Testing and Licensing**
  - Given the characteristics of a PTW and their high accident rate, it is obvious that riders need a high level of competence both in terms of vehicle control and in terms of safe interaction with other road users.

- There is a recent review on licensing and training of motorcycle riders from Australia2. The review emphasises that there is no convincing evidence of the effect of licensing systems and very little of elements of such systems. The review presents an optimal motorcycle licensing and training model. The model is based on the concept of gaining experience in low risk situations before graduating to higher risk situations. According to the review this requires that potential riders should gain experience driving a car before they start learning to ride a motorcycle. The model specifies a learner stage, a provisional stage and a full license stage with both a minimum and maximum period for a learner license and a minimum period for holding a provisional license. Off road training and testing is needed to obtain a learner license aimed at acquiring skills for unsupervised riding. On road training and testing is needed for a provisional license aimed at improving ability to detect and respond to physical hazards as well as hazards associated with other road users. Both stages also have restrictions on power to weight ratio of the motorcycle, on carrying of passengers and a zero alcohol level. Fully licensed riders are retested on road each ten years. The Australian review does not address the licensing of moped riders or the voluntary advanced training of fully licensed riders.
- **Hazard perception and responding**: According to the Australian review the present tests and training programs do not adequately address rider motivation and riding style or hazard perception and responding. A traffic hazard is an element of a traffic situation with the potential of initiating an accident and therefore requiring special attention. It may be related to the road (a change in road surface, a curve) or related to the presence and behaviour of other road users. Hazard perception and responding is the behaviour in between normal and timely actions (to avoid a situation with little or no time to avoid an accident) and emergency actions (with little or no time left)
- Haworth et. al.[3] argue that hazard perception in relation to motorcycling is different because motorcyclists have to deal with additional hazards which are road based as well as related to the behaviour of other road users in the presence of a motorcycle. Responding to a hazard is also more crucial because other road users may not respond to the motorcyclist and controlling the motorcycle trying to avoid the risky situation is difficult. The subject of hazard perception and responding is complicated because whether the situation becomes risky also depends on the behaviour of the rider. Motorcyclists may start actions like overtaking and accepting small gaps in situations where car drivers would not do so.
- **Voluntary, advanced training programs**: many private organisations offer voluntary, advanced training programs. Their aim may differ e.g. improving the detection and avoidance of (potential) emergency situations or improving vehicle control in difficult situations. The effects will depend on the motivation of the participants. With riders who are safety minded these programs can be expected to improve their behaviour and prevent accidents. With performance-oriented riders the result may be the opposite.

[2] http://erso.swov.nl/knowledge/content/45_poweredtwowheelers/references.htm#ref_22_Haworth_2005_review
[3] http://erso.swov.nl/knowledge/content/45_poweredtwowheelers/references.htm#ref_23_Haworth_2005_hazard

- **SARTRE 4**
  - The percentage of motorcyclists that completed advanced motorcycle courses differed greatly from one country to another. In the entire sample only a minority of 23% reported having completed such a course, but this figure ranged from only 6% in Serbia to 55% in Sweden. Figure 3 gives the results for all participating countries.

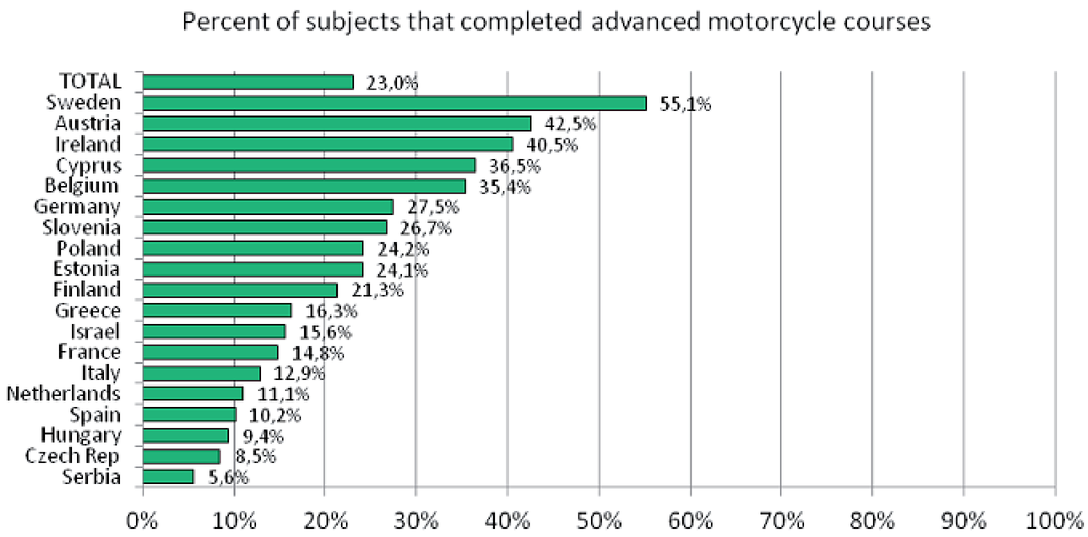
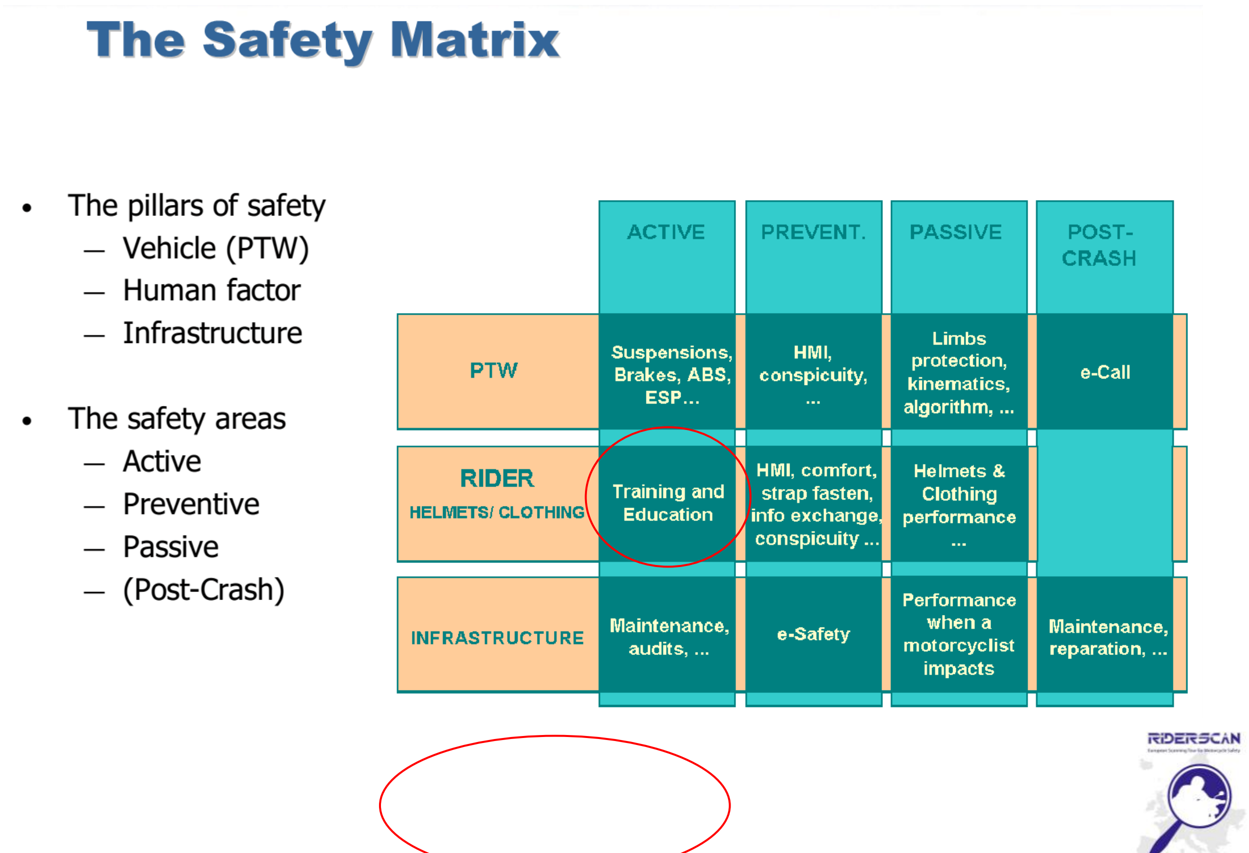


Figure 3: Percentage of motorcyclists that completed advanced motorcycle courses.

  - Little impact of advanced courses on risky behaviour. To analyse the specific characteristics of the motorcyclists that decide to take advanced courses as well.

- **SIM (2009) – In-Depth Accident Analysis**
  - Training/Education = active safety => Avoiding accidents



- o Analyses comprises 1093 in-depth accident cases (> APROSYS SP4 – Accident databases from The Netherlands/Italy/Spain/Germany):
  - 7 main accident scenarios:

Urban Area	Non Urban area
Moped against car at intersections	
Moped against car on straight roads	
Motorcycle against car at intersections	Motorcycle against car at intersections
Motorcycle against car on straight roads	Motorcycle against car on straight roads
	Motorcycle single vehicle accidents

  - Accident avoidance manoeuvres identifiable in 70% of the cases
  - Emergency manoeuvres consisted mostly in full-breaking, partly swerving and/or braking
  - High percentage of "loss of control" before impact
  - Most of the accidents are influenced by human behaviour both of PTW rider and OV driver (inattention, perception failure, traffic scan error, faulty traffic strategies)

- **SUNFLOWER (2005) – Final report**
  - ✓ encourage further effort to educate motorcyclists about risks and teach them effective strategies for riding more safely, noting particularly the safety issues associated with older drivers taking up motorcycling either for the first time or after a long break.

- **SUPREME (2007) – Best practice Handbook**
  - o Driver training is an important tool for preparing people to drive safely and for raising awareness of the risks of driving motorised vehicles. Whereas minimum requirements for the driving test are already laid down in EU Directives, driver training itself has not yet been addressed by European-level regulations and hence remains the full responsibility of individual countries.
  - o For driver education it is important for learner drivers not only to learn to master their vehicle, and to be familiar with traffic regulations, but also that to learn to assess risks and risk-increasing factors in road traffic as well as to be a good judge of their own skills and limitations. This is reflected in the GDE matrix (Goals for Driver Education) that was applied in the EU-project GADGET[4]

[4] Hatakka, Keskinen, Glad, Gregersen & Hernetkoski, 2002 - See also http://ec.europa.eu/transport/road_safety/pdf/projects/gadget.pdf

	GDE matrix: essential elements of driver training		
	Knowledge & Skills	**Risk-increasing factors**	**Self-evaluation**
IV. Goals for life and skills for living	Lifestyle, age, group, culture, social position, etc. vs. driving behaviour	– Sensation-seeking – Risk-acceptance – Group norms – Peer pressure	– Introspective competence – Own preconditions – Impulse control
III. Goals and context of driving	– Modal choice – Choice of time – Role of motives – Route planning	– Alcohol, fatigue – Low friction – Rush hours – Young passengers	– Own motives influencing choices – Self-critical thinking
II. Mastery of traffic situations	– Traffic rules – Co-operation – Hazard perception – Automatization	– Disobeying rules – Following too closely – Low friction – Vulnerable road users	– Calibration of driving skills – Own driving style
I. Vehicle manoeuvring	– Car functioning – Protection systems – Vehicle control – Physical laws	– No seatbelts – Breakdown of vehicle systems – Worn-out tyres	Calibration of car-control skills

- **TRAIN-ALL (2008) – D1.1**
  - The prevalence of traffic-scanning errors in motorcyclists is typically high (Sagberg 2002). Furthermore riders typically have no experience of using safety equipment (i.e. ABS and ASR) and little experience of driving different types of motorcycles
  - Twelve out of 20 training tools had a car as a simulated ego-vehicle. Four simulators could additionally simulate emergency driving conditions to normal car driving conditions. A total of five simulators could use busses as their ego-vehicle (one simulator only used busses as an ego-vehicle) whilst another nine could simulate a truck as the ego-vehicle. No simulators reported using motorcycles as ego-vehicle
- **TRAIN-ALL (2008) – D1.2**
  - Although motor driving differs from car driving, there is a big congruence between the training needs for novice motorcycle drivers and the training needs for novice car drivers. Nevertheless motorcycle drivers experience some other risks than car drivers. The following types of hazards for motorcyclists have been identified:
    - Road-based hazards:
      - permanent characteristics of the road surface,
      - temporary characteristics of the road surface,
      - visual obstructions,
      - characteristics of the road alignment,
      - the extent to which it obscures the presence of the motorcyclists and other road users,
      - the extent to which it affects the dynamics of the motorcycle and hence its travel path,

- Roadside hazards such as street furniture;
- Hazards arising from other road users:
  - failure to give way,
  - sensation seeking (speed).

- From the GADGET-Matrix, and the limited research literature on rider training, three main axes for PTW rider training can be discerned (excluding the Highway Code):
  - Initial skills training (manoeuvring level or operational level): mastering of the motorbike. This includes equilibrium control at low speed as well as control of the dynamics of the motorbike for breaking and avoidance manoeuvres;
  - Mastering of interactions with other road users (cognitive level or tactical level). This includes recognition of road situations and anticipation of their dynamics. Here, it is very important to train the riders to understand and predict the behaviour of pedestrians, car drivers and other road users;
  - Risk avoidance training. This includes training to develop self-awareness of contributing factors, such as inattention or distraction that interfere with an avoidance response to a precipitating event. This also includes training to develop self awareness of riders regarding their own competencies, behaviour and judgmental tendencies and those of other road users.

Knowledge and skills concerning	Risks connected with	Self-evaluation
Steering/ lane following Steering and lane following needs to be trained with both car drivers and motorcyclists. Both groups have to train steering in curves and both groups should internalize that both hands are needed for steering properly.	Insufficient skills and incompletely automation As explained above, the understanding for a certain driving speed is important.	Realistic self-evaluation After each training session the trainee's performance must be discussed. The discussion should include a trainee's rating of his performance and a realistic rating by a driving instructor and/or by the simulator training result. This should lead to a realistic self-evaluation of the trainee.
Speed control Both groups need to experience the effects of speeding. This will hopefully lead to understanding and keeping speed limits.		

Table 1:Knowledge and skills regarding the GADGET-Matrix concerning the control tasks –

"Motorcycle mastering": Accidents and training needs related to the dimension "control tasks"[5]

Traffic conditions	Roadway characteristics	Environment
Following (distance keeping) The trainee needs to train distance keeping and distance estimating. However, the effects of failure of distance keeping should be shown.	Negotiating intersections, junctions and roundabouts Behaviour at junctions should be trained. Interaction with others would also be covered. Road surface and obstructions (skid control, obstacle avoidance) Different road surfaces are important for motorcyclists and play a major role in on-road training. Thus, it should also be regarded in simulator training. Approach/ exit of motorways See Entering and leaving traffic. Reacting to traffic signs and traffic lights Failure of reacting to signs can cause accidents. Proper behaviour on traffic lights should be trained.	Weather conditions (fog, rain, snow) Driving under different weather conditions should be trained because some conditions cannot be trained in on-road training.
Overtaking Safe overtaking needs to be included in training. Entering and leaving the traffic Entering (e.g. on a motorway or after parking) and leaving (e.g. on a motorway or for parking) the traffic should be included in simulator training even though it was not proven to be a major accident factor.		Night driving Night driving is an accident risk due to the lack of visibility.
Lane changing Since overtaking and lane changing often happen on motorways, they are combined with high speeds. Due to this combination of three accident factors, all of them should be trained.		
Reacting to other vehicles (cars, bicycles) Since there is always interaction with other vehicles, this should be trained. It is important to keep in mind that other traffic participants might make mistakes, too, and thus, attention should be high.	Urban driving Since motorcyclists tend to have most accidents in urban driving, simulator training should cover this.	
Reacting to pedestrians Pedestrians are vulnerable and, thus, accidents involving pedestrians often end more tragic. Thus, attention with pedestrians should be extra-high.	Country road driving Country road driving needs to be covered for car drivers. However, since serious motorcycle accidents seem to happen on country roads, motorcyclists need to be trained on country roads in simulators as well.	
Parking Although parking is no accident factor, it should be trained, since being able to park fast and well is quite convenient.	Motorway driving Motorway driving needs to be trained due to the high speed driven.	

Table 2:Knowledge and skills regarding the GADGET-Matrix concerning the manoeuvring tasks –

[5] DRIVABILITY: a new concept for modelling driving performance
Revue Cognition, Technology & Work, Éditeur Springer London
ISSN 1435-5558 (Print) 1435-5566 (Online) Numéro Volume 5, Number 2/ juin 2003

“Traffic interactions mastering”: Accidents Training needs related to the dimension “manoeuvring tasks”[6]

Risks connected with	Self-evaluation
Information overload/ Not realistic self-estimation. Situations with information overload needs to be trained and a realistic self-estimation.	Realistic self-evaluation After each training session the trainee’s performance must be discussed. The discussion should include a trainee’s rating of his performance and a realistic rating by a driving instructor and/or by the simulator training result, self knowledge regarding own competencies, behaviour and judgmental tendencies, knowledge regarding other road users competencies, behaviour and judgmental tendencies and also the Highway Code. This should lead to a realistic self-evaluation of the trainee.
Drivers condition (stress, mood, fatigue) Driving under conditions like stress, mood or fatigue should be simulated to raise the understanding of not driving when being in one of these conditions. The trainee needs to train under these conditions. Novice drivers should also train environmentally friendly riding (which is closely linked with anticipation and with economical driving) and preparation for the journey (package etc.).	
Consequences of social pressure, use of alcohol and drugs Driving under the influence of alcohol should be simulated to show the effects of it.	

Table 3:Risks connected with the strategic tasks and behavioural aspects

- Riding simulators are new tools (always topics of research), which are important to new candidates for riding training. Depending on the objectives of the training (operational, cognitive, risk avoidance), the tools have to fit some requirements:
  - For training of mastering skills, they have to render (i.e., simulate), at least partially, the dynamics of a motorbike. The expected gains by using riding simulators are reduction of injuries during training, reduction of cost and safe exposure to dangerous events. The limit here is that the motion rendering for riding simulators is still a topic of research; getting the right “feeling” is difficult.
  - For training of cognitive skills, rendering of the dynamics of the motorbike is not so critical, but the lack of motion (or the reduced motion) should not to perturb the riders' behaviour. The behaviour of other road users, which are simulated, has to be coherent and “realistic” to ensure immersion in the virtual world and acceptable to the rider (the training session has to be experienced as an actual situation and not as a game situation). The expected gains are the increase in the number of risky road situations the trainee can safely manage and a reduction in the cost of the training. A limitation is the number of risk exposures it is possible to produce in a limited time, as too high a frequency for the same simulated journey leads to an unrealistic driving situation which is probably inefficient in terms of training.

[6] Ibid

- **TRAINER (2003) – Delivrable 1.2**
  - In overview, the descriptions of the training possibilities in the different countries lead to the extraction of six different training models.
    - Model 1 Theory and practical training at a driving school is compulsory
    - Model 2 Theory and practical training possible at a driving school, without obligations
    - Model 3 Theory and practical training must begin at a driving school, followed by training with a non-professional supervisor
    - Model 4 Theory and practical training must begin at a driving school, followed by training with a non-professional supervisor; obligation to report regularly to the driving school
    - Model 5 Training with a non-professional supervisor, without the involvement of a driving school
    - Model 6 Training at a driving school or with a non-professional supervisor, followed by a non-accompanied internship

Country	Training Model 1	Training Model 2	Training Model 3	Training Model 4	Training Model 5	Training Model 6
A	x		x	x		
ALG	x		x			
B					x	x
BUL	x					
CH	x		x			
D	x					
DK	x					
E		x			x	
EST	x			x		
F				x		
FIN	x				x	
GB		x			x	
H	x					
HR	x					
IL			x			
L	x		x			
LV	x				x	
MC		x				
N	x		x			
NI		x			x	
NL		x				
P	x					
RUS		x			x	
S		x			x	
TUN		x				

  - Tasks requiring further training for which simulator is proposed to be used:

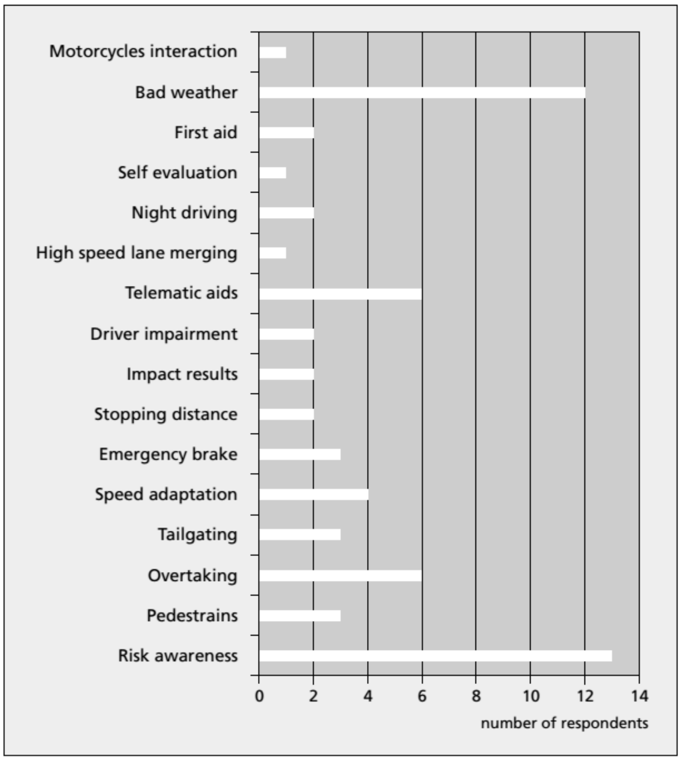


Figure 3 Tasks requiring further training, for which simulator is proposed to be used (cont.)

3.2.2 Average number of hours spent on theory training per item

Country	Traffic regulations	The Driver	The Road	Behaviour towards others	Documents	Vehicle equipment	Vehicle technique	Environment friendly driving	Drugs, medicine, alcohol	First aid	Emergency handling	Loading	Bad weather conditions
A	4	2	4	4	1	1	4	2	2		1	3	2
ALG													
B													
CH		*100	*100	*100		*100	*100	*100	*100	10		*100	*100
D	9	1.5	1	3	1	1.5	2	1	2		1	1.5	1.5
DK													
E													
EST	12	7	4	4	1	1	3	2	1		2	1	2
F													
FIN	5	1	2	2	1	1	1	1	1	1	1	1	2
GB													
GR	2		3	2.5	0.5	2	5	0.5	1	1	1.5		1
H	10	2	2	3	0.5	2	4	1	0.5	0.5	0.5		1
HR	11	1	2	4		1	1	3	1	1	1	1	2
IL													
LV	44	1	1	1.5	0.5	0.5	0.5	0.5	0.5	15	0.5	0.5	1
MAR													
N													
NI													
P	*100	*100	*100	*100	*100			*100	*100			*100	*100
TUN													

*100 means that the subject is treated on a compulsory base, but that the exact number of hours spent on this subject is not known

3.2.5 Average number of hours spent in different traffic areas during practical training

Country	Residential areas	Inside built-up areas	Outside built-up areas	Motorways	Other locations
A					
ALG		5	5		*100
B					
CH		*100	*100	*100	*100
D	4	10	6	4	3
DK					
E					
EST	5	10	6		
F					
FIN	6	6	1	4	4
GB					
GR	6	6		3	
H	1	13	4	*100	
HR	4	10	4	2	2
IL		*100	*100	*100	
LV		13	3		
MAR					
N	*100	*100	*100	*100	*100
NI					
P	*100	*100	*100	*100	*100
TUN					

3.2.4 Compulsory number of hours spent in different traffic areas during practical training

Country	Residential areas	Inside built-up areas	Outside built-up areas	Motorways	Other locations
A					
ALG		5	5		*100
B					
CH					
D	4	10	5	4	3
DK					
E					
EST	3	8	4		
F					
FIN				4	
GB					
GR	6	6		3	
H	1	13	4	*100	
HR	4	10	4	2	2
IL		*100	*100	*100	
LV		4.5	2		
MAR					
N	*100	*100	*100	*100	*100
NI					
P	*100	*100	*100	*100	*100
TUN					

*100 means that the subject is treated on a compulsory base, but that the exact number of hours spent on this subject is not known

3.2.8 Wishes of the driving examiners concerning the practical training

Country	Wishes and Remarks
A	
ALG	
B	A basic practical training should be compulsory
CH	Training should be spread over a longer period
D	Second training phase within current training
DK	
E	Driving training on toll-highways is hindered
EST	
F	Focus is too much on passing the driving exam
FIN	
GB	
GR	Focus is too much on passing the driving exam
H	
HR	Gross training should last 60' instead of 45'
IL	
LV	
MAR	
N	
NI	
P	Lack of defensive driving training
TUN	Trainee follow-up document feasibility study

-

3.2.3 Wishes of the driving examiners concerning the theory training

Country	Wishes and Remarks on theory training
A	
ALG	
B	Theory training should be compulsory
CH	Theory training should be more connected to practical training
D	Total amount of hours should be prescribed, not the contents
DK	Theory training should be more connected to practical training
E	A minimum compulsory theory training is planned
EST	
F	Theory training is too commercial with too little content
FIN	
GB	
GR	
H	
HR	Increase the educational level of the teacher
IL	
LV	
MAR	No national training programme, low level of trainers
N	
NI	99% of the candidates are satisfied
P	Driving schools lack quality training programmes
TUN	Modification of exam support and content is planned

- **TRAINER (2003) – Delivrable 2.1**
    - A general conclusion is that future driver training should take into account or intensify training of perceptual and cognitive skills, i.e. scanning skills, and hazard detection. With regard to the GADGET matrix, the driving task should be understood as a task involving also decisional and motivational aspects.
    - Novice drivers can have superior maneuvering skills and still have many crashes. Teaching scanning and anticipating as well as self-evaluation skills appear to be promising ways to reduce accidents rates for novice drivers.

D2: Data collection and statistics

Project/website	Ending date	Final report	Relevant Deliverables
2-BE-SAFE	1/09/2011	http://www.2besafe.eu/sites/default/files/deliverables/2BES_D35_FinalReport.pdf	• 1.1 Rider/Driver behaviours and Road safety for PTW • 1.3 Weather conditions and road safety for PTWs
APROSYS	1/12/2009	http://www.transport-research.info/Upload/Documents/201203/20120313_143223_50861_Final%20APROSYS%20Report.pdf	• Motorcyclists: Accident National Data
DaCoTA	30/06/2012	http://www.dacota-project.eu/Deliverables/DaCoTA_Final_Report.pdf	• Motorcycle & Mopeds (Basic Fact Sheet 2012) • Powered Two Wheeler report (ERSO)
eSum	30/11/2010	-	• MAIDS data on urban accidents • Diagnosis of urban motorcycling safety
MAIDS	1/12/2002		• Final report : http://www.fema-online.eu/riderscan/IMG/pdf/maids2-2.pdf
PISA	30/11/2009	-	• D02 - PISa - FINAL - Powered two wheeler Integrated Safety Review of current PTW accident data-04072007.pdf
PROMISING	1/01/2001	http://www.transport-research.info/Upload/Docume	• Deliverable 3

		nts/200310/promisingrep.pdf	
SAFERWHEEL		ongoing	
SAFETYNET	1/12/2008	http://erso.swov.nl/knowledge/Fixed/45_PoweredTwoWheelers/powered%20two%20wheelers.pdf	• Safety of PTWs • Accident characteristics • In-depth studies
SARTRE 1-4		http://www.attitudes-roadsafety.eu/index.php?eID=tx_nawsecuredl&u=0&file=fileadmin/Results/SARTRE%203%20results/S3_reports/Part%201_Report%20on%20principal%20results.pdf&t=1426947005&hash=37ce58463fddcf23253e64977ec9e93f	• SARTRE 3 Principal results (p.249) • Sartre 4 - European road users' risk perception and mobility
SIM	31/08/2009		• In-depth Accident analysis
Smart RRS	1/12/2011		• D.2.1a – Report on revision of regulation UNE135900
STAIRS	31/12/1998		• Article
SUNFLOWER +6	1/12/2005	http://www.20splentyforus.co.uk/UsefulReports/SUNflower%2B6_Final_Report.pdf	• Final report (pp.307, 323 on)
TRACE	30/06/2008		• D1.3. Road Users and Accident Causation - Part 3: summary report • D1.1 Road users and accident causation - Overview and General Statistics • D1.2 Road users and accident causation - in-depth analysis • D2.1 Accident causation and pre-accidental driving situations.Part 1. Overview and general statistics • D2.2. Accident causation and pre-accidental driving situations Part2 In-depth analysis • D2.3. Accident causation and pre-accidental driving

			situations - Summary report
VRUITS	ongoing		• Deliverable 2.1 Technology potential of ITS addressing the needs of Vulnerable Road Users

- **2-BE-SAFE – Deliverable 1.1**
  - PTW accidents present several complex interactions with the manner riders or drivers behave on the road system. These interactions are magnified in certain accident configurations, such as accidents at intersection and accidents during an overtaking manoeuvre, right of way violations (ROWVs) most frequently caused by a party other than the motorcyclist, loss of control, speeding, influencing greatly the severity of PTW injuries
  - From the extensive analysis of the literature concerning the interactions of drive/rider behaviour with the PTW accidents, several critical factors have emerged:
    - Riding/Driving Attitudes and Patterns (such as sensation seeking, risk taking, speeding and so on)
    - Age, Gender and experience
    - Licensing, Education and Training
    - Type of PTW (relate to the power engine, type of use, tampered PTW)
    - Perception of drivers/riders and human errors (from the point of view of the PTW or the passenger car)
    - Collision type (rural or urban, PTW single accident or more than one vehicle accidents, more than one, front side crash, side-side and so on)
    - Conspicuity, perception of drivers for motorcycles.
    - Alcohol and other impairments (medical prescriptions, drugs, fatigue and so on)
    - Personal Protective Equipment (Helmet protection and other PTW apparel)

- PTW accidents are issues for all countries and distinguishing mopeds and motorcycles, the first national statistics on the five 2BESAFE countries [Italy, Greece, Finland, The United Kingdom and France] enable the identification of 9 accident scenarios:
  - Scenario 1: Moped / passenger car accident – Inside urban area – No intersection,
  - Scenario 2: Moped / passenger car accident – Inside urban area – Intersection,
  - Scenario 3: Single motorcycle accident – Outside urban area – No intersection,
  - Scenario 4: Single motorcycle accident – Inside urban area – No intersection,
  - Scenario 5: Single motorcycle accident – Inside urban area –Intersection,
  - Scenario 6: Motorcycle / passenger car accident – Outside urban area – No intersection,
  - Scenario 7: Motorcycle / passenger car accident – Inside urban area – No intersection,
  - Scenario 8: Motorcycle / passenger car accident – Inside urban area – Intersection,
  - Scenario 9: Motorcycle / passenger car accident – Outside urban area – Intersection.

- **2-BE-SAFE – Deliverable 1.3**
  - It was found that:
    - On sunny weekend days, eight times more motorcycle accidents happen than on rainy weekend days.
    - On sunny workdays, five times more motorcycle accidents happen than on rainy workdays.
    - On sunny days, six times more motorcycle accidents happen than on rainy days.
  - It was also found that there are different characteristics in terms of accident types and crash severity depending on rain likeability.
  - Finally, it was approved that controlling for precipitation as a moderating factor of annual crash records is reliably possible. About 70% of the variation of motorcycle rider injuries and about 40% of the variation of fatalities can be attributed to variation of weather conditions. In total, predicting the number of motorcycle rider injuries based on the weather characteristics of this particular year, average weather conditions and the relation between weather and accidents is possible with an error less than 3%

  Recommendation:

  ✓ Research in the relation between weather and accidents should be continued by including more data to be able to consider additional factors. Mobility data is needed to separate impact of exposure, intrinsic risk and compensatory behaviour of riders

- **APROSYS**
  - The APROSYS project analysed national accident databases from Germany, Italy, The Netherlands and Spain.
  - In Italy, the most common scenarios of accident for mopeds are (1) an accident again a car in urban area on a straight road, (2) an accident again a car in urban area at an intersection and

(3) an accident again a car in non-urban area on a straight road. For motorcycles, the most common scenarios of accident are (1) an accident again a car in urban area at an intersection, (2) an accident again a car in urban area on a straight road, (3) an accident again a car in non-urban area on a straight road, and (4) an accident again a car in non-urban area at an intersection.

- In the Netherlands, almost 50% of the moped victims in urban area are at age 14-18 and do not use a helmet. The majority of accidents occur during evening rush hour, occur on dry and clean roads, and occur on straights and intersections. The majority of accidents have a car as opponent. Good weather means large amount of accidents, due to large amount of PTW's on the road. Inside urban areas most accidents with an opponent occur at intersections. Outside urban areas most accident with an opponent occurs on straights. Outside the urban area most single accidents with motorcycles occur in curves. Outside the urban area most single accidents with mopeds occur on straights. In a quarter of the run-off-road accidents a pole / tree is hit.
- In Spain, in urban area, the most common case of accident for mopeds is an accident against a car at an intersection (1000 cases approx.). The second most common scenario is a moped running off the road in a straight road and hitting a tree, a ditch or no object (40 cases approx.). In urban area, the most common case of accident for motorcyclists is an accident against a car at an intersection (300 cases approx.). Only 10 cases are related to a motorcycle running off the road. In non-urban area, the most common case of accident for mopeds is an accident against a car at an intersection or at straight road (375 cases approx.). Mopeds running off the road on straight road and on curves represent approximately 100 cases. In non-urban area, the most common case of accident for motorcyclists is an accident against a car at an intersection, at curve or at straight road (200 cases approx.). Motorcycles running off the road on curves represent approximately 120 cases.

- **DaCoTA (2012) – Motorcycle & Mopeds, Basic fact sheet**
  - PTW use in Europe: Southern European countries (Greece, Italy and Spain) have in general high ownership rates for motorcycles and even higher for mopeds (Figure 1). Greece is at the top with 136 mopeds and 126 motorcycles per 1000 inhabitants. Figures for Finland lie between those for southern and other countries with a rate of 49 for mopeds and 41 for motorcycles. For the other

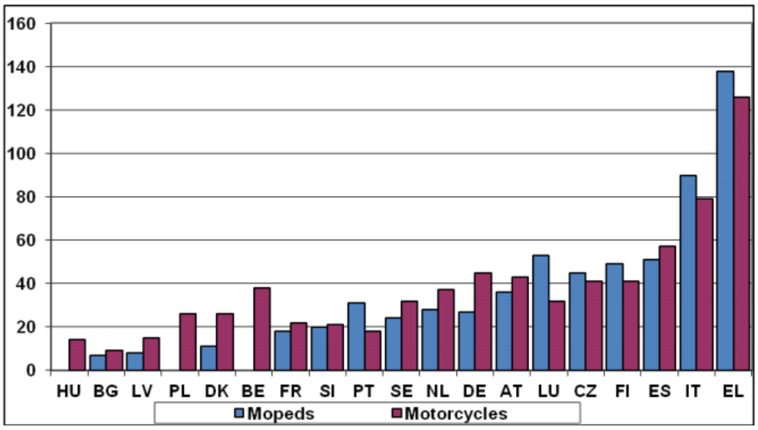
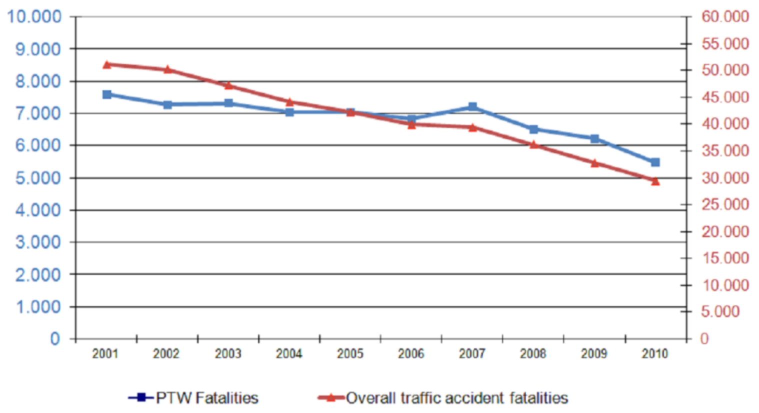


Figure 1 Rate of PTWs per 1000 inhabitants, 2009. Countries ordered by the total PTW use. Source: CARE Database / EC

countries the rates are between 7 and 53 for mopeds (with Luxembourg highest at 53 and Bulgaria lowest at 7) and between 14 and 45 for motorcycles (with Germany and Austria higher at 45 and 43 respectively and Bulgaria and Hungary lower with 9 and 14)

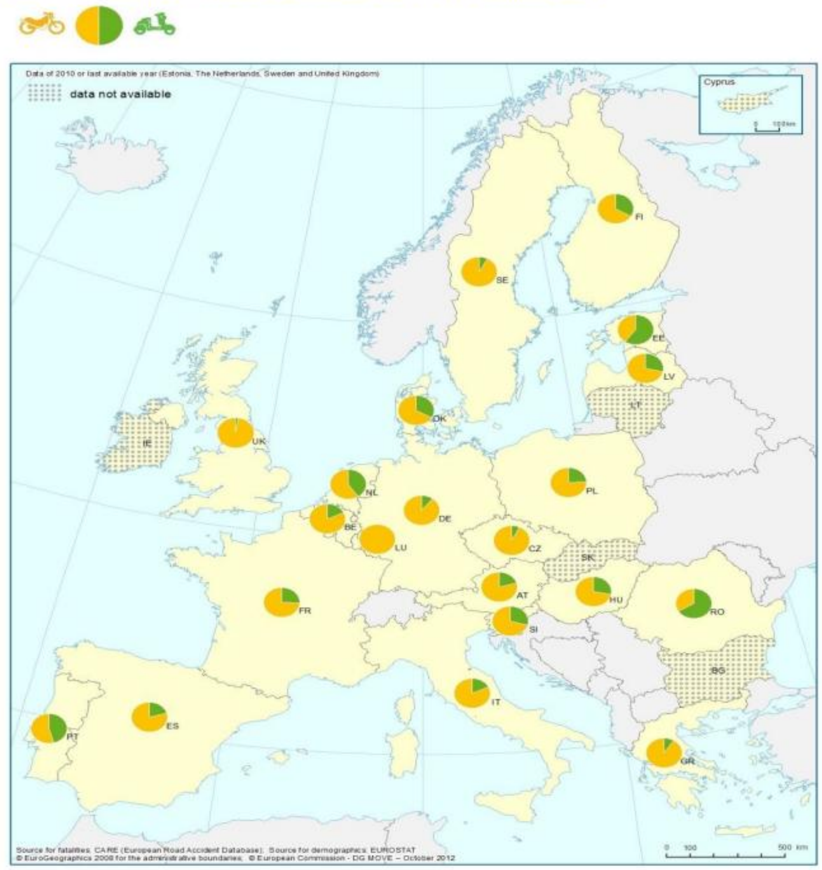
- There have been remarkable changes in recent decades. In southern countries the rate of mopeds per 1000 inhabitants increased relatively slowly over the last 20 years with the exception of Portugal which showed a decrease over the last 10 years. Most western and northern countries saw a marked decrease between 1980 and 1995, followed by a relatively stable period.
- The trends for motorcycles are quite different. Almost all countries experienced an increase in motorcycle ownership rates between 1990 and 1995, some with a marked increase (e.g. Austria, Germany and Greece), and some less so (e.g. France and Portugal). In contrast the available information from middle European countries indicates a continuing downward trend in motorcycle ownership rates. Information on ownership per age group per country is not generally available, but it is likely that the age distribution of moped and motorcycle owners varies between countries
- Motorcycle and moped fatalities, together referred to as Powered Two Wheelers (PTW), accounted for 15% of the total number of road accident fatalities in 2010 in the EU-24 countries.
- The annual total decreased by more than 51% during the decade for these countries, an average of more than 7% per year
- As there is no reliable data available about the exposure of PTWs (vehicle kilometres or fleet numbers) in each of the above countries, it is difficult to interpret the numbers of fatalities in the group of PTW or the difference in the distribution over mopeds and motorcycles.

Figure 1: Distribution of road traffic fatalities in the EU-20[1] 2001-2010[2]



Source: CARE Database / EC
Date of query: September 2012

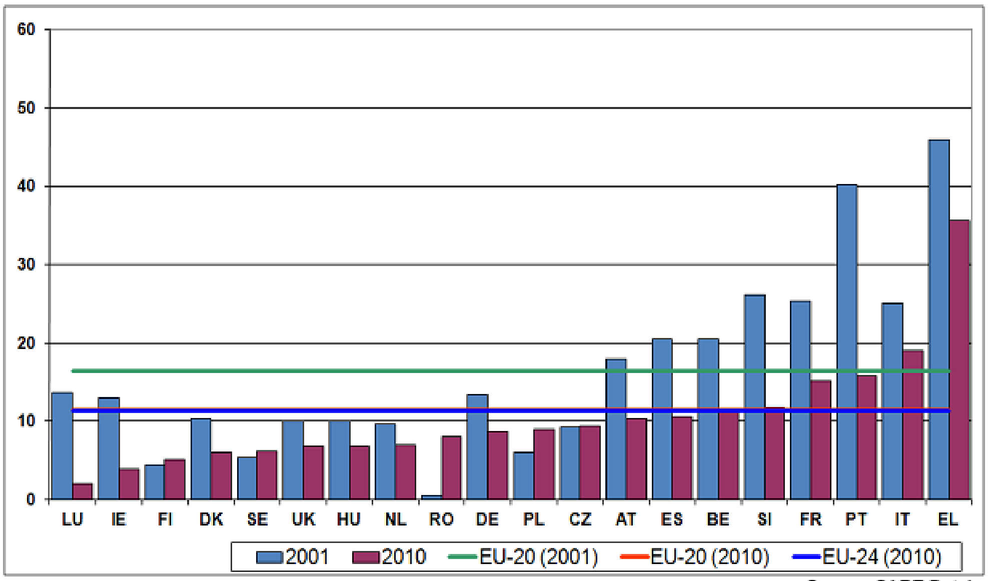
Map 1: Percentage of mopeds and motorcycles in PTW fatalities, 2010[2]



Source: CARE Database / EC

- the fatality rate of motorcycle and moped riders, which is defined as the number of PTW rider fatalities per million inhabitants, is much higher in Southern European countries like Greece, Italy and Portugal than in the other countries.

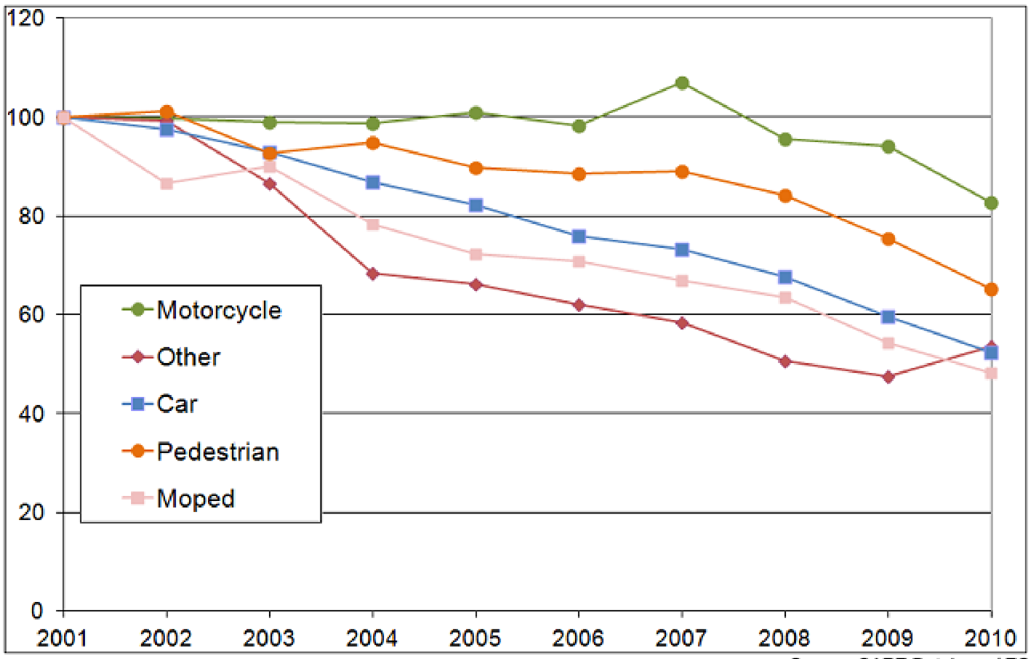
Figure 2: Motorcycle and moped rider fatalities per million inhabitants, 2001 versus 2010[2]



Source: CARE Database / EC
Date of query September 2012
Source of population data: Eurostat

- Between 2001 and 2010 the fatality rate of PTW declined in most of the EU-20 countries. The most significant reduction occurred in Portugal (61%), whereas the fatality rate increased in Romania, Finland, Sweden, Poland and Czech Republic
- the number of PTW fatalities as a proportion of the national fatality total varied in the EU-24 countries from 6% to 32% in 2010
- The trend for motorcycle riders' fatalities differs clearly from the trend for other modes of transport. Motorcycle is the only mode of transport for which number of fatalities has increased over the first seven years of the period studied and only during the last year there was significant decrease compared to 2001. However, this is still eight times less than next smaller one of pedestrians which stresses the importance of taking immediate appropriate counter measures.

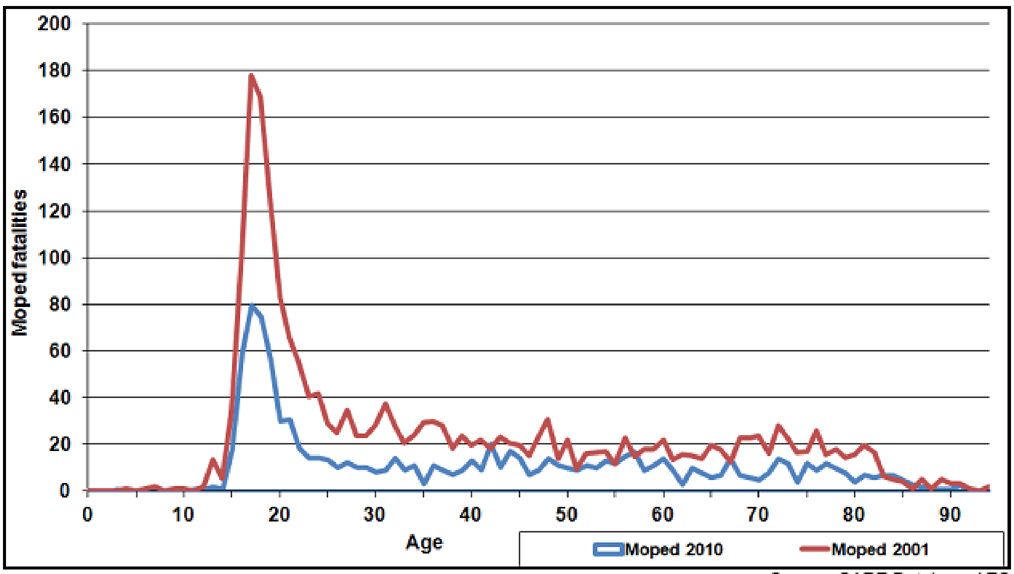
Figure 3: Index (2000=100) of motorcycle and moped fatalities compared with other modes EU-20[3], 2001-2010[2]



Source: CARE Database / EC
Date of query: September 2012

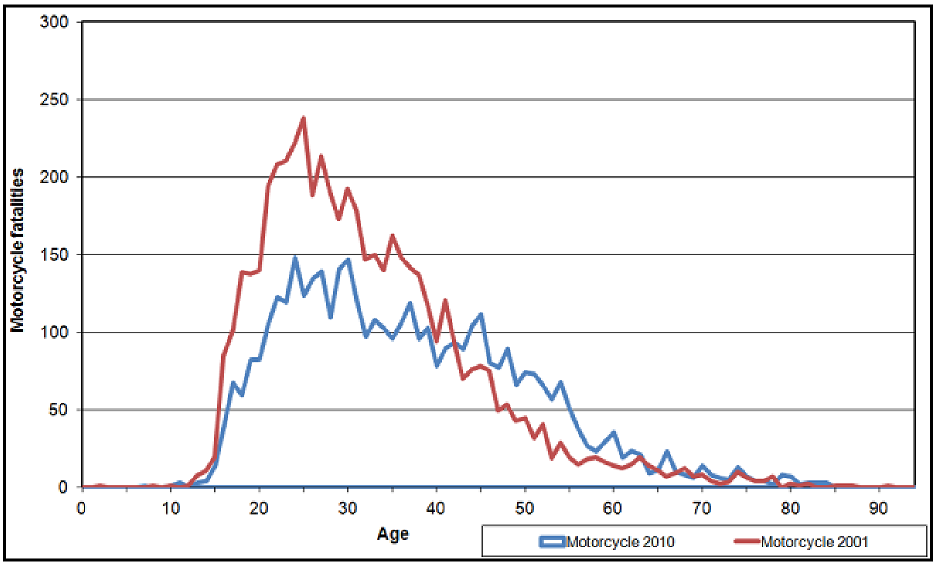
- The distribution of motorcycle and moped rider fatalities by gender. As presented, the large majority of the PTW fatalities were male in all countries. In 2010 11% of moped riders and 6% of motorcycle riders who were killed were female
- The number of motorcycle rider fatalities fell between 2001 and 2010 only for those between 11 and 42 years old, while it rose for most ages over 42.

Figure 4: Moped rider fatalities by age in 2001 and 2010[2], both EU-19[1]



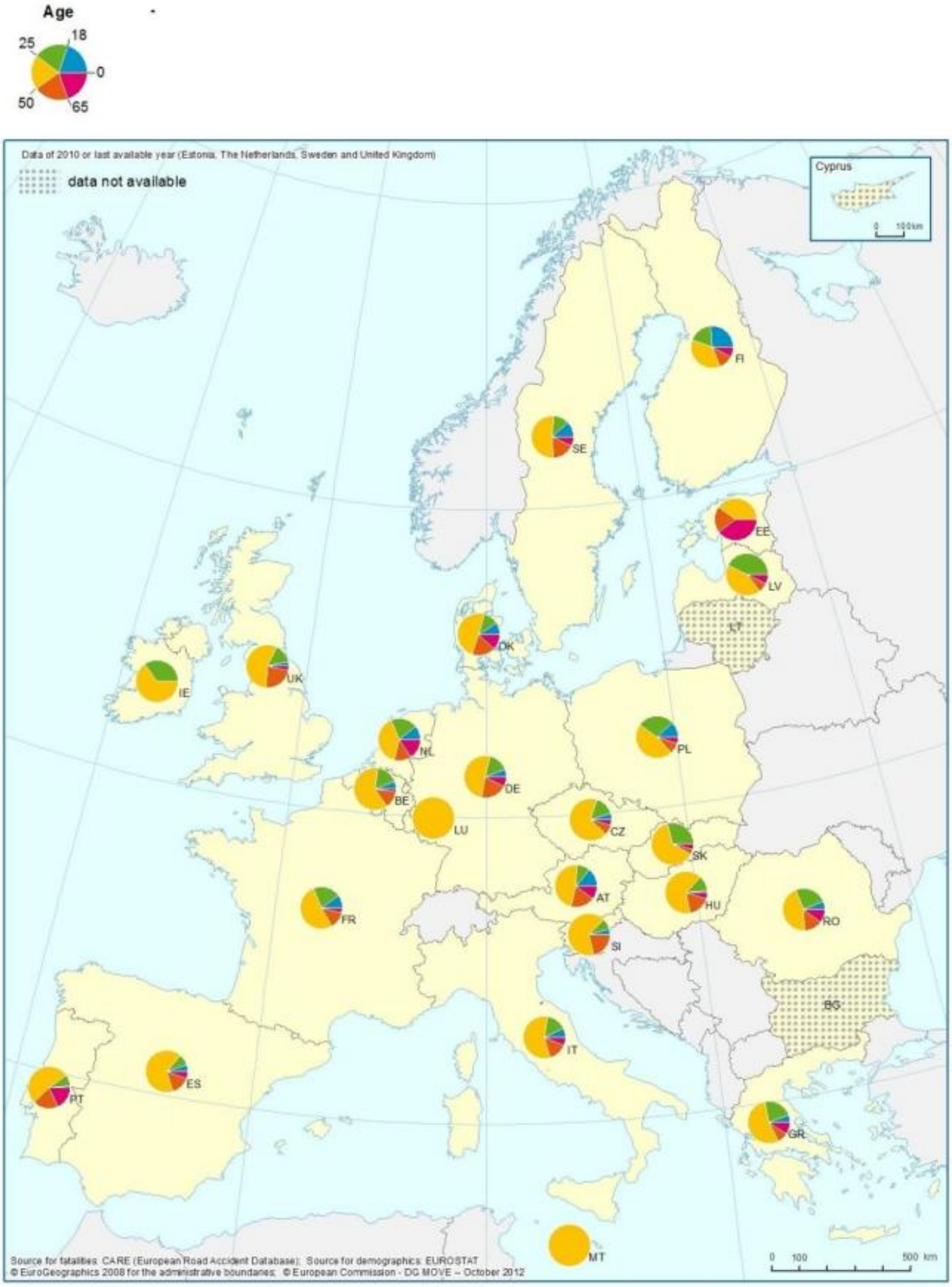
Source: CARE Database / EC
Date of query: September 2012

Figure 5: Motorcycle rider fatalities by age in 2001 and 2010[2], both EU-20[1]



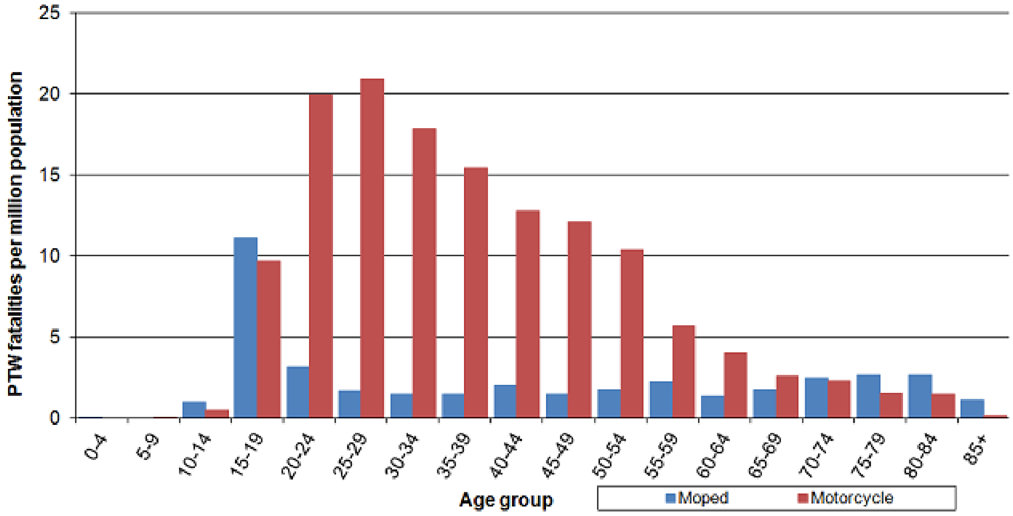
Source: CARE Database / EC
Date of query: September 2012

Map 2: Percentage of motorcycle and moped rider fatalities by age group, 2010[2]



Source: CARE Database / EC

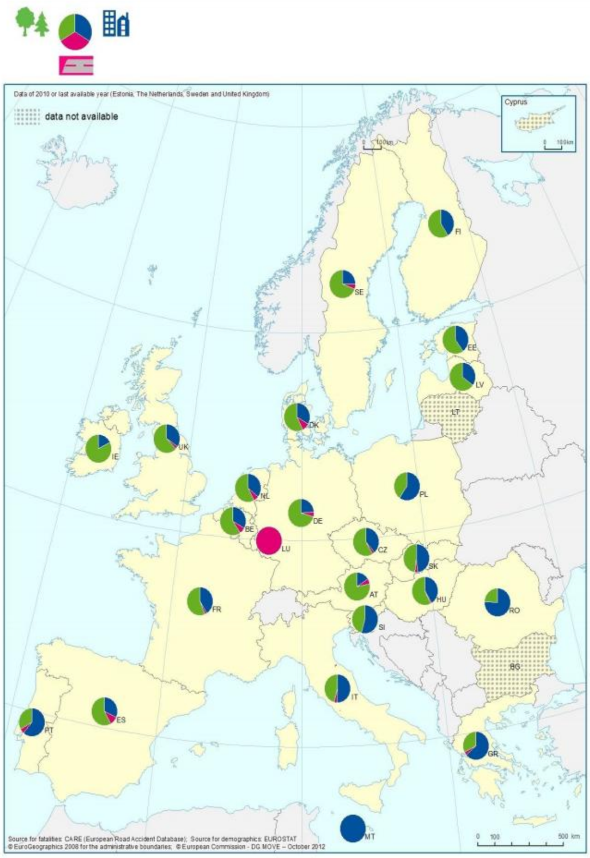
Figure 6: Motorcycle and moped fatalities per million inhabitants by age group - EU-24, 2010[2]



Source: CARE Database / EC
Date of query: September 2012

- Passenger fatalities: the highest proportion of passengers among PTW fatalities is in Slovakia (11%) by comparison with other countries.
- The majority of PTW fatalities in all countries occur on non-motorway road network.
- The majority of moped fatalities occur in urban areas whereas the majority of motorcycle fatalities occur in rural areas.

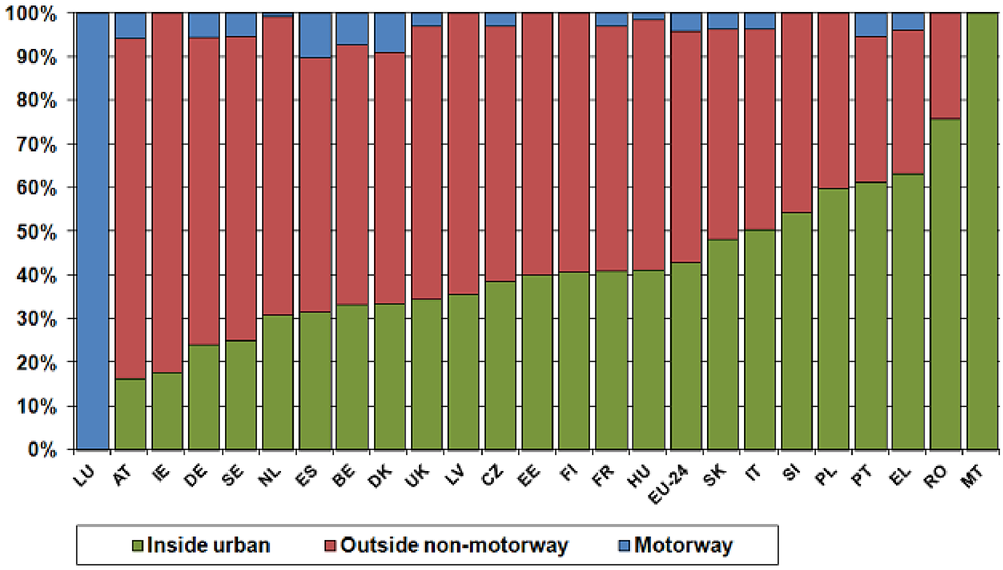
Map 3: Percentage of PTW rider fatalities by area type, 2010[2]



Source: CARE Database / EC

- Accident location: in the EU-24 in 2010, 43% of the motorcycle and moped rider fatalities were killed inside urban areas. In 2010, relatively few motorcycle rider fatalities occurred on motorways (5%), compared to car occupant fatalities (11%)

Figure 7: The distribution of PTW fatalities by area and road type, 2010[2]



Source: CARE Database / EC
Date of query: September 2012

- ***Junctions***: Close to a third of all motorcycle and moped rider fatalities occur at a junction (28%). The respective figure for car occupant fatalities occurring at a junction is only 18%. Crossroads is the most dangerous type of junctions for motorcycles and mopeds, as 51% of the overall respective fatalities recorded at a junction occurred there. The majority of fatalities occur away from junctions for all transport modes. The highest proportions of fatalities at junctions are found for bicycles and powered two-wheelers.

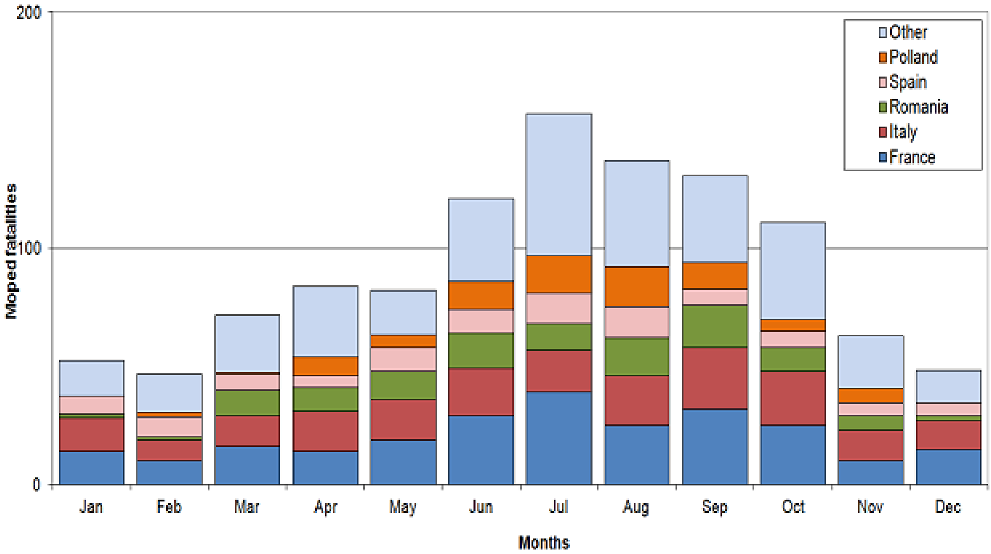
Table 9: Fatalities by junction type and mode of transport - EU-24, 2010[2]

	Not at junction	At junction	Not defined
Pedestrian	74%	19%	7%
Bicycle	59%	33%	8%
Moped	67%	29%	4%
Motorcycle	67%	27%	6%
Car and taxi	77%	14%	9%
Lorry, under 3,5 t.	76%	13%	11%
Heavy goods vehicle	71%	7%	23%
Other / Unknown	81%	15%	5%
EU-24 all modes	73%	19%	8%

Source: CARE Database / EC
Date of query: September 2012

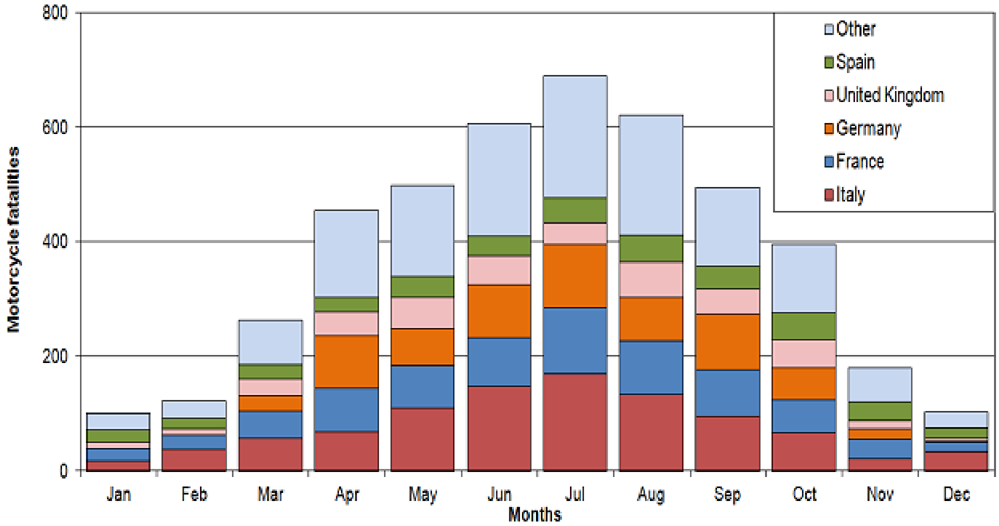
- There are relatively few fatalities in the winter, and relatively many in the summer. This reflects the seasonal pattern of use of mopeds and motorcycles. The number of moped fatalities does not vary over the months as much as the numbers of motorcycle fatalities, however in all countries there are more fatalities per month in the period April – October. A large number of motorcycle fatalities occurred when the weather was good, especially from May to September

Figure 8: Moped fatalities by month - top 5 countries and other EU-24, 2010[2]



Source: CARE Database / EC
Date of query: September 2012

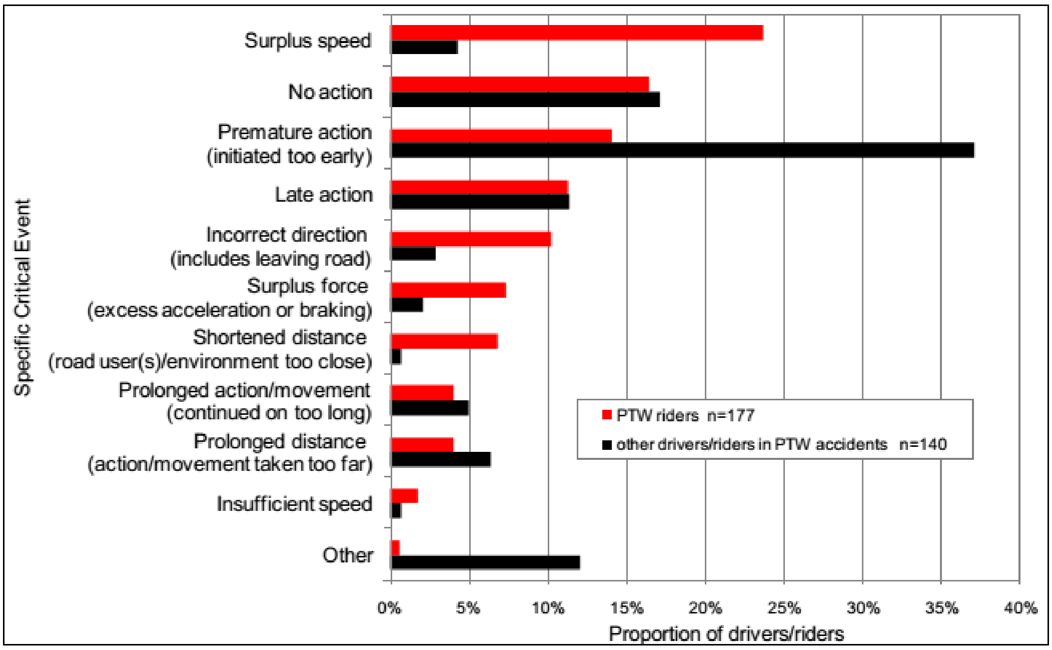
Figure 9: Motorcycle fatalities by month - top 5 countries and other EU-24, 2010[2]



Source: CARE Database / EC
Date of query: September 2012

- *Accident causation*: The most frequently recorded specific critical event for PTW riders is surplus speed, very much in contrast to other drivers/riders in PTW accidents. Surplus speed describes speed that is too high for the conditions or manoeuvre being carried out, travelling above the speed limit and also if the rider is travelling at a speed unexpected by other road users. It is recognised that the PTW riders here are in a mix of single vehicle and multiple vehicle accidents, whilst the other drivers/riders are, by selection, in multiple vehicle accidents. Single vehicle accidents will be reflected in higher representations of surplus speed and incorrect direction (as it includes leaving the road). The events under the general category of 'timing', no action, premature action and late action, account for the next three most frequent events after surplus speed. Premature action (one undertaken before a signal has been given or the required conditions are established, for example entering a junction too early) is recorded far more often for the other drivers/riders in PTW accidents than for the PTW riders

Figure 10: Distribution of specific critical events - PTW riders and other drivers/riders in PTW accidents



N=317

Source: SafetyNet Accident Causation Database 2005 to 2008 / EC
Date of query: 2010

- Faulty diagnosis, inadequate plan and observation missed are frequently recorded causes. Faulty diagnosis is an incorrect or incomplete understanding of road conditions or another road user's actions. It is linked to both information failure (for example, a rider thinking another vehicle was moving when it was in fact stopped and colliding with it) and communication failure (for example, pulling out in the continuing path of a driver who has indicated for a turn too early). The main cause leading to inadequate plan (a lack of all the required details or that the driver's ideas do not correspond to reality) is lack of knowledge (for example, not understanding a complex junction layout), followed by psychological stress. The causes leading to observation missed can be seen to fall into two groups, physical 'obstruction to view' type causes (for example, parked cars at a junction) and human factors (for example, not observing a red light due to distraction or inattention).

Table 11: Ten most frequent links between causes – PTW riders

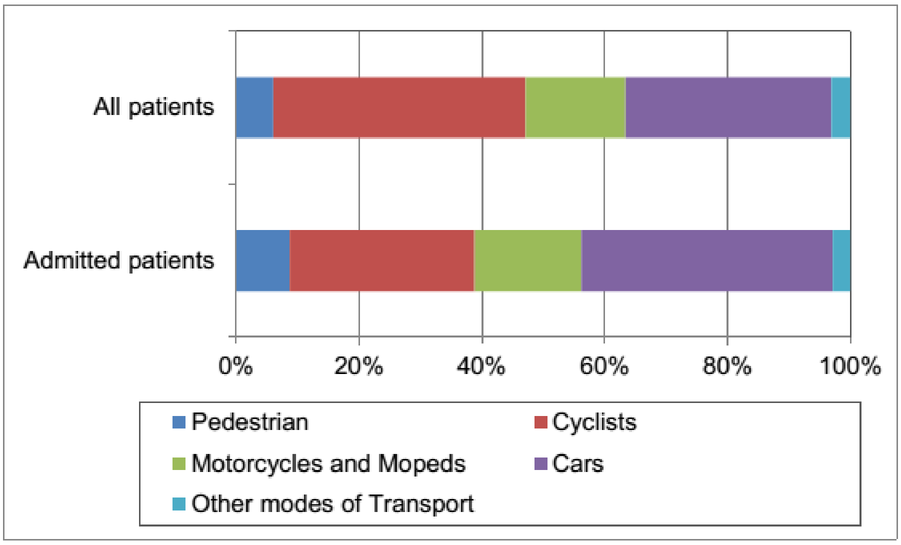
Links between causes	Frequency
Faulty diagnosis - Information failure (driver/environment or driver/vehicle)	26
Inadequate plan - Insufficient knowledge	24
Observation missed - Permanent obstruction to view	16
Observation missed - Temporary obstruction to view	16
Observation missed - Inadequate plan	13
Observation missed - Inattention	12
Faulty diagnosis - Communication failure	8
Inadequate plan - Psychological stress	8
Observation missed - Faulty diagnosis	5
Insufficient knowledge - Inadequate training	5
Others	63
Total	196

Source: SafetyNet Accident Causation Database 2005 to 2008 / EC
Date of query: 2010

- ***Injury data*** :can be obtained from a wide range of sources, such as police and ambulance reports, national insurance schemes, and hospital records, each of which provides a specific but yet incomplete picture of the injuries suffered in road accidents. In order to obtain a comprehensive view of these injuries, the EU Council issued a Recommendation7 that urges member states to use synergies between existing data sources and to develop national injury surveillance systems rooted in the health sector. At present, thirteen member states are routinely collecting injury data in a sample of hospitals and delivering these data to the Commission. This system is called the EU Injury Database (EU IDB). These variables can complement information from police records, in particular for injury patterns and the improved assessment of injury severity. The indicators used include the percentage of casualties attending hospital who are admitted to hospital, the mean length of stay of hospital admissions, the nature and type of body part injured, and potentially also long term consequences of injuries.

[7] OJ C 164/1, 18.7.2007

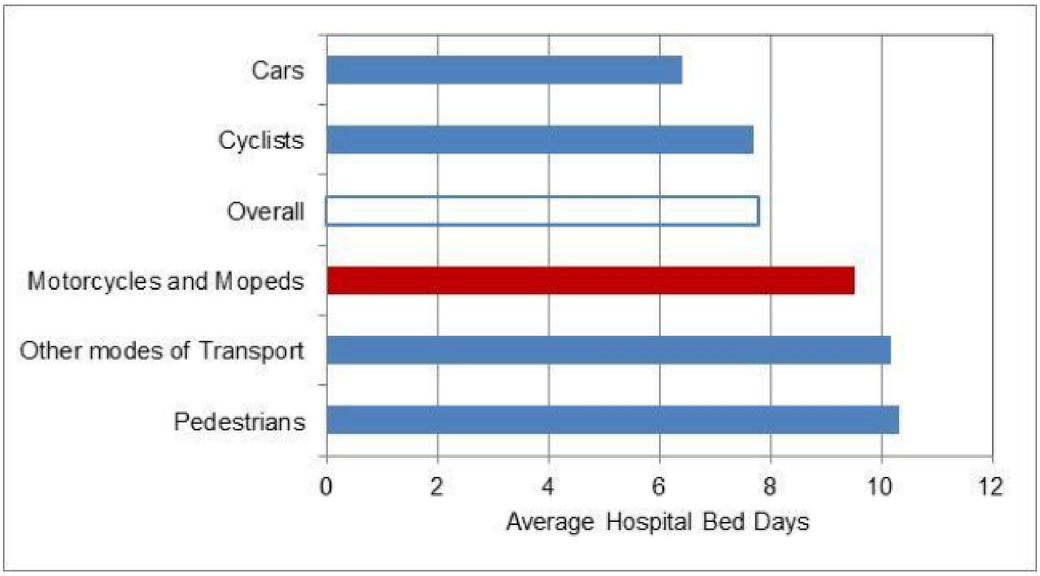
Figure 11: Distribution of non-fatal road accident casualties attending hospital, by mode of transport



EU Injury Database (EU IDB AI) - hospital treated patients. IDB AI Transport module and place of occurrence (code 6.n [public road]); n-all = 73 600: n-admitted = 23.568 (DE, DK, LV, MT, AT, NL, SE, SI, CY, years 2005-2008).

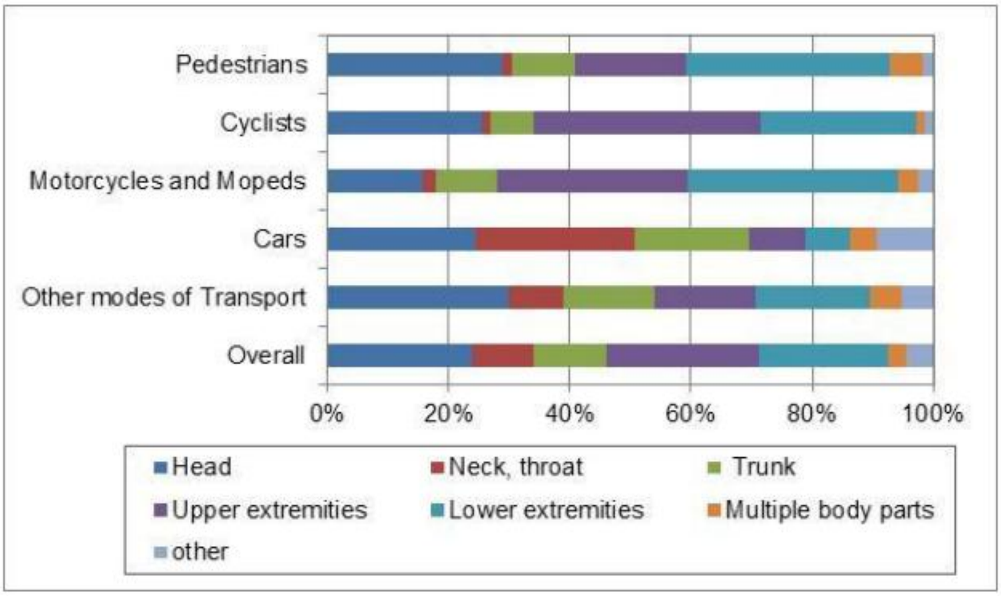
- Between 2005 and 2008, vulnerable road users (pedestrians, cyclists, motorcycles and mopeds) accounted for almost two thirds (63%) of road accident casualties attending a hospital, and for over half of casualties admitted to a hospital (56%); overall 32% of road accident casualties recorded in the IDB were admitted to the hospital, compared with 34% of riders of mopeds and motorcycles; the overall average length of stay was eight days, compared with almost ten days for riders of mopeds and motorcycles.

Figure 13: Average length of stay (hospital bed days), by mode of transport



- Injured riders of mopeds and motorcycles, for example, suffered relatively many injuries to the lower extremities.

Figure 14: Body part injured, by mode of transport



○

Table 12: Top ten types of injury in mopeds & motor cycles

	Mopeds & motor cycles	All road user groups
Contusion, bruise	26%	34%
Fracture	42%	27%
Open wound	10%	10%
Distortion, sprain	3%	8%
Concussion	6%	7%
Other specified brain injury	2%	2%
Luxation, dislocation	2%	2%
Injury to muscle and tendon	1%	2%
Abrasion	1%	1%
Injury to internal organs	1%	1%
Other specified types of injury	6%	6%
Total	100%	100%

- **eSum**
  - *MAIDS urban sub-data* highlighted
    - a clear commuting use of the powered two wheelers suggested by the fact that accidents occurred more during the early morning and end of the day, mainly during the week days and when riders are travelling from home to work and vice versa;
    - the major cause of accident was due to a human error, although the environmental factor was found to be of bigger relevance in the urban accident causation, especially when view

obstructions along both rider's and other vehicle driver's line of sight were present, and roadway surface was contaminated by maintenance defects

- PTW riders involved in urban accidents were found to be less trained and skilled than other riders, having less official training and more control unfamiliarity and skill deficiencies
- A different pattern was found when single and fatal urban accidents were analyzed separately. These accidents showed to be less commuting related and more connected to some recreational activities: they occurred more during the evening and night hours and PTW rider was more prone to take risks, such as speeding over the posted speed limit, wearing helmets improperly or being alcohol impaired

- In general the problem of moped rider fatalities in Europe's urban areas is reducing, whilst the number of motorcyclist fatalities has not generally improved. Italy has the biggest (growing) problem – both for moped rider and motorcyclist fatalities - followed by France (where moped rider fatalities have recently increased). The UK has the lowest level of moped rider fatalities and Spain the lowest level of motorcyclist fatalities (but with increases during recent years)
- Comparing data:
  - Differences in classifications for serious injury data are noted along with possible under-reporting of PTW serious injury collisions in Rome. Changes are also observed in the classification of injury collisions in Paris since 2005.
  - Whilst the numbers of motorcycles are considered to be comparable, mopeds are not always subject to vehicle registration. Data was not available for Paris, and were estimated for London
  - Concerning exposure, there are additional difficulties in obtaining comparable measures of mobility and hence in generating comparable "traffic safety risk" indicators. Trips rather than veh-kms are used, with data from at least two surveys giving an indication of PTW mode share trends

✓ **Recommendations:**

- It is evident that the benchmarking (cross-city) comparison of PTW safety in cities is a complicated process. The analysis presented identifies some of the key issues to be taken into consideration. A step-wise approach is recommended:
  - Basic data about study area, population, vehicle stock (mopeds – if this is of national importance – and motorcycles separately) are collected.
  - A times series of PTW fatalities and KSI (MAIS>=3) be produced covering at least 7 years.
  - The main regulatory actions (including data about enforcement of drink driving, speed and red-light jumping) and safety campaigns.

        - The evolution of the PTW share of trips be computed (last two trip surveys).
        - Of particular importance is the selection of appropriate cities for making comparisons.
    - To provide a contextual overview of PTW safety in a partner or follower city, comparison data should be high level and kept to the minimum necessary to assess comparative casualty rates. The following variables are suggested:
        - PTW fatalities & KSI casualties
        - All fatalities
        - Number of PTWs registered
        - Population of city
        - Modal split
    - EU Commission to
        - Provide a contextual overview of PTW safety in a partner or follower city, comparison data should be high level and kept to the minimum necessary to assess comparative casualty rates. The following variables are suggested:
        - Increase the number of cities involved in PTW collision studies; more big cities from countries with PTW problems, develop a medium city group
        - Develop common monitoring methods for key actions; camera enforcement of speeding and red-light jumping and for the evaluation of training /awareness campaigns
        - Promote the development of resourced road safety units having quantities collision reduction targets.
        - Promote the figure of a specific individual responsible for PTW safety within the aforementioned road safety units.

- **MAIDS**
    - Main findings from the overall Dataset
        - the object most frequently struck in an accident was a passenger car
        - The second most frequently struck object was the roadway itself, either as the result of a single vehicle accident or of an attempt to avoid a collision with an OV
        - the majority of the accidents took place in an urban environment
        - Travelling and impact speeds for all PTW categories were found to be quite low, most often below 50 km/h; There were relatively few cases in which excess speed was an issue related to accident causation
        - The cause of the majority of PTW accidents collected in this study was found to be human error;

- The most frequent human error was a failure to see the PTW within the traffic environment, due to lack of driver attention, temporary view obstructions or the low conspicuity of the PTW
- the use of alcohol increased the risk of being in an accident, although the percentage was lower than in other studies
- Unlicenced PTW operators who were illegally riding PTWs that required a licence, were also found to be at greater risk of being involved in an accident when compared to licenced PTW riders

o Findings on single urban accidents

- Single accidents were found to be underrepresented in urban areas
- 66.7% of single accidents were caused by a PTW rider's failure: 47.8% of perception and 21.7% of reaction failures
- 24.6% of single accidents had the environment as primary contributing factor: road environment, roadway maintenance defect and adverse weather
- L3 vehicles were more involved in urban single accidents than L1 vehicles
- Single accidents had a higher percentage of fatal outcomes (15.6% vs. 6.5%)
- Riders were found to wear helmets less and to adjust them less properly
- Single accidents occur more during evening and night hours
- 43.4% of single accidents occurred incurves: more left than right curves
- Home and recreation/free time locations were the most common origins and destinations
- Riders with no training and no license were found to be over represented
- 40.6% of single accident riders were speeding over 10 km/h the speed limit vs.
- 19.8% of multi vehicle accident riders
- 14.5% of single accident riders drunk alcohol before departure and 7.2% of these were significantly impaired
- 14.5% of single accident riders had control unfamiliarity, 23.4%had skill deficiency and 15.9% were unfamiliar with their PTW

o Findings on fatal urban accidents

- Fatal accidents are more common in rural than urban areas
- L3 vehicles are more involved in fatal accidents (64.0% vs. 47.4%)
- 50% of fatal accidents were caused by the PTW rider (vs. 34% non fatal)
- PTW riders failures are found to contribute more in fatal than in non fatal accidents (50 vs. 34.1%)
- Single accidents are more likely to have a fatal outcome (22% vs. 9.4%)

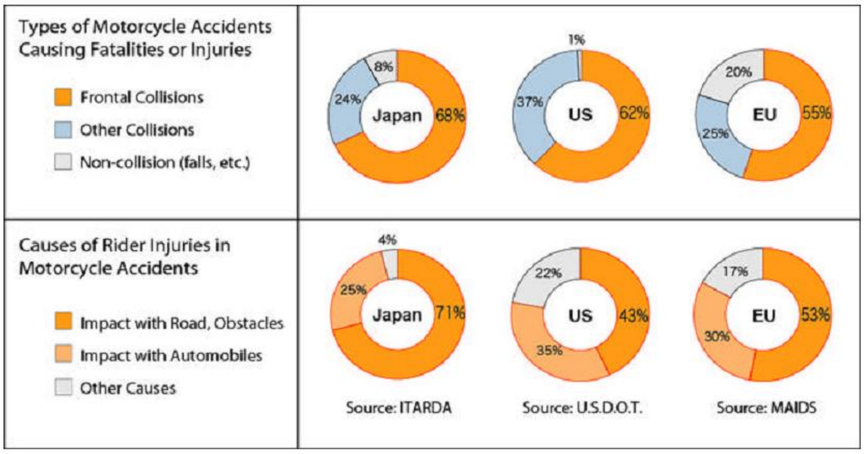
- Fatal accidents are more likely to occur during evening and night time and less likely during the morning
- In fatal accidents home and work are the most common origins and destinations
- Trips longer than 45 minutes were found to be more frequent in fatal than in non fatal accidents
- Accidents in a non intersection road are more likely to have a fatal outcome (48.0% vs. 30.5%)
- Accidents in major arterials are more likely to be fatal (48.0% vs. 17.2%)
- Accidents on left curve are more likely to have a fatal outcome (22.0% vs. 9.7%)
- Riders of 16-17, 22-25 and over 41 were found to be more involved in a fatal
- accidents
- Conventional street motorcycles, sport replica and sport touring were the styles more involved in fatal accidents
- Motorcycles over 501cc were more frequent in fatal accidents
- Among all accidents, fatal accidents werefound to have higher travelling speeds
- 10.0% of control unfamiliarity, 12.0% of skill deficiency and 14.0% of vehicle unfamiliarity of the rider was contributing to the fatal accidents causation
- In 29.4% the rider did not attempt any evasive action, mostly due to a strategic detection failure. 8.0% of riders made the wrong choice of evasive action, 32.0% of evasive actions were not properly executed

• **PISA (2009) – D02**

  ○ ***PTW market***: Following a decline in 2000-04, the overall European PTW parc has again increased reaching a peak of 1.9 million units in 2006. For mopeds the parc has declined by 5% whilst for motorcycles it has risen by 41%. Predicted Global motorcycle demand will increase by 4.9 percent annually through 2009 to 41.6 million units whilst fatalities for 2010 are predicted to be 27,000 with riders of large machines identified as a specific class of concern. The industrialised triad market predominantly relates to: leisure use, larger machines, increased use across all PTW sectors and higher profit margins per unit. The Emerging Asian economies market predominantly relates to: family/work use, smaller machines, growth likely to be related to scooters, mopeds and lighter motorcycles, switch to rural markets and high volume (but low unit profit) market. In terms of future casualties, projections for the year 2020 estimate a decline of about 30% in mortality for high income countries. Within the established EU countries, projected fatalities for 2010 are 27,000 with riders of larger machines facing increasing risks. Mortality rates in middle and low-income countries are predicted to increase substantially

  ○ ***Accident trends***: Whilst the overall picture for Europe since the early 1990s is that fatality rates for all vehicle and road user types are decreasing including PTW' s undated), at national levels within Europe, the pattern is more varied; Southern European countries have a greater accident frequency particularly with respect to fatalities than central or northern countries. Less-motorised countries (India, Indonesia, Malaysia, Sri Lanka, Thailand) have a higher proportion of vulnerable road user fatalities than high income countries (Australia, Japan, Norway , The Netherlands, USA)

- ***Accident risk***: Over the EU as a whole, PTW fatalities vary from 5% to 25% of the national road fatalities. The largest proportion of fatalities across all PTW's and for moped/mofas is Portugal and for motorcycles it is the UK. Across Europe as a whole, the fatality risk for motorcyclists is approximately 20 times that of car occupants. At a national level within Europe, Belgium, France, Portugal and the UK have particularly high PTW accident involvement rates compared to comparable rates for cars/taxis. A similar pattern may hold for the US and Singapore.
- ***Accident scenarios***: Within Europe, according to MAIDS data there is a wide range of PTW accident scenarios with no single dominant configuration. This is borne out by the APROSYS project which, D2 Powered two wheeler Integrated Safety (PISa). Review of current PTW accident data classifying accident scenarios according to their frequency and severity , found seven important configurations



o **Figure 4: Motorcycle accidents by injury severity and injury causation (Honda 2006)**

Table 7: Summary of the most frequent and severe PTW accident configurations identified by APROSYS

Importance	Location	PTW type	Struck object	Junction
1	Urban	Moped	Car	Intersection
2	Urban	Moped	Car	Straight
3	Urban	Motorcycle	Car	Intersection
4	Urban	Motorcycle	Car	Straight
5	Non-urban	Motorcycle	Single vehicle	Not stated
6	Non-urban	Motorcycle	Car	Straight
7	Non-urban	Motorcycle	Car	Intersection

- Common ***accident types*** are:

a) Right of way violations (Most frequently occurring and involve cars turning in front of the PTW. In most cases the PTW will be upright with the rider in position) and a PTW overtaking a turning car are common scenarios.

b) Overtaking/filtering accidents and

c) Loss of control at bend at speed.

- ***Road type***: Most PTW accidents occur within urban areas and at higher involvement rates than for other road users. Based on the MAIDS, APROSYS and other, national studies, the TRACE programme concluded that in urban areas most accidents occur at intersections, in non-urban areas most occur on straight sections. Moped/mofas are more likely to be accident involved in urban areas than motorcycles

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- ***Other vehicles:*** Both MAIDS and APROSYS indicate a car or the roadway as the most frequent offending object. UK data suggests that these accidents account for a significant number of PTW fatal and serious injuries. MAIDS and national studies indicate single vehicle PTW accidents account for approximately 15% of all PTW accidents.

- ***Relative vehicle locations:*** Most other vehicles were in front of the PTW and driver (90% and 60% respectively). The most frequent first points of contact are to the front (left, centre and right) for both the PTW (more than 60%) and the other vehicle (more than 30%). A study from the United States also shows the significance of intersection accidents and the prevalence for the first point of contact to be the front of the motorcycle whilst studies from Singapore supports the prominent role of other vehicles in accidents resulting in a serious rider injury; the prevalence of approaching turn collisions and the hazards posed by road bends..

- ***Accident causation***

  PTW errors:

  - Failed to see, faulty decisions,
  - Loss of control (related to excessive speed, alcohol impairment, lack of judgement and careless/thoughtless/reckless behavior)
  - Loss of control (related to excessive speed, lack of judgement in own path)

  Other drivers errors:

  - Failed to see (lack of attention, visual obstruction, reduced PTW conspicuity)

- Failed to give way and poor turn/manoeuvre (related to failure to observe satisfactorily , careless/thoughtless/reckless behaviour and failure to judge the rider's path or speed)
- Failed to give way , poor turn/manoeuvre (related to Looked but did not see, failure to judge other person's path)

Accident types:

- Right of way violations –Young riders (16-20) were more likely to be at fault. Most associated with other drivers where the most common failure was incorrect observation of the scene. Clustered around peak time traffic flows
- Bends –Those aged 26-30 had an increased propensity to loose control at bends. These are nearly always regarded as the fault of the rider who are nearly three times as likely to be rated as 'inexperienced'. Their occurrence was spread more evenly throughout the day and was more often on a Sunday which suggests that these accidents may be associated with recreational riding
- Overtaking/filtering –Those aged 51-55 were under-represented whilst those aged 56-60 were over-represented but these results may have been influenced by small sample sizes. Only 5% of such accidents were considered solely the fault of the motorcyclist and there was an increased tendency for these accidents to be classified as 'combined fault'. Overtaking/filtering accidents were clustered around peak time traffic flows.

○ ***Injury distribution:*** The most frequent injury sites are the upper and lower extremities and the head. A similar finding was presented for the US, UK and Germany. Most injuries over all the body areas are minor or moderate although the head, neck, thorax, abdomen and spine are more likely to be classified as severe or greater. Several studies have noted that riders often have more than one injury on their body and sometimes more than one per body site.

○ ***Time:*** The MAIDS report stated that due to a lack of exposure data –risk factors associated with month could not be determined. Other studies of European data have stated that most travel, accidents and serious and fatal injuries occur spring to autumn

The MAIDS report stated that due to a lack of exposure data –risk factors associated with day of week or time of day could not be determined. A study from Sweden gave rise to similar conclusions. Other studies suggest that:

- For weekdays –rider casualties peak between 07.00-08.00 and 17.00-18.00 or 18.00-21.00
- For weekends –rider casualties peak between 12.00-18.00.

○ ***Weather/light conditions***

The APROSYS project stated that although most accidents occur in dry weather conditions and daytime, due to most usage at this time risk factors cannot be concluded. UK studies state that most accidents occur in fine weather conditions, although according to Lynam et al 2001, weather conditions may be of minor importance. The MAIDS study found that nearly 75% of accidents occurred in daylight supported by a UK study by Sexton et al 2004 who similarly stated that most accidents occur in daylight

- ***Speeding:*** Speeding of the rider is often an important causation factor in all types of accidents. A study by Broughton (2005) found that the predominant failure leading to a motorcyclist fatality was loss of control by the rider due to excessive speed (37% of accidents)and that excessive speed was found to be more prevalent amongst the riders of larger motorcycles. The APROSYS in-depth review found that braking effectively reduces the impact speed and that braking effectiveness was at least 40-50%. It also found that cruising speed and impact speed are often within the same range of velocity , indicating that speed reductions prior to the impact are not very large. MAIDS data indicates that 75% of PTW impact speeds were below 50km/h; for PTW single vehicle collisions only this reduced to 56%. With respect to precipitating speed, these percentages were reduced by one third. Research by Lynam et al 2001 found that in accidents with rider fatalities where the rider was judged to be primarily responsible, the mean speed was 57mph
- ***Engine size:*** The MAIDS data indicated that engine displacement is not a risk factor for accident involvement and a study by Schultz and Koch 1991 similarly found that PTW type is not a risk factor. Astudy by Wick et al 1998 found that more than half of accident involved motorcycles were greater than 500ccand Frantzeskakis (1998) reported Greek data which showed that casualty risk was lowest for PTW under 50cc and greatest for those 126-250cc, although greatest injury severities related to machines of 750ccc or more due to greater speeds involved. A UK study suggests that there is a relationship between engine size and injury severity which is also associated with rider age. Data from outside of Europe also supports a positive relationship between engine size and injury severity and engine size and age of rider fatality
- ***Hardware and traffic control:*** MAIDS and UK data specify poor quality road surfaces as a causal or contributory factor in up to 5% of accidents, although Greek data cited it as a major cause.. Guardrails cause serious head, spinal and lower extremity injuries and increase the incidence of serious injury two-fold and a fatal injury by five-fold. Cable barriers pose additional cutting injuries. Trials in the UK indicate no safety disbenefits to restricted use of bus lanes by motorcyclists)
- ***Crash test scenarios:*** ISO13232 specifies seven impact scenarios to assess against but does not account for a PTW overtaking a car which is turning left which was a clear accident scenario found within the ARPOSYS literature review.

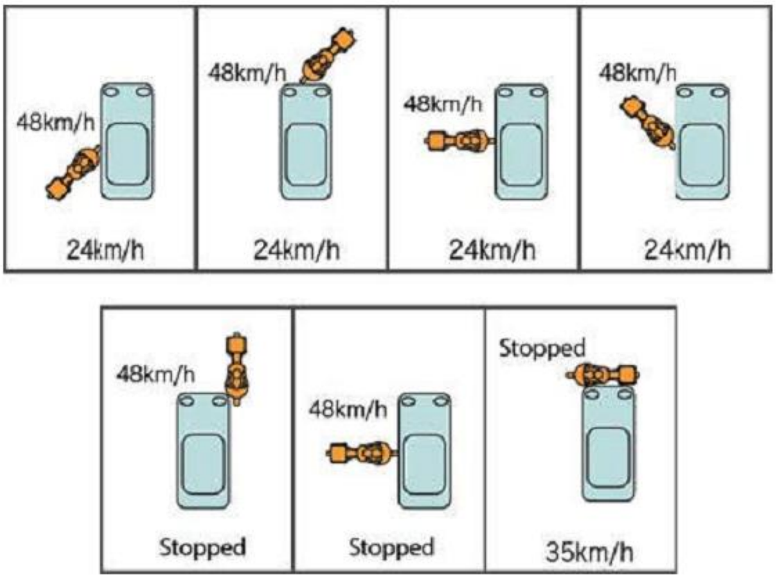


Figure 20: ISO 13232 crash test scenarios

Honda, in development of their motorcycle airbag, added four further configurations:

- Influence of rider ' s size
- Influence of the rider ' s forward tilted posture
- Influence of high-impact speed whilst carrying a passenger
- Front wheel non-impact collision

- ***Design implication***

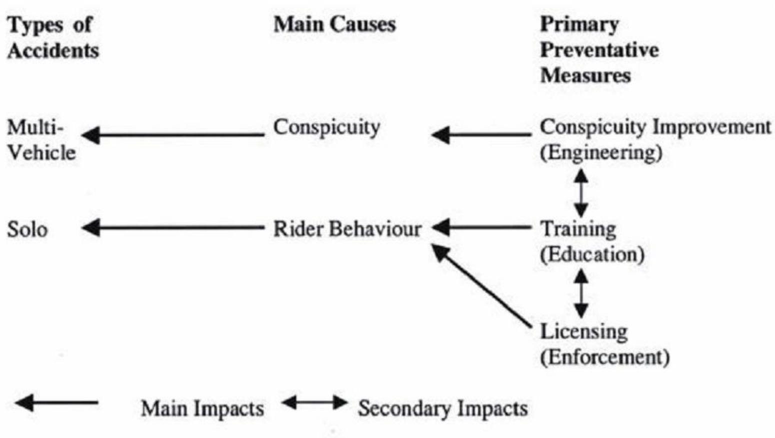


Figure 21: The interrelationship between motorcycle accidents, causes and preventative measures taken from Huang and Preston (2004)

The findings from a UK study were that the greatest potential for future casualty reduction is through improved primary and/or secondary safety rather than through medical intervention. Studies from the UK and USA state the role of: reduced forces, reduced speed, improved secondary safety and sympathetic traffic control in future casualty reduction whilst other study notes the importance of riders of large machines to casualty reduction due to their increased number, higher exposure time and raised fatality rate. A variety of measures are required to address the variety of causal factors.

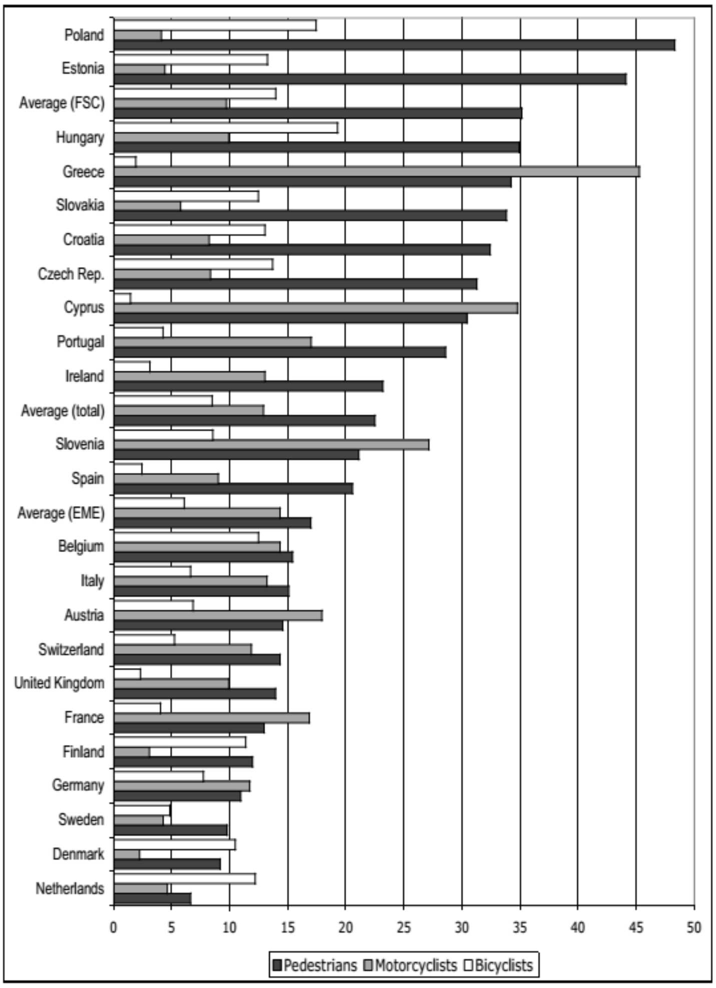
- **PROMISING (2001) – Deliverable 3**
  - Statistical information in this report refers mostly to Western Europe, i.e.: A, B, D, DK, E, F, FIN, GB, GR, I, IRL, N, NL, P, and S. Sufficient information on Eastern European countries was not available. Some of the information was not even available for all western European countries
  - In Western Europe the absolute number of mopeds is 13-14 million. This number has not changed much over the last ten years, but used to be higher before that. France shows a remarkable decline in number of mopeds from over 5 million in 1980 to less than 2 million in recent years.
  - The absolute number of motorcycles in Western Europe is lower than the number of mopeds, with almost 10 million. This number is slowly, but constantly increasing. Great Britain is an exception with decreasing numbers of motorcycles and mopeds.
  - The number of motorcycle fatalities in western European countries is more than 4000 per year. For moped fatalities the number is about 2500. Together they represent 10-15% of all traffic fatalities. These numbers are high in relation to the numbers of vehicles. Since there are more mopeds than motorcycles, the rate of fatalities per 105 vehicles is even worse for motorcycles. However, the use of motorcycles in terms of kilometrage is probably higher.
  - France has a high rate of moped fatalities (circa 30/105 mopeds/year) and this has not changed much over time. Sweden and Norway have shown a considerable decline and now have a very low rate (circa 5). The trends are quite different between countries.
  - For motorcycle fatalities, the rate is again high for France (100-90/105motorcycles/year) and in this case low for Italy (20). Except for Greece, the rate is decreasing. Great Britain shows a strong decline in absolute number of fatalities because the number of motorcycles declined as well as the rate of fatalities per number of motorcycles.
  - Several factors contribute to the wide variation between countries in fatality rates of mopeds and motorcycles. The characteristics of the rider population may be different. As a consequence of differences in legislation, the age distribution and level of training will vary. The conditions of riding in terms of type of road, other traffic etc. may also differ between countries. But to what extent these factors actually contribute in the case of each country is not known.
  - In most European countries, the absolute number of moped fatalities under 25 years of age is about the same as for older riders. For both moped and motorcycle, the rate of fatalities per 105 vehicles is much higher for young than for older riders. Nevertheless, there are more motorcycle fatalities over 25 years than younger.
  - This does not apply to Greece, Spain and Italy, where the numbers are about equal in both age groups. Ten to fifteen years ago most countries used to have many more young rider fatalities, but the age distribution of the motorcycle rider population has changed to more older riders.
  - For both moped and motorcycle more than two-thirds of the serious accidents are collisions with a car, many of these at intersections with the car driver coming from a side road or

turning in front of the rider. Of course there are some differences between moped and motorcycle accidents related to their use (lower speed and more short trips in urban areas for mopeds)

- Data collection and research are not safety measures by themselves, but serve to study the need for and the effects of such measures. In the case of mopeds and motorcycles there is a strong need for more reliable data and more and better research.

- **SAFETYNET**
  - Cf. outcomes PISA
- **SARTRE 1-4**
  - For motorcyclists, the lowest fatality rates are found in Denmark, Finland, Poland, Estonia and the Netherlands, all below 5 motorcyclist fatalities per 1 million inhabitants (figure 12.2). The situation is worst in Greece, Cyprus and Slovenia. The situation is worst in Slovenia with 448 motorcyclists killed per 100,000 motorcycles, and best for Finland, Denmark, Switzerland, the Netherlands and Poland (< 20 fatalities/100,000 motorcycles)

Figure 12.2: Fatality rates for different groups of traffic participants (fatalities per 1 million inhabitants).



  - Greece, Switzerland and Cyprus have the highest rates for motorcycles (> 60/1,000 inhabitants), while it is lowest in Estonia, Croatia and Slovenia, with fewer than 8 motorcycles per 1,000 inhabitants
  - Cyprus has a dense motorway network, but is generally a country with a low vehicle density. However, there are a large number of motorcycles. Fatalities are above European Union and Western countries' averages.
  - Greece has a high share of motorcycles and commercial/heavy goods vehicles. Fatality rates are the highest in the European Union.

- **SARTRE 4**
  - ***Gender:*** there are large differences in the proportion of male or female riders. The largest proportions of male rides are in Hungary and Serbia. The largest proportions of female riders are in Italy, France and Netherlands. The largest proportions of younger riders are in Serbia and Israel, and the largest proportions of older riders are found in Italy and Germany.

Table 1: Gender and age of motorcyclists separated for countries (in %).

	Gender	Age category					
	Male	18-24	25-34	35-44	45-54	55-64	65+
Austria	86%	13%	20%	22%	32%	11%	5%
Belgium	90%	11%	15%	26%	32%	13%	4%
Cyprus	86%	22%	43%	20%	10%	4%	1%
Czech Rep	83%	17%	37%	28%	8%	6%	3%
Estonia	92%	23%	38%	26%	10%	3%	1%
Finland	89%	10%	23%	22%	24%	17%	4%
France	77%	16%	22%	29%	22%	8%	2%
Germany	88%	14%	16%	17%	29%	14%	10%
Greece	87%	14%	29%	29%	20%	8%	1%
Hungary	96%	13%	31%	31%	15%	6%	4%
Ireland	94%	11%	28%	33%	19%	7%	4%
Israel	85%	29%	48%	15%	4%	3%	0%
Italy	70%	14%	17%	22%	20%	15%	11%
Netherlands	74%	10%	16%	23%	31%	18%	3%
Poland	93%	9%	20%	30%	20%	15%	5%
Serbia	96%	30%	46%	14%	5%	3%	1%
Slovenia	94%	14%	29%	17%	19%	19%	3%
Spain	81%	9%	23%	27%	25%	12%	4%
Sweden	81%	11%	22%	24%	24%	16%	4%
MEAN	86%	15%	27%	24%	19%	10%	4%

  - ***Education***: There are large differences concerning education of motorcyclists. Primary school level of motorcyclists has most frequently been found in Austria, Hungary, Germany and Spain. Further education level is more often in Israel, Cyprus and Netherlands than in the other countries
  - ***Family situation***: Motorcyclist's family status differs a lot between the countries. In total motorcyclists are most often married followed by single and as married living

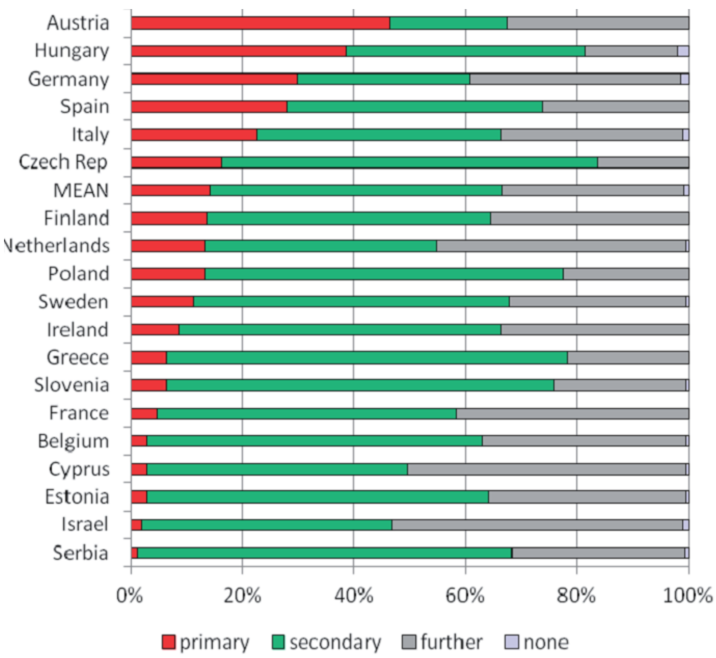


Figure 1: Education (CO13), in %.

motorcyclists. Separated for the countries the highest rate of singles can be found for Israel, Cyprus and Serbia. As married living motorcyclists are most often found for Estonia, Sweden and Austria and married motorcyclists are mostly living in Poland, Italy, Germany and Netherlands. Half of motorcyclists have at least one child. Belgium, Poland and Netherlands have the highest rates of motorcyclists with children.

Table 2: Family situation (CO10) and children (CO11), in %.

	Situation					children	
	single	as married	married	separated	widowed	yes	no
Austria	31%	27%	31%	11%	1%	39%	62%
Belgium	25%	20%	46%	9%	0%	68%	33%
Cyprus	49%	10%	35%	5%	0%	33%	67%
Czech Rep	41%	11%	40%	7%	1%	49%	51%
Estonia	26%	43%	25%	5%	1%	51%	49%
Finland	24%	20%	45%	11%	0%	52%	48%
France	30%	25%	34%	10%	0%	56%	44%
Germany	28%	11%	51%	8%	1%	61%	39%
Greece	42%	6%	49%	3%	0%	42%	58%
Hungary	40%	16%	37%	5%	1%	43%	57%
Ireland	43%	21%	33%	4%	1%	48%	53%
Israel	72%	0%	21%	6%	1%	22%	78%
Italy	27%	7%	55%	8%	3%	56%	44%
Netherlands	26%	20%	51%	2%	0%	66%	34%
Poland	26%	4%	63%	5%	2%	67%	33%
Serbia	48%	18%	28%	6%	0%	28%	72%
Slovenia	32%	25%	39%	3%	1%	60%	40%
Spain	33%	12%	49%	6%	0%	55%	45%
Sweden	31%	32%	33%	4%	0%	63%	37%
MEAN	35%	17%	40%	6%	1%	50%	50%

- ***Motorcycle types***: There are also large country differences concerning motorcycle type. Scooters are most frequently used in Israel, Greece, Italy and Spain. The sport styleis found most frequently in Serbia, Czech Rep, Sweden and Estonia. Conventional street motorcycles are most frequently used in Poland, Ireland and Austria. Enduro or offroad motorcycles will mainly be found in Cyprus, Greece, Italy and Slovenia. Touring style motorcycles are typical for Netherlands, France, Israel and Hungary. Choppers are most frequently used in Finland, Netherlands and Sweden. In general

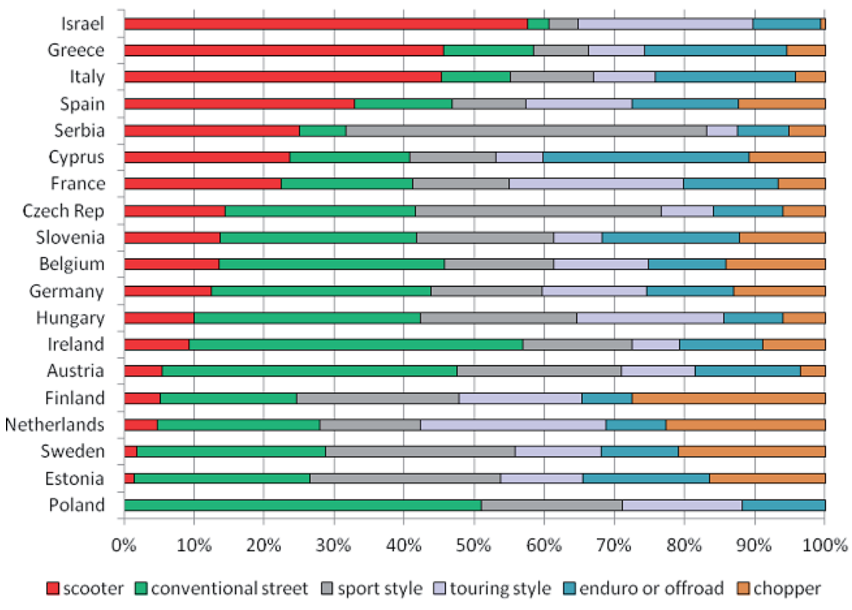


Figure 2: Kind of Motorcycle (MC28), in %.

there is a high proportion of scooter riders in mediterranean countries and high proportions of conventional street machines in northern countries.

- *Engine size*: There are large country differences concerning engine size (see Figure 3). Less than 126cc is most frequently used in Greece, Spain, Israel and France. 126-250 is most frequently used in Israel, Italy, Serbia and Hungary. 251-500cc is typical for Israel, Austria and Czech Rep. 501-750cc will be most frequently seen in Serbia, Estonia, Netherlands and Sweden. 751+cc is most frequently used in Finland, Sweden and Belgium. In general, smaller engine size up to 250cc is more typical for mediterranean countries. In northern countries higher engine size above 750cc is used

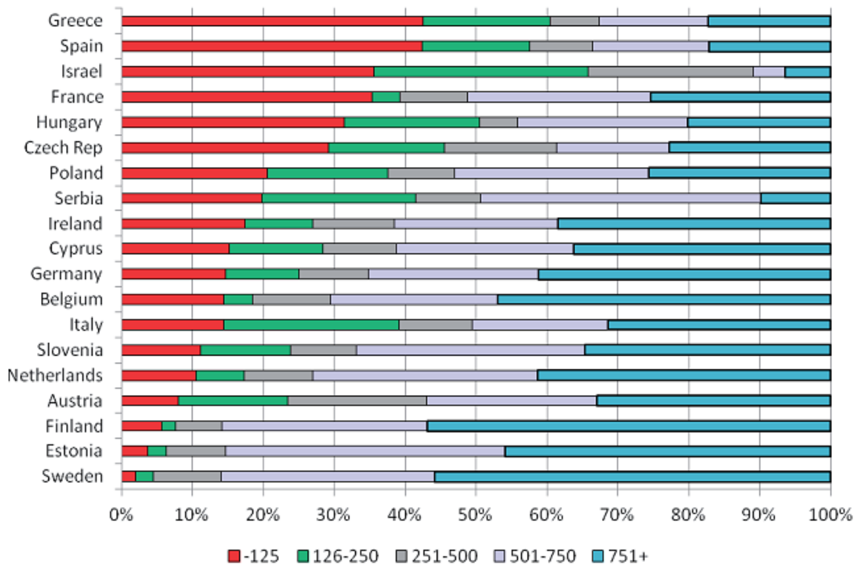


Figure 3: Engine size (MC27), in %.

- *Riding frequency*: Nearly daily use of motorcycle most frequently occurs in Greece, Israel, Cyprus and Ireland. Nearly daily use is seen more often in southern countries than in northern countries (see Figure 4). The fewest riding frequency is found in the Netherlands, Poland and Germany

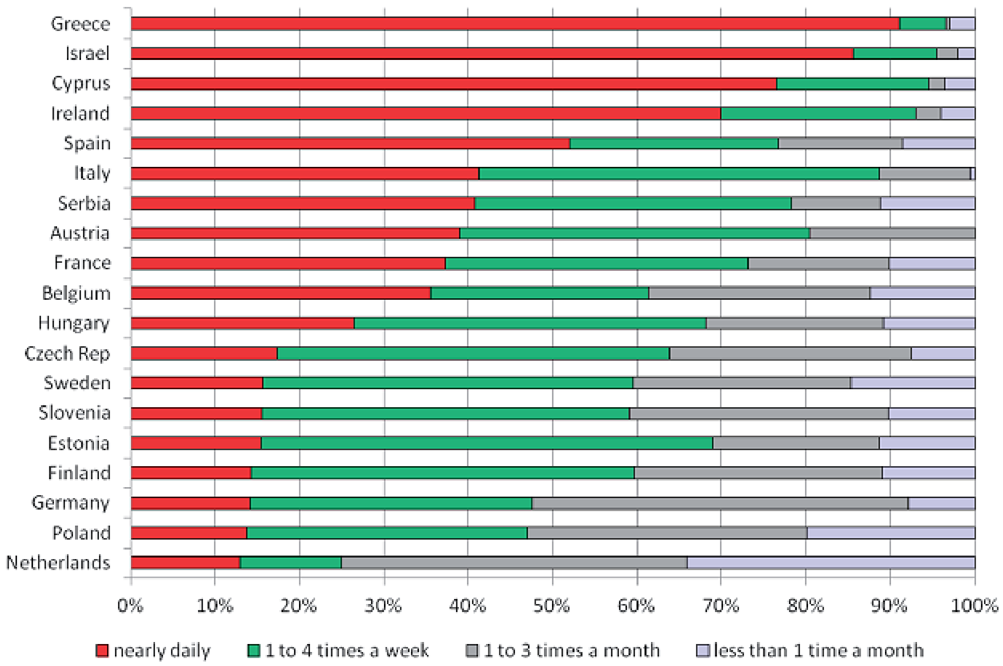


Figure 4: Motorcycle riding frequency (C001c), in %.

o ***Localisation***: The largest proportion of motorcyclists who are living in a rural area is found in Slovenia, followed by Germany Belgium, Poland and Netherlands (see Figure 5). The fewest proportion of this group lives in Sweden, Israel and Serbia. In Israel and Sweden most of the motorcyclists live in urban areas.

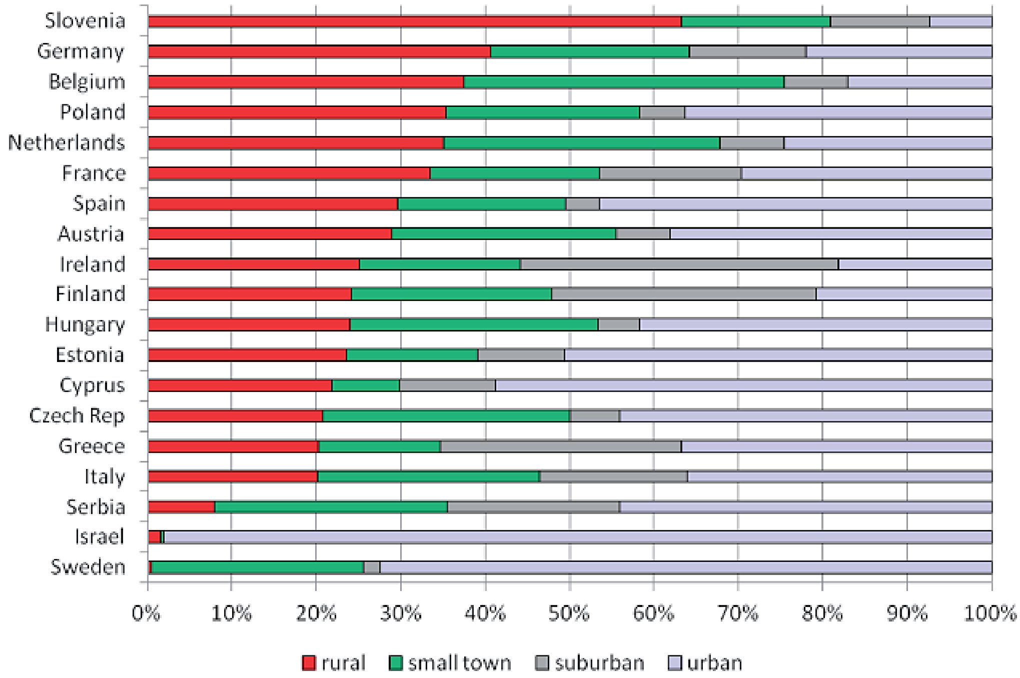


Figure 5: Area description (C014), in %.

o ***Risky behabviour***: The analysis of self-reported risky driving behaviour, such as for instance following the vehicle in front too closely or overtake when you can just make it, revealed that on average one of five motorcyclists admitted to engage in these behaviours; Southern European motorcyclists (Greece, Cyprus, Israel, Serbia) behave more risky than average and that the Western European countries (Germany, Ireland, France, Sweden, The Netherlands and Belgium) tend to drive less risky than average. On an individual level, male motorcyclists under the age of 34 and motorcyclists whose annual use of the motorcycle is high tend to be more risky

o ***Perceived risks***: Overall, motorcyclists seem to perceive two types of overtaking behavior (overtaking between lines on highway/beltway - overtaking between lines on highway/beltway) and of two types of weaving (weaving in and out between cars when traffic is dense in urban area - weaving in and out between cars on a highway) as very to fairly dangerous; the perceived risk appeared the highest in France, Germany and Ireland and the lowest in Cyprus and Hungary; despite the high correlation between age and experience in the entire sample, the effect of motorcycle experience on risk perception was less straightforward; on an individual level, risk perception increases with age.

o ***Alcohol:*** Thirteen percent of motorcyclists declared they may have driven their motorcycle while being probably over the legal BAC during the previous month. The proportion of motorcyclists who declared that they drove, at least once during the last month, after they had drunk even a small amount of alcohol is 23%. Most of them declared that they performed this behaviour rarely though. This result is consistent with data about alcohol prevalence among killed motorcyclists;

Overall, the vast majority of drivers - almost 93% - believed that alcohol increases the probability of collision with a third party;

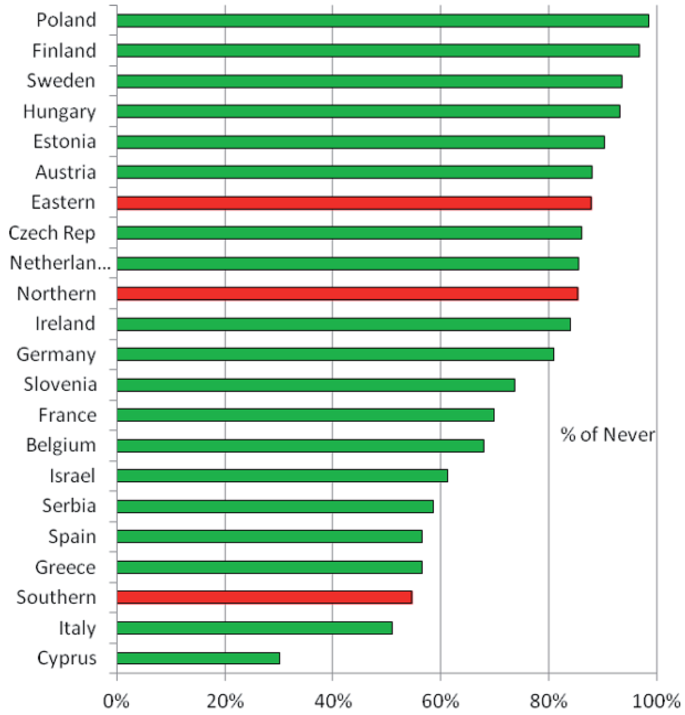


Figure 1: «Over the last month, how often have you driven a motorcycle after having drunk even a small amount of alcohol?».

Participants were asked, in a list of 10 potential accident factors, whether they thought that drinking and driving was a cause of motorcyclists being involved in road accidents. The results contrasted with those exposed above. Indeed when we compared countries (see Figure 4), the rankings were totally different than for previous questions. For example, in Sweden people were fully aware of the increased risk of accident when drink-driving and perceived, on the other side, a low involvement of this factor in road accidents. It may be that Swedish motorcyclists are convinced that very few of them are actually driving under the influence of alcohol. On the contrary, in Germany we found high proportions of positive answers for both questions. It could be that German motorcyclists perceive a high risk in drinkdriving and associate it with a high involvement of this factor in road crashes.

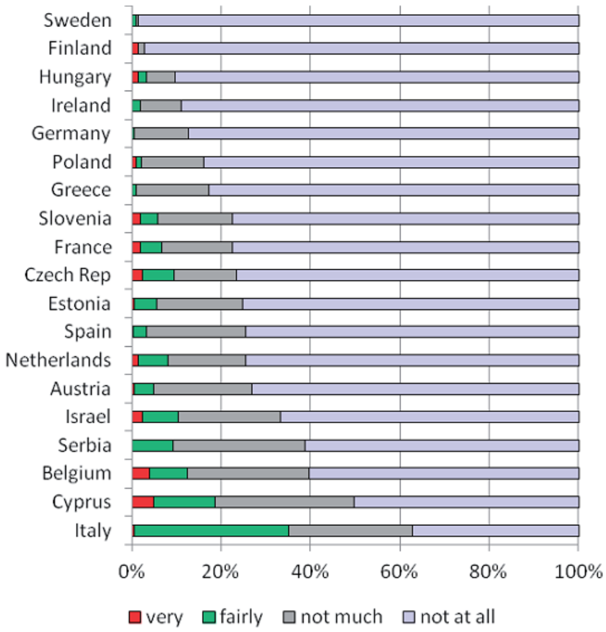


Figure 3: «You can drink and drive if you do it carefully», by country.

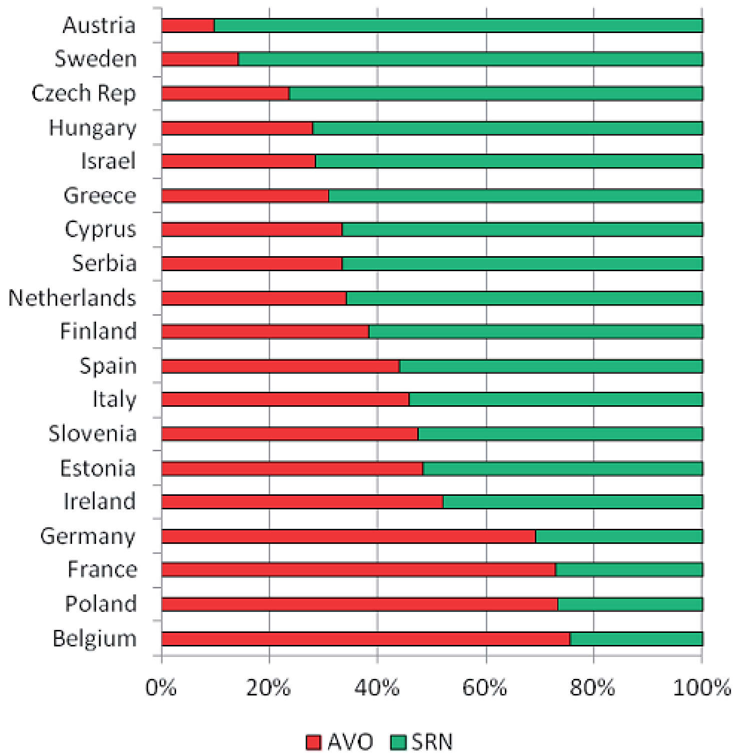


Figure 4: «How often do you think that drinking and motorcycling is the cause of motorcyclists being involved in road accidents «, by country.

Note: AVO is the sum of "Always", "Very often" and "Often" answers. SRN is the sum of "Sometimes", "Rarely" and "Never" answers.

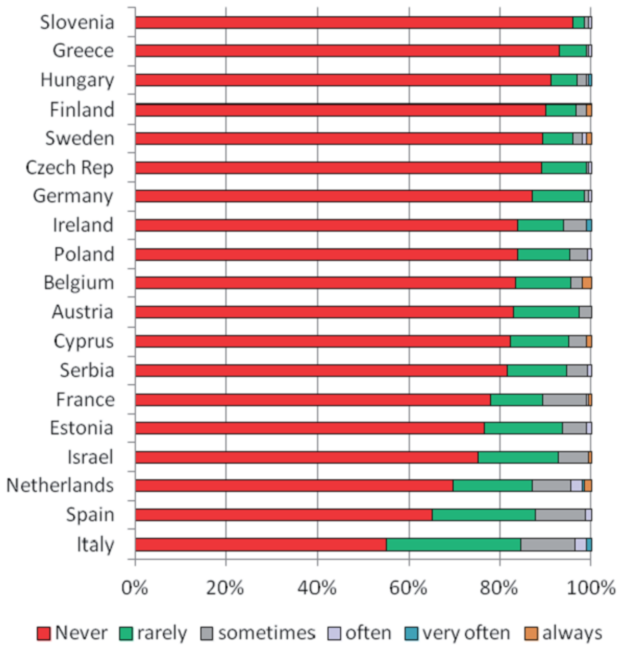


Figure 6: «Have you driven while taking a medication that carries a "warning: it may influence your driving ability"», by country.

- ***Drugs***: motorcycle driving under the influence of medication was reported even more scarcely in our sample than driving under the influence of alcohol (Figure 6). 81% of the motorcyclists reported that they "never" drive while taking a medication that carries a "warning: it may infl uence your driving ability"
- A detailed analysis of the motives for driving a motorcycle showed that overall, the pleasure of motorcycling, the feeling of freedom and the easiness to find parking are the most important motives. Motives regarding motorcycling advantages for mobility and biking spirit revealed to be important secondary motives. On the basis of an international comparison of high and low national scores on the different motives, two opposite groups of countries, generally having opposite motives, were identified: a group of five Mediterranean countries (Greece, Israel, Cyprus, Spain and Italy) and a group of four North and Central European countries (Finland, Sweden, Germany and Slovenia). Motorcycling advantages for mobility appeared to be crucial reasons for using a motorbike in the Mediterranean group, but less important for the Northern group. Similarly, imposed constraints like not having a car or having no choice revealed more crucial for the Mediterranean group then for the others. Northern and Southern countries proved partially mixed concerning biking spirit and speed enjoyment
- ***Helmet wearing***: According to respondents, their safety helmet wearing rate is high with less than 2% reporting that they "never" or "rarely" wear a helmet. The type of road that the motorcyclist uses is one factor affecting helmet use with the highest rate on motorways ("always" wear a helmet 91,4%) while it is the lowest in built-up areas ("always" wear a helmet 84,6%). However, the proportion of the riders always wearing a helmet is not satisfactory.

- *Gender*: The percentage of females "always" wearing a helmet is somewhat higher (consistently greater than 2% higher) than that of males for each of the four road categories
- *Engine size*: The helmet-wearing rate is higher among drivers riding motorcycles with an engine size greater than 250 cc, consequently with higher performance and faster
- *Annual mileage*: The percentage "always" wearing a helmet is somewhat lower among those who drive more than 5000 kilometres a year on a motorcycle compared to those who drive less than 5000 kilometres a year. However the helmet wearing rate is signifi cantly lower if the motorcycle vehicle-kilometres are over 10 000 km/year
- *Location*: A signif cant relationship between the countries and helmet wearing has been found for all road categories

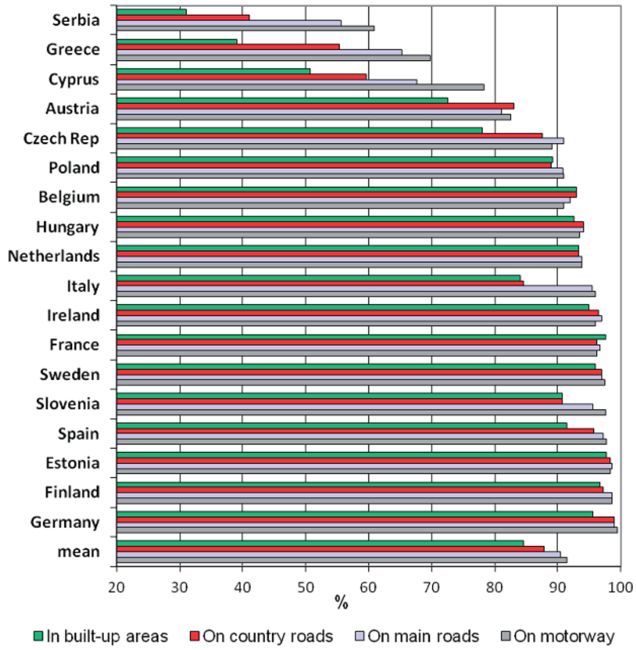


Figure 4: Percentage of motorcyclists "always" wearing a helmet in the different countries by different road types.

- *Passengers' helmet-wearing* rate is somewhat poorer than that of the drivers with 78,5% of the motorcycle drivers "never" carrying a passenger without a helmet; The proportion of motorcycle riders who report "never" carrying passengers without a helmet is the lowest for the youngest age-group (18-24 years of age); as age rises the proportion of those not carrying passengers without helmet increases
- *Helmet wearing attitude:*

Table 7: Percentage agreement with statements about helmet wearing.

%	Very or fairly	Not much, not at all
In most accidents helmets reduce the risk of serious injury for drivers and passengers	96,1	3,9
If you drive carefully it is not really necessary to fasten helmet	10,7	89,3
I enjoy driving without wearing a helmet	16,3	83,6
Most of my friends use a helmet when driving a motorcycle	90,3	9,7
I only wear a helmet because it is the law	19,9	80,1

Table 8: Mean of the motorcyclists' agreement rate with the statements about helmet wearing.

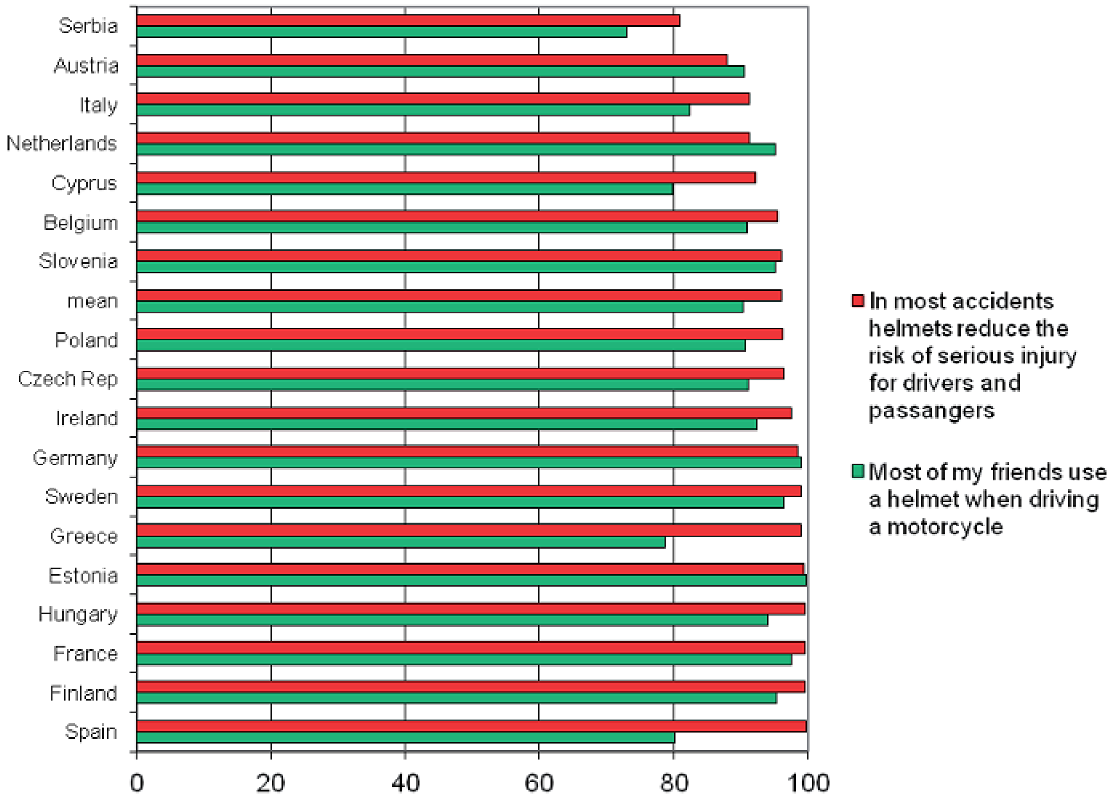
	mean
In most accidents helmets reduce the risk of serious injury for drivers and passengers	1,27
If you drive carefully it is not really necessary to fasten helmet	3,59
I enjoy driving without wearing a helmet	3,44
Most of my friends use a helmet when driving a motorcycle	1,44
I only wear a helmet because it is the law	3,31

Table 9: Mean of the motorcyclists' agreement rate by age-groups with the statements about helmet wearing.

	Age category						Mean of means
	18-24	25-34	35-44	45-54	55-64	65+	
In most accidents helmets reduce the risk of serious injury for drivers and passengers	1,30	1,28	1,27	1,24	1,29	1,25	1,27
If you drive carefully it is not really necessary to fasten helmet	3,49	3,60	3,64	3,62	3,56	3,54	3,59
I enjoy driving without wearing a helmet	3,27	3,35	3,49	3,51	3,57	3,59	3,44
Most of my friends use a helmet when driving a motorcycle	1,53	1,43	1,40	1,41	1,44	1,46	1,44
I only wear a helmet because it is the law	3,20	3,28	3,32	3,34	3,40	3,35	3,31

Table 10: Mean of the motorcyclists' agreement rate by engine size with the statements about helmet wearing.

	Engine size (cc)					
	0-125	126-250	251-600	601-1000	1000+	Mean of means
In most accidents helmets reduce the risk of serious injury for drivers and passengers	1,27	1,36	1,28	1,25	1,24	1,27
If you drive carefully it is not really necessary to fasten helmet	3,54	3,37	3,60	3,67	3,65	3,59
I enjoy driving without wearing a helmet	3,44	3,26	3,42	3,48	3,51	3,44
Most of my friends use a helmet when driving a motorcycle	1,61	1,60	1,43	1,33	1,33	1,44
I only wear a helmet because it is the law	3,21	3,06	3,32	3,40	3,40	3,31



- Other protective clothing: The percentage of motorcyclists wearing a technical jacket is highest in Austria, Sweden, Estonia, and the lowest in Greece, Italy and Hungary. Back protection equipment is most used in Sweden, Ireland and Austria and the lowest use is found in Italy, Greece and Hungary. The use of technical shoes/boots is most often found in the Netherlands, Sweden and Austria, while less often in Italy, Greece and Serbia. Finally, use of a phone system installed in the helmet is highest in Serbia, Israel and Austria, while the lowest usage is in France, Sweden and Slovenia; Concerning use of other safety equipment, such as technical jacket, back protection, or technical boots, the highest wearing rates we can find in Austria, Sweden, Estonia, Ireland and Netherlands, and the lowest in Italy, Greece, Hungary and Serbia. There is a relation to styles of motorcycling typical for individual countries, but also to weather conditions.

Table 18: Frequency of use of other motorcycle safety devices by countries ('Always'+'very often'+'often''sometimes'+'rarely').

	Technical jacket		Back protection equipment		Technical shoes/ boots		Phone system in the helmet	
	%	adj.res.	%	adj.res.	%	adj.res.	%	adj.res.
Austria	98,5	5,6	84,0	6,1	92,5	6,2	42,5	6,2
Belgium	95,0	4,2	72,6		85,9	4,0	16,6	
Cyprus	77,4	-2,7	59,4		64,7		29,4	
Czech Rep	87,6		63,7		76,6		24,0	
Estonia	97,1	6,8	73,6		90,1	7,1	27,7	
Finland	93,4	3,7	64,9		86,3		10,4	
France	84,7		58,9		63,2		5,3	-6,5
Germany	96,1	4,7	69,1		90,2	5,5	18,9	
Greece	56,4	-11,2	39,1	-7,4	46,0	-9,2	17,8	
Hungary	73,0	-4,6	51,0	-3,9	64,7		13,9	
Ireland	95,5	4,4	85,0	6,4	92,0	6,0	17,6	
Israel	79,1		54,3		64,6		52,0	9,4
Italy	59,8	-9,6	36,1	-8,2	34,0	-12,9	31,4	
Netherlands	95,7	4,6	68,3		94,2	6,9	26,9	
Poland	74,7	-6,7	53,2	-5,4	65,7		31,0	
Serbia	85,5		75,7		59,9	-4,0	59,2	10,3
Slovenia	89,7		75,6		86,6		9,8	-4,9
Spain	77,9	-3,7	58,5		60,6	-6,3	17,1	
Sweden	98,0	5,4	85,4	6,5	93,5	6,5	8,5	-5,2
Total	84,4		63,7		73,8		24,1	

- The results of the survey revealed important differences between various groups of motorcyclists and also various countries in usage of helmets and other safety devices. Besides general safety awareness of individual countries, there are complex factors affecting wearing rates

- ***Accidents/***

  - ***Vehicle type:*** With regard to the engine size there are again differences between the Southern and the Northern European countries. While in the Southern European countries there is a high proportion of small sized motorcycles up to 250 cc involved in accidents (e.g. Israel 66%, Greece and Spain 60%), in Northern countries the

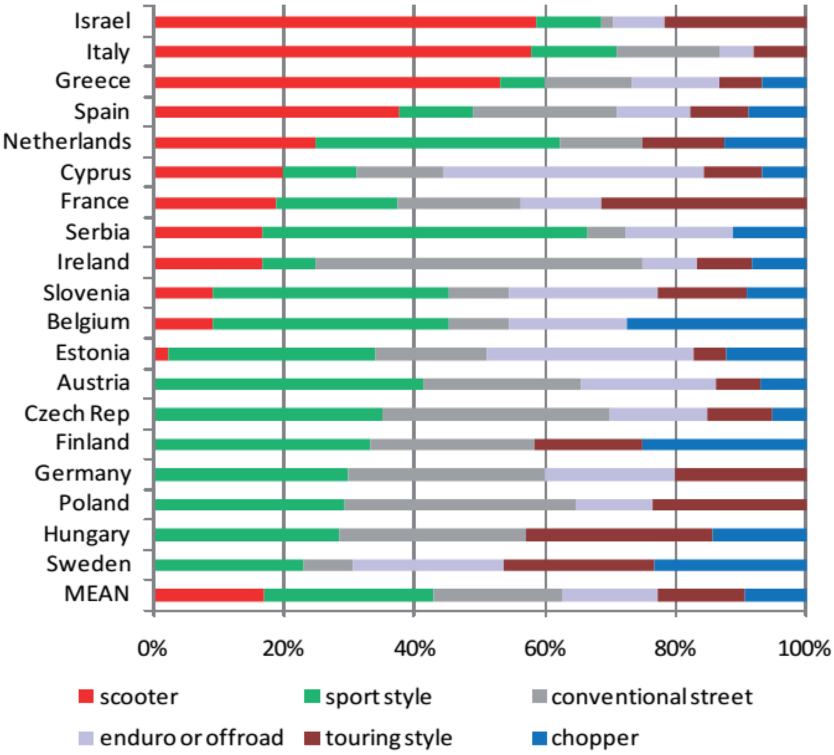


Figure 2: Injury accident involvement by country for motorcycle type (in % of accident involved motorcyclists).

highest proportion of accident involved motorcycles has an engine size of more than 750 cc (e.g. Finland 75%, Estonia 59 % and Sweden 47%)

- Location: The proportions of accident involved motorcyclists differ between these two groups. In mean 8% of the motorcyclists from northern Europe have been involved in an accident whereas this proportion is 15% for southern Europe

Figure 3: Participating countries separated into northern and southern European countries.

- *Age*: Within the group of accident involved motorcyclists 18-24 year-olds have a proportion of 20% and 25-34 yearolds 35%, whereas within the group of non accident involved motorcyclists 18-24 year-olds have a proportion of 14 % and 25-34 year-olds of 26%

- *Family Status*: The majority of accident involved motorcyclists is single (41%), followed by married (31%) and as married living motorcyclists (20%). In comparison to the distribution among all motorcyclists, single and as married living motorcyclists are overrepresented in the distribution of accident involved motorcyclists.

o ***Risk factors***: Several risk factors are related to accident involvement of motorcyclists in the literature. Besides the lack of experience also younger age (even if corrected for experience), alcohol consumption and speeding behaviour are factors which affect the accident risk of motorcyclists;

In comparison to non accident involved motorcyclists, the group of accident involved motorcyclists

- *is distributed of a higher proportion of young motorcyclists between 18-34 years of age,*
- *(II) scores higher on questions about risky behaviour,*
- *(III) has more tickets for traffic violations,*
- *(IV) indicates to have a riskier attitude towards driving under the influence of alcohol and towards helmet use,*
- *(V) scores lower on questions about risk perception and (VI) indicates more often to enjoy acceleration and high speed*

Overall the most important factors in the comparison of accident involved and non accident involved motorcyclists are age, risky riding behaviour, tickets and drink driving. Motorcyclists attitudes, motives to ride a motorcycle and risk perception do not highly affect the accident risk of motorcyclists

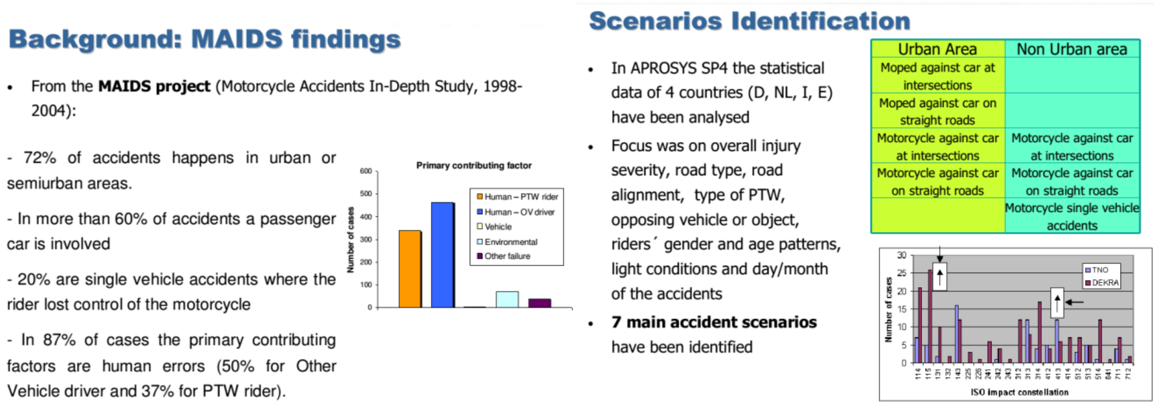
- ***Motorcyclists Profiles***:
  - *Commuters*: typically ride Scooters and less powerful motorbikes; less interested by advanced motorcycle skill courses; use their motorbike during all the year; motivations for driving a motorbike primarily concern motorcycling advantages for mobility(i.e. avoiding traffic jam, saving time, easiness for parking, cheaper mean of transport and lastly, reduce CO2 pollution) or because of imposed constraints (i.e. having no car or not any other choice for mobility for); pleasure of riding is significantly less important for this group of motorcyclists against the others, and they are clearly not interested in biking spirit or acceleration feeling; have lower number of speed tickets; generally wear a helmet when they drive a motorbike; are well aware of helmet positive effect for their safety in case of accident; however, sometime ride a passenger without helmet; they significantly less frequently used other safety equipment when riding (like jackets, back protections and motorbike shoes); risky manoeuvres include *too close car-following distance keeping* and *critical overtaking;* very aware of the dangerousness of riding manoeuvres like *weaving* or *overtaking cars between lines*
  - *Sport Riders*: ride Sport style powerful motorbikes; keener towards advanced motorcycle skill courses; motivations for driving a motorcycle primarily concern the pleasure of riding, freedom feeling and acceleration sensations; Biking spirit is also very important; even if less essential, motorcycling advantages for mobility(more particularly avoiding traffic jam, saving time, and easiness for parking) are also very important motivations; imposed constraints like having no car or not any other choice for mobility, is not relevant; like speed and acceleration when riding, and they have had a significantly highest number of speed tickets than the 2 other groups, aware of alcohol risk when riding, and like the other groups, they generally not ride their bike when they have drunk; generally wear a helmet when they ride and they are well aware of helmet positive effect for their safety in case of accident; they frequently used specific jackets, back protections

and motorbike shoes when riding (// ramblers and travelers); have more risky practices than the others groups; seems also less aware of the dangerousness of weaving manoeuvres (in urban area or on motorway) and overtaking vehicles on the right

- *Ramblers*: mainly ride Conventional Street Power full motorbikes, but also Sport Style motorbikes, , Touring motorbikes or Choppers; Against Commuters (but like Sport Riders and Travellers), they have completed advanced motorcycle skill courses; significantly use less their motorbike during the year (only 6 months in means, against 8 for Sport Riders and Travellers and for Commuters); main motivations for driving a motorbike were clearly fun and pleasure of riding and freedom feeling. However, Biking spirit and Acceleration enjoying are also important for this group of riders; On the contrary, motorcycling advantages for mobility (more particularly avoiding traffic jam, saving time, and easiness for parking) were clearly not important motivations for a large part of them and imposed constraints - like having no car or not any other choice for mobility – are totally marginal motivations for this group of motorcyclists; In the same way, economical motivations (i.e. cheaper mean of transport) are clearly less important for this group than for the others; they have had a lower number of speed tickets than Sport Riders and Travellers; seemed more aware than Commuters of speed risk in urban area; had also a very careful attitude towards alcohol when riding and, with the group of Travellers, they had the highest positive attitude towards helmet wearing when they drove a motorbike, and they were very aware of helmet interest for riders' safety, for themselves as well as for their passenger; seemed also very aware of the dangerousness of weaving manoeuvres, and overtaking vehicles on the right as well as between lines.
- *Travellers:* highest level of motorcycling experience; No difference in term of attitudes towards speed and alcohol when riding in terms the number of kilometres covered per year with a motorcycle; ride mainly Conventional Street motorbikes, but a high number of Travellers also ride Touring motorbikes and Choppers; a significant highest proportion of them ride Off-Road bikes; group with the highest number of motorcyclists having completed advanced motorcycle skill courses; main motivations for driving a motorbike were clearly pleasure of riding and freedom feeling and Biking spirit; motorcycling advantages for mobility(more particularly for saving time, avoiding traffic jam, and parking easiness) were also important motivations for a large part of them; imposed constraints like having no car or not any other choice for mobility, was not relevant; They ride above all because they like it; seemed less interested by speed than other groups; seemed globally aware of alcohol risk when riding and they had a very positive attitude towards helmet wearing; also fully aware of helmet interest in case of accident; frequently used specific jackets, back protections and motorbike shoes when riding; they less often followed vehicle with a too close distance than Commuters or Sport Riders, and they less often implemented critical overtaking manoeuvres (i.e. when they think they can just make it) than these 2 other groups of motorcyclists; also more aware than Sport Riders of the dangerousness of weaving manoeuvres (in urban area or on motorway) and overtaking vehicles on the right

- No difference in term of attitudes towards speed and alcohol when riding.

- **SIM**



In-depth analysis - Parameters

- PTW design
- PTW colour
- PTW user injury patterns
- Accident location
- Rider behaviour before impact
- Kind of collision
- Tyre conditions
- Influence of tyre fault
- Classification of skid marks
- Road characteristics
- Road condition
- Involved parties
- Right-of-way regulations
- Visibility conditions
- Weather conditions
- Lighting conditions
- Technical defects
- Evasive manoeuvres
- Kind of PTW driver reaction
- Accident avoidance
- Accident causation
- Question of guilt
- PTW initial driving speed
- PTW speed of first collision
- PTW driving speed – collision speed
- PTW brake system

- **SIM (2009) – In-Depth Accident Analysis**
  - Analyses comprises 1093 in-depth accident cases (> APROSYS SP4 – Accident databases from The Netherlands/ Italy/ Spain/ Germany). 7 main accident scenarios:
    - Accident avoidance manoeuvres identifiable in 70% of the cases
    - Emergency manoeuvres consisted mostly in full-breaking, partly swerving and/or braking
    - High percentage of "loss of control" before impact
    - Most of the accidents are influenced by human behaviour both of PTW rider and OV driver (inattention, perception failure, traffic scan error, faulty traffic strategies)
    - The ISO configurations are diverse and no clear main scenario can be distinguished

Urban Area	Non Urban area
Moped against car at intersections	
Moped against car on straight roads	
Motorcycle against car at intersections	Motorcycle against car at intersections
Motorcycle against car on straight roads	Motorcycle against car on straight roads
	Motorcycle single vehicle accidents

- In most of the impacts the PTW is still upright and the rider is not separated from the PTW at the time of impact
- The object hit primarily is mostly the car, then the road and the PTW itself
- Primary impact occurs to the lower extremity, followed by head, upper extremity and thorax
- The severity of injuries reported for certain body areas show a marked increase in line with increased speed.
- The wearing of protective clothing reduces the severity of the injuries
- ABS and traction control seems to be the main appropriate countermeasures

- **Smart RRS (2011) – D2.1a**
  - In-depth accident causation analysis: SPAIN
  - ***Accident share***
    - Decrease from 1995 to 2003, from 12000 to about 10000 accidents. Unfortunately, this long and slow decrease turns over in 2 years, when the accidents involving motorcycle raised from10211 in 2003 to 12722 in 2005, representing an increase of more than 20%.

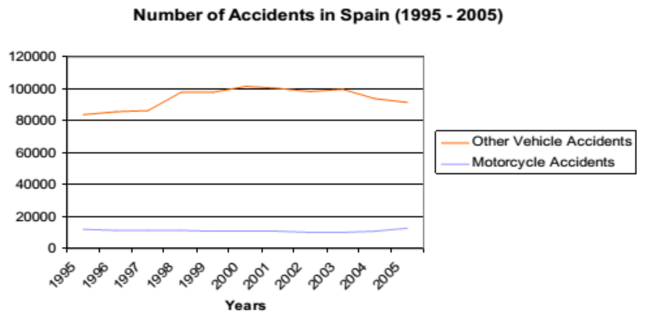


Figure 2. Number of accidents in Spain, according to the type of vehicle

    - The data available on the Spanish vehicle park show that the number of vehicles on the roads in Spain has actually raised from approximately 20,300,000 vehicles in 1997 to 27,700,000 in 2005 which corresponds to a growth of more than 36%
    - The number of accidents involving motorcyclists is related to the sharply increasing number of motorcycles on the roads. While the vehicle park evolution is a cause of the recent accident growth, the decrease in other vehicle accidents consequently results as an increase in the proportion of these accidents

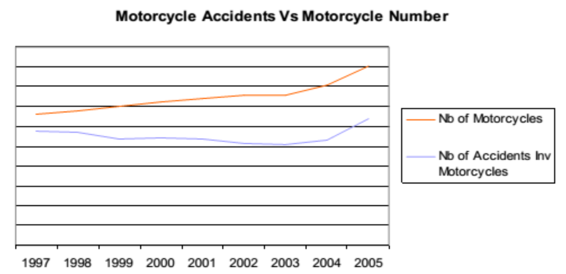


Figure 3. Relation between motorcycle accidents and motorcycle number

    - Motorcycle accident victims represent approximately 10% of all road victims,
    - Accident severity is usually identified as Fatal, Severe and Slight

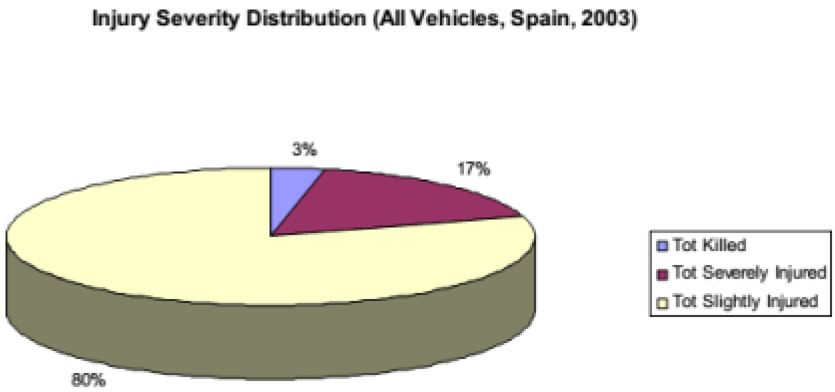


Figure 8. Severity distribution, all vehicles

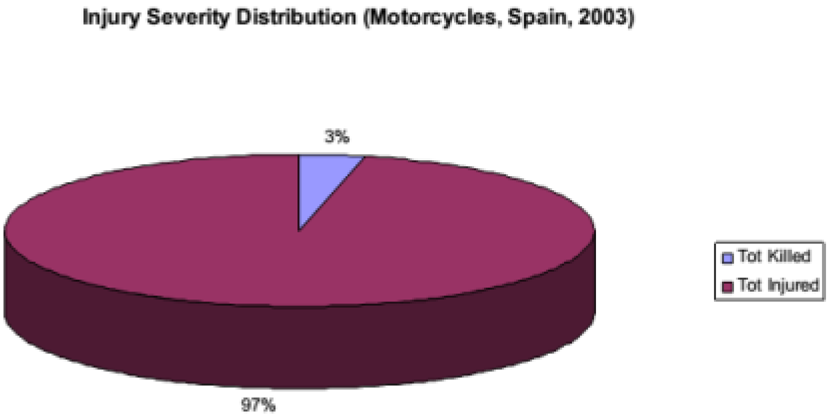


Figure 9. Severity distribution, motorcycles

- These figures show that the death toll (ratio of killed persons to the number of victims of accidents) characterizing motorcycle accidents in Spain is 3%, meaning that as an average 1 victim out of 33 was fatally injured in the road traffic accidents in 2003.
- In fact these values are difficult to quantify since the definition of "injured" is not fundamentally strict when it comes to slight injuries. Also the results of the accidents are usually different between motorcycles and other vehicles, almost all motorcycle accidents leading to at least slight injuries. Most of the motorcycle accidents (about 70%) are occurring in urban area, and usually result in slight injuries, which is very different from other vehicles

- ***Accident location and types***

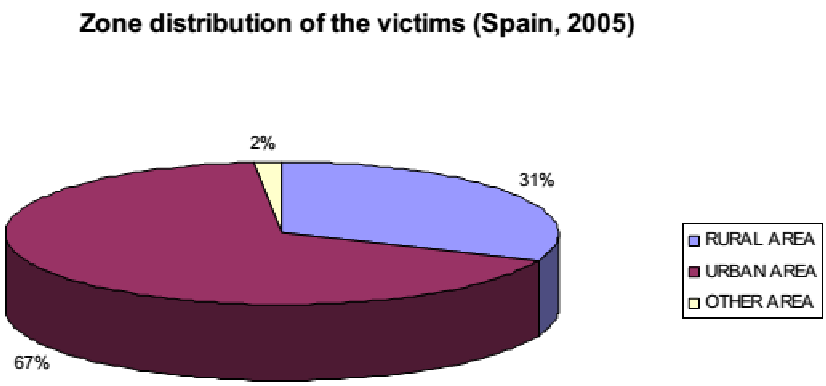


Figure 12. Average distribution of the accidents for the year 2005

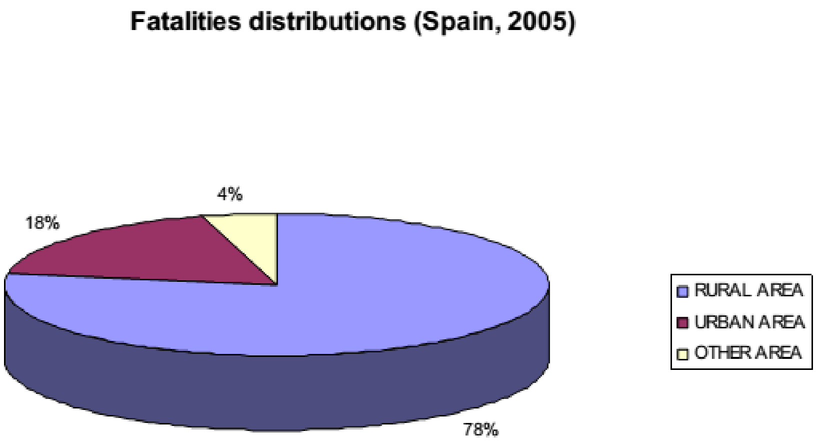


Figure 13. Average fatalities distribution for the years 2003, 2004 and 2005

- ***URBAN Area***

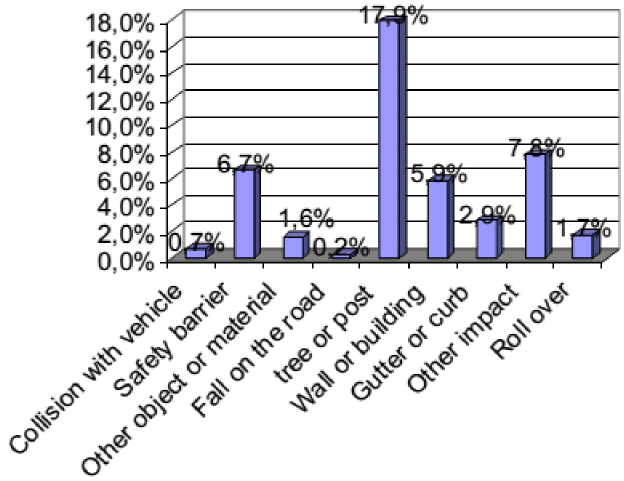


Figure 14. Fatality Risk in urban area

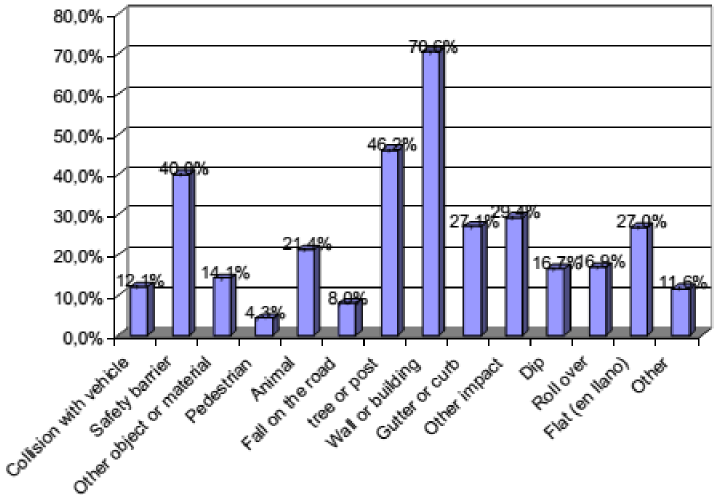


Figure 15. Severe Injury Risk

- ***RURAL area***

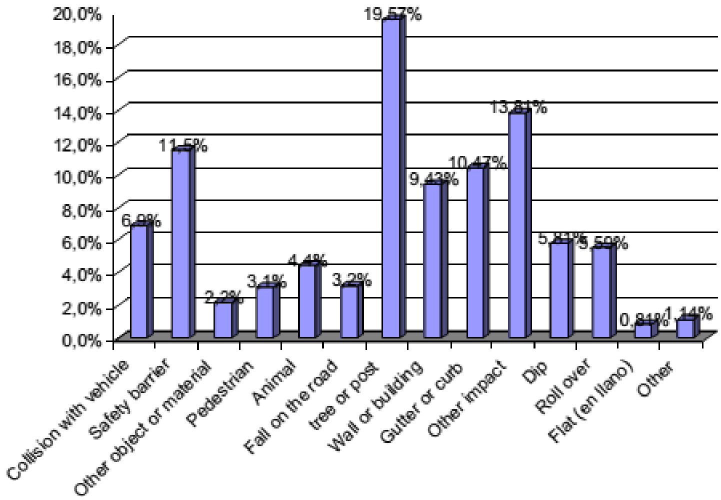


Figure 16. Fatality risk (FR) according to accident configurations

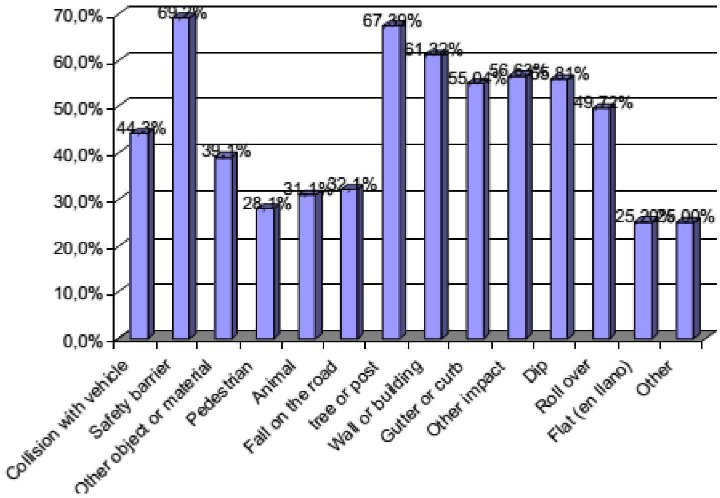


Figure 17. Severe Injury Risk (SIR) in different accident configurations

- **SUNFLOWER+6**

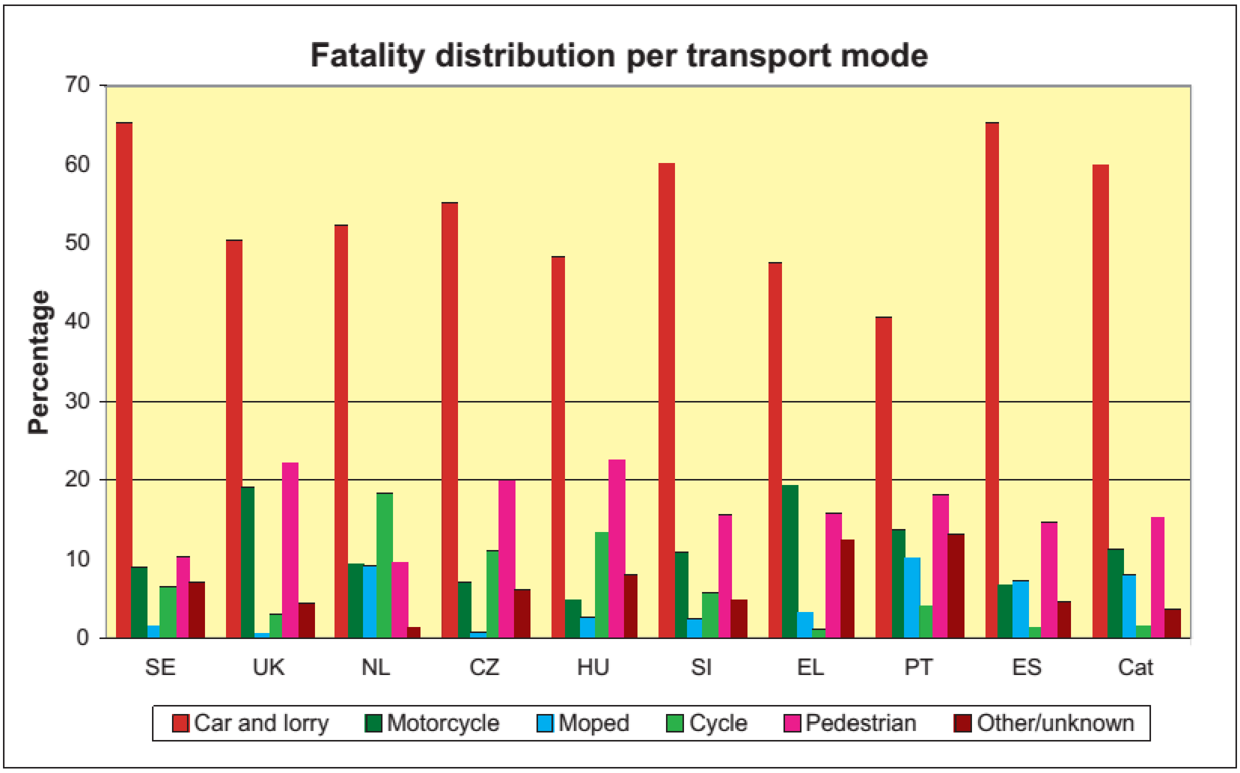
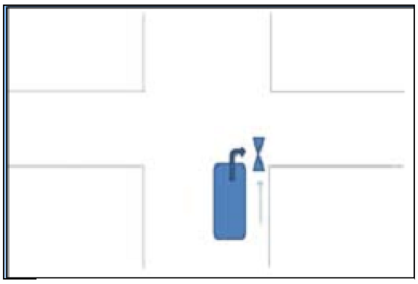


Figure 3.1. *Percentages of fatalities per transport mode in the SUNflower+6 countries and Catalonia in 2003.*

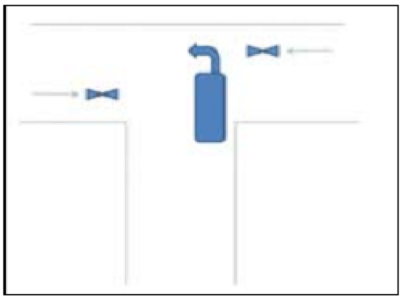
- **TRACE**
  - Cf. outcomes PISA

- **VRUITS** (ongoing project) **- Deliverable 2.1**
  - The VRUITS project undertook a comparison between CARE and several EU databases of motorcycle accidents, both in-depth and macroscopic, pan-European and national[8]. According to CARE, most motorcycle accidents:
    1. Happen at crossroads;
       - ⇨ this is consistent with Austrian and UK data, the 3 others do not have that information
    2. involve far more males than females involved in the accidents;
       - ⇨ This is consistent with the data from Spain, Austrian, UK, Finland, and Sweden
    3. Take place mostly urban environment;
       - ⇨ This is consistent with the data from Spain, Austrian, UK, Finland, and Sweden
    4. At speeds between 30-50 km/h
       - ⇨ this is consistent with the UK and Swedish data, the only 2 countries with speed specification
    5. with similar number of incidents on all days of the week;
       - ⇨ yes, with a slight dip during at weekends in Spain, yes in Sweden, no in Finland, no in Austria but with a slight dip at weekends, unknown for the UK



VRUITS PTW Scenario 2

    6. in daylight conditions;
       - ⇨ yes for all
    7. between 12pm and 6pm
       - ⇨ yes for all countries, except for th UK which do not have the information
    8. in warmer months of May to September;
       - ⇨ yes for all countries
    9. in fine weather;
       - ⇨ yes for all countries
    10. and a majority of riders wore a helmet
        - ⇨ yes for Spain and Sweden, almost certainly for the UK, unknown for Finland, and a majority did not for Austria (?)



VRUITS PTW Scenario 1

8 The following databes were analyzed: CARE, SafetyNET, PENDANT, The Austrian Statistics of Road Accidents, DGT, STRADA, STAT19 – Source: First Interest Group Workshop, 18/09/2013, Brussels

- With regards to accident scenario, CARE finds that 'Being hit by a car going the same direction then turning into them' (VRUITS PTW scenario 2) is the most commonly occurring accident scenario, which is:
  - Partially consistent with Spanish data which did not give direction but did involve the vehicle turning into the motorcyclist.
  - NOT consistent with UK, and Finnish national database analyses which suggest that the most common scenario involves vehicles pulling out from intersections into the path of the PTW (VRUITS PTW scenario 1);
  - For Austria, neither scenario was representative of Austrian statistics at junctions.[9]
- However, it has to be noted that researchers from 2BESAFE and VRUITs projects underlined the limits of CARE, and most of the national data, as all these databases information are mainly based on police recordings. Moreover, the safety characteristics of mopeds and scooters have resemblance with motorcyclists as well as cyclists. There are significant differences as well, justifying a separate category. Mopeds, scooters and motorcycles are often combined in one category 'powered two-wheeler' (PTW's), as in CARE.
- OTS investigations (UK) and MAIDS databases: the results of On the Spot (OTS) Investigations[10] (2008) in Great Britain have provided over 200 motorcycle cases in the OTS database which can be analysed and compared to the MAIDS[11] results (2004). The two databases highlighted some similarities in the accident populations of OTS and MAIDS data, which are:
  - Collision partner: both OTS and MAIDS show that the major collision partner in motorcycle accidents are passenger cars, accounting for approximately two-thirds of accidents. This is the case regardless of whether the accident occurred in a rural or urban setting.
  - Junction accidents: the proportions of accidents which occur away from a junction are similar between the studies (38% for MAIDS and 42% for OTS).
  - Causation: a traffic scan error by the motorcycle rider contributed to the accident in 28% of MAIDS records and 22% of OTS records. Traffic scan errors by other vehicles users in the collision accounted for 64% of accidents in MAIDS and 67% of accidents in OTS.
- Mopeds and Scooters Accident[12] : There are two main difficulties for a specific assessment of safety issues with light PTW's (mopeds and scooters) in Europe:
  - Mopeds and scooters are not uniformly defined across Europe. Member States tend to have different definitions of categories (in terms of maximum speed, maximum motor

[9] The VRUITS First Interest Group Workshop – Brussels- September 18, 2013 – Deliverable 2.1 Technology potential of ITS addressing the needs of Vulnerable Road Users (not published)

[10] Mansfield et al (2008) Analysis of the On the Spot (OTS) Road Accident Database; Road Safety Research Report No.80, Department for Transport, Great Britain.

[11] MAIDS (2004): Motorcycle Accident In depth Study, ACEM.

[12] ITS ACTION PLAN / framework contract TREN/G4/FV-2008/475/01 http://ec.europa.eu/transport/themes/its/studies/its_en.htm

volume or maximum power), different requirements as to require driving licenses and mandatory use of a helmet. As a result, statements about light PTW's have different meanings from country to country.

  - As with bicycles, there are large differences in the use of light PTW's between Member States.

- These differences are also reflected in national accident statistics that are difficult to aggregate on a European level. According to the EU's CARE database, moped fatalities constitute some 4% of all traffic fatalities in Europe. This seems a modest share, yet the normalised fatality rate is the highest of all modalities, even higher than for motorcycles. Dutch statistics over 2003-2006, indicate a fatality rate of 70 per billion kilometres travelled - compared to 66 for motorcyclists, 12 for pedal cyclists and 3 for car drivers. The corresponding figures in the UK in 2008 were 89 for mopeds & motorcyclists and 2 for car drivers. Moped riders stand out more when considering severe injuries: the severe injury rate (fatalities + in-patients) equals 800, almost twice the corresponding value for motorcyclists.

  The group of young drivers, aged 15-17 is of special concern as their injury rate is even two times higher than for average moped riders.

- In conclusion, the following types of accidents involving motorcycles are reported to be most common in various national and European studies:

  - Accidents at an intersection: 29% of motorcycle fatalities occur at junctions (compared to 16% for passenger car occupants), mostly on crossroads and T- or Y-junctions. Often a right-of-way violation is involved, where in many cases the error is made by the car driver failing to notice the motorcycle.

  - Accidents during an overtaking manoeuvre, often caused by a car driver having a motorcycle in the adjacent lane blind spot, or not observing the upcoming motorcycle when overtaking on single carriageway roads.

  - Single motorcycle accidents, due to loss of control. This type of accident often takes place in curves. Excess speed and/or locally deteriorated road surfaces are common causes for this type of accidents.

- From this review, it appeared that:
  - Critical situations for VRUs proved to be usually related to high (car) speeds, high complexity and density of traffic, local weather conditions and maintenance of infrastructure;
  - Main identified benefits and advantages of ITS for VRUs are increased *visibility* of VRUs (communication, warning, intervention); increased overall *traffic flow* (automation of processes such as traffic lights, etc.); while the adverse effects are a perceived *loss of autonomy*, *distraction* (sounds, visuals, interaction with HMI), and potential for *overreliance/overconfidence,* technical limitations and reliability;
  - Future technological advances are mainly expected in view of *connecting road user groups* (communication between VRUs and vehicles); *increasing visibility and vision*;

standardisation of technologies; *infrastructural developments* and *adaptation of legal requirements* for broad scale deployment of technologies.

- For Powered Two Wheelers, the most common scenario in the CARE accident analysis was found to be the PTW being hit by a vehicle (mainly passenger car) initially heading in the same direction and then turning across the path of the PTW. This was not consistent with the national database analyses which suggest that the most common scenario involves vehicles pulling out from intersections into the path of the PTW. Most accidents occurred within urban environments. It is thought that the majority occurred on roads with low speed limits (<50km/h). The majority of accidents occurred in fine and dry weather conditions during daylight hours. The majority occurred during the'summer months' (May to September)
- A limitation of CARE, and most of the national data, is that they mainly based on police recordings, which have an underreporting of single accidents

Table 4 Summary of CARE Data Analysis – Powered Two-Wheelers (PTW's)

Description
The most common scenario was found to be for PTW's being struck by a car going in the same direction then turning into them (scenario PTW 2 – see addendum).
Far more males were involved compared to females involved in the accidents
Most accidents occur in Urban environments
The road-speed at the accident location is mostly between 30 and 50kmh
The majority occur at crossroads
The most common time is between 12pm and 6pm
There are a similar number of incidents on all days of week
Most accidents occur in daylight conditions
Most accidents occur in the warmer months of May to September
Most accidents occur in fine, dry weather
Majority of accident-involved PTW riders wore a helmet

- Some results were not as expected and are somewhat at odds with the national data analysed. Each of the other databases is now described in turn. A summary of the analysis of the database is described and this is also compared to the CARE dataset.

Table 6 Comparison of consistency of the Spanish GDT data with CARE for PTWs

Description (CARE findings)	Spanish data consistency with CARE
Being hit by a car going the same direction then turning into them (PTW 2) is the most commonly occurring accident scenario.	Partially - didn't give direction-but did involve the vehicle turning into the motorcyclist
Far more males than females involved in the accidents	Yes
Mostly Urban environments	Yes
Between 30-50kmh	N/a - didn't specify speed
At crossroads	N/a - didn't specify junction type
Between 12pm and 6pm	Yes
Similar number of incidents on all days of week	Yes- slight dip at weekend though
In daylight conditions	Yes
In warmer months of May to September	Yes (warmer months but only May to July)
In fine weather	Yes
Majority wore a helmet	Yes

Table 9 Comparison of consistency of the Austrian data with CARE for PTWs

Description (CARE findings)	Austrian data consistency with CARE
Being hit by a car going the same direction then turning into them (PTW 2) is the most commonly occurring accident scenario.	No- 'Other' was most commonly occurring and both going straight ahead, neither yield was most common at junction accident
Far more males than females involved in the accidents	Yes
Mostly Urban environments	Yes
Between 30-50kmh	Unknown
At crossroads	Yes
Between 12pm and 6pm	Yes
Similar number of incidents on all days of week	No- slight dip at weekends
In daylight conditions	Yes
In warmer months of May to September	Yes
In fine weather	Yes
Majority wore a helmet	No- majority did not wear helmet

Table 12 Comparison of consistency of the UK data with CARE for PTWs

Description (CARE findings)	UK data consistency with CARE
Being hit by a car going the same direction then turning into them (PTW 2) is the most commonly occurring accident scenario.	No – PTW1 thought to be most commonly occurring
Far more males than females involved in the accidents	Yes
Mostly Urban environments	Yes
Between 30-50kmh	Yes
At crossroads	Yes – partially (junctions)
Between 12pm and 6pm	Unknown
Similar number of incidents on all days of week	Unknown
In daylight conditions	Yes
In warmer months of May to September	Yes
In fine weather	Yes
Majority wore a helmet	Almost certainly

Table 15 Comparison of consistency of the Finnish data with CARE for PTWs

Description (CARE findings)	Finnish data consistency with CARE
Being hit by a car going the same direction then turning into them (PTW 2) is the most commonly occurring accident scenario.	No- 'Other' was most commonly occurring and vehicle pulling out on the PTW was the most common at junction scenario
Far more males than females involved in the accidents	Yes
Mostly Urban environments	Yes
Between 30-50kmh	Unknown
At crossroads	Unknown
Between 12pm and 6pm	Yes
Similar number of incidents on all days of week	No- slight dip on Sunday
In daylight conditions	Yes
In warmer months of May to September	Yes
In fine weather	Yes
Majority wore a helmet	Unknown

Table 18 Comparison of consistency of the Swedish data with CARE for PTWs

Description (CARE findings)	Sweden consistency with CARE
Being hit by a car going the same direction then turning into them (PTW 2) is the most commonly occurring accident scenario.	Unknown
Far more males than females involved in the accidents	Yes
Mostly Urban environments	Yes
Between 30-50kmh	Yes (50kmh)
At crossroads	Unknown
Between 12pm and 6pm	Yes
Similar number of incidents on all days of week	Yes
In daylight conditions	Yes
In warmer months of May to September	Yes
In fine weather	Yes
Majority wore a helmet	Yes

PTW Data

Table 21 Summary of data analysis for PTWs

CARE data analysis findings	Spanish data consistency	Austrian data consistency	UK data consistency	Finnish data consistency	Sweden data consistency
Being hit by a car going the same direction then turning into them (PTW 2) is the most commonly occurring accident scenario.	Partially - didn't give direction- but did involve the vehicle turning into the motorcyclist	No- 'Other' was most commonly occurring and both going straight ahead, neither yield was most common at junction accident	No – PTW1 thought to be most commonly occurring	No- 'Other' was most commonly occurring and vehicle pulling out on the PTW was the most common at junction scenario	Unknown
Far more males than females involved in the accidents	Yes	Yes	Yes	Yes	Yes
Mostly Urban environments	Yes	Yes	Yes	Yes	Yes
Between 30-50kmh	N/a - didn't specify speed	Unknown	Yes	Unknown	Yes (50kmh)
At crossroads	N/a - didn't specify junction type	Yes	Yes – partially (junctions)	Unknown	Unknown
Between 12pm and 6pm	Yes	Yes	Unknown	Yes	Yes
Similar number of incidents on all days of week	Yes- slight dip at weekend though	No- slight dip at weekends	Unknown	No- slight dip on Sunday	Yes
In daylight conditions	Yes	Yes	Yes	Yes	Yes
In warmer months of May to September	Yes (warmer months but only May to July)	Yes	Yes	Yes	Yes
In fine weather	Yes	Yes	Yes	Yes	Yes
Majority wore a helmet	Yes	No- majority did not wear helmet	Almost certainly	Unknown	Yes

Table 24 Analysis of PTW accidents in the SafetyNet database (N=188)

Scenario	Description	N	%
PTW1	Vehicle pulls out at junction into path of PTW rider	23	12.2
PTW2	PTW going straight ahead, in same direction as vehicle, vehicle turns across path	14	7.4
PTW3	Vehicle and PTW heading in opposite directions, vehicle turns across path	23	12.2
PTW4	Vehicle and PTW heading in opposite directions, PTW turns across path	2	1.1
PTW5	Vehicle and PTW both going straight ahead at intersection, neither yield	29	15.4
PTW6	PTW hits parked car in road	7	3.7
PTW8	Vehicle runs into rear of stationary PTW	1	0.5
PTW10	Vehicle overtakes PTW but doesn't leave enough room	5	2.7
PTW11	PTW rider overtakes vehicle but in path of oncoming vehicle	1	0.5
PTW12	Single vehicle PTW accident - PTW runs off road into roadside object	36	19.1
PTW3/4	Vehicle and PTW heading in opposite directions, turn across path...(nfs)	4	2.1
PTW77	Not applicable	4	2.1
PTW88	Other	21	11.2
PTW98	Unknown - case review	17	9.0
PTW99	Unknown	1	0.5
	Total	**188**	**100.0**

- The issue of single vehicle accidents is thought to be somewhat greater than that reported in the European CARE data and national statistics. According to CARE, single vehicle accidents account for 8.3% of total moped (up to 50 cc) accidents, 28% of total accidents of PTWs up to 125cc and 37% of total accidents of PTWs over 125cc. The issue was first highlighted in Hurt et al (1981) in which approximately one-quarter of cases investigated in an in-depth study were found to be single-vehicle accidents whereby the motorcycle collided with the roadway of some fixed obstacle in the road environment. In these single vehicle accidents, motorcycle rider error was present as the accident precipitating factor in about two-thirds of the cases, with the typical error being a slide-out and fall due to over-braking or running wide on a curve due to excess speed or under-cornering. Only a small minority of cases were attributable to road or motorcycle defects.
- Findings from Fatal Accident Reporting System (FARS) data collected between 1975 and 1999 in the USA (described in Shankar, 2001) provide insight into possible reasons for motorcyclist fatalities in single vehicle motorcycle crashes and could aid in the design of crash prevention programs. These were found to be as follows:
  - More motorcyclist fatalities were occurring on rural roads
  - Half of the fatalities were related to negotiating a curve prior to the crash;
  - Over 80% of the fatalities occurred off roadway;
  - Undivided roadways accounted for a majority of the fatalities
  - Almost two thirds of the fatalities were associated with speeding as an operator contributing factor in the crash;
  - Almost 60% of motorcyclist fatalities occurred at night;
  - Collision with a fixed object was a significant factor in over half of the fatalities;

- Braking and steering manoeuvres possibly contributed to almost 25% of the fatalities;
- Helmet use among fatally injured motorcyclists was below 50%; and,
- Almost one third of the fatally injured operators did not have a proper license.

o There are a number of limitations that need to be taken into account from the data analysis. These are as follows:

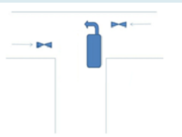
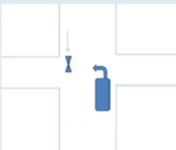
  - The CARE data only represents EU-25 and therefore overall representative-ness and abstraction to the whole of the EU is not possible.
  - The CARE data contains limited detail relating to individual accidents so it is not possible to determine accident characteristics an in-depth level.
  - However, there are no available in-depth databases with sufficient numbers of cases which can be used to determine 'representative scenarios' within the EU.
  - For the reasons stated, there may be scenarios in individual Member States that cannot be determined from the accident analysis and therefore the ITS solutions that may follow on from this analysis may not applicable across the whole of the EU.
  - For the same reason, there may be unique accident scenarios in some EU Member States that may not be taken into account through ITS countermeasures and future work may need to be conducted to look more specifically at these individual situations.
  - Limited capability for discrimination between mofa/moped and motorcycle accidents makes it difficult to generalise about ITS countermeasures – technologies that may be suitable for larger PTW's (those over 50cc's) may not be suitable for smaller PTW's since the capacity for installing new technologies on either classification will be different.
  - The CARE database does not allow discriminating between the different types of urban roads. In urban areas at least three classes of roads can be distinguished: trunk roads (only motorized traffic), collector (main) roads (connecting districts) and residential/traffic calmed roads. Most VRU accidents happen on collector roads, where traffic is heterogeneous and mixed functions apply.
  - It is acknowledged that overall national datasets are not detailed enough to allow discrimination of specific circumstances and causal factors that are evident in VRU accidents. Therefore more analysis is required to look at these circumstances and this will involve data which were collected at a more in-depth level. However, it has to be remembered that the data that are gathered using an in-depth approach are rarely if ever representative therefore caveats will be required for these analyses as well. This follow-up analysis will be undertaken for all VRU groups.
  - A major limitation of the data analysis in its present format is that the data are not sufficient to address the issue of 'single vehicle VRU accidents'. Further analysis of this important issue will follow in an addendum report focussing specifically on accidents where no second vehicle is involved. For this analysis, different data sets will be used that are at a more in-depth level.

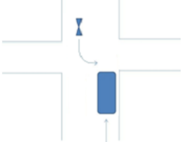
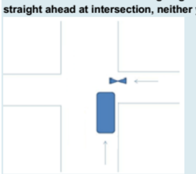
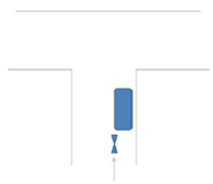
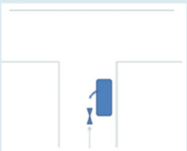
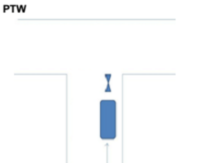
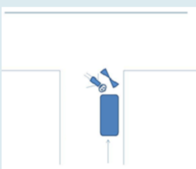
- However, the caveats that will apply in the point above will also apply to this addendum analysis. The issue of exposure needs to be taken into account. It is not surprising that there are more VRU accidents in daylight, in good weather, and in the summer months, because that is when the exposure is at its highest and thereby the high numbers do not indicate higher accident risks. However, overall, the VRUITS project will aim to develop solutions for accidents which occur with greatest frequency (and hence where the exposure is correspondingly much hig her) as opposed to high-risk situations whereby the risks of accident involvement are highly significantly enhanced but where the absolute numbers of cases are relatively small in number.

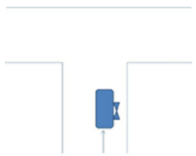
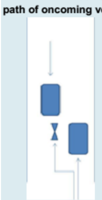
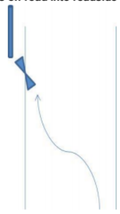
o Underlines the need for sound data basis for traffic safety related data including traffic conflicts, task demands and accident data to adapt existing and future ITS to the actual situation in traffic. Lack of data is an especially pressing topic as even general VRU mobility (i.e.: kilometres travelled by bike, on foot, etc.) is hardly available in European countries.

o VRUITS PTW scenarios database

A.3 VRUITS PTW Scenarios - Database used

Scenarios	Numbers of cases	Age (mean /SD)	Gender %M / %F	Road Class	Signals	Speed Limit (km/h)	Time	Day	Month	Lighting	Weather	Collision Partner	PTW rider Ac-tion	PTW hel-met used	PTW protec-tive clothing worn
PTW1. Vehicle pulls out at junction into path of PTW rider 	N=			Motorway n = Non-motorway urban n = Non-motorway rural n = Mixed n= Other/Unknown n =	Signalised n = Non-signalised n = Unknown n = Not applicable n =	30 n= 40 n= 50 n= 60 n= 70 n= 80+ n=	00.001am to 06.00am n= 06.01am to 12.00pm n = 12.01pm to 18.00pm n= 18.01pm to 00.00am n= unknown n =	Mon n= Tues n= Wed n= Thu n= Fri n= Sat n= Sun n= unknown n =	Jan n= Feb n= Mar n= Apr n= May n= Jun n= Jul n= Aug n= Sep n= Oct n= Nov n= Dec n= unknown n =	Darkness no lighting n = Darkness lighting on n = Daylight n = Twilight n= Unknown/Other n =	Fine without high winds n = Raining without high winds n = Snowing without high winds n = Fine with high winds n = Raining with high winds n = Snowing with high winds n = Mist/fog n = Unknown/Other n =	Passenger car n = Light goods vehicle/van n = Truck n= Bus n = PTW n = Bicycle n= Unknown/other n=	Stationary n = Going straight ahead n = Crossed path of collision partner n = Veered into path of n = PTW rider fell off in path of collision partner n =	Helmet used n = Helmet not used n = Other/unknown n =	Protective clothing worn n = Protective clothing not worn n = Other/unknown n =
PTW2. 'PTW going straight ahead, in same direction as vehicle, vehicle turns across path' 	N=			Motorway n = Non-motorway urban n = Non-motorway rural n = Mixed n= Other/Unknown n =	Signalised n = Non-signalised n = Unknown n = Not applicable n =	30 n= 40 n= 50 n= 60 n= 70 n= 80+ n=	00.001am to 06.00am n= 06.01am to 12.00pm n = 12.01pm to 18.00pm n= 18.01pm to 00.00am n= unknown n =	Mon n= Tues n= Wed n= Thu n= Fri n= Sat n= Sun n= unknown n =	Jan n= Feb n= Mar n= Apr n= May n= Jun n= Jul n= Aug n= Sep n= Oct n= Nov n= Dec n= unknown n =	Darkness no lighting n = Darkness lighting on n = Daylight n = Twilight n= Unknown/Other n =	Fine without high winds n = Raining without high winds n = Snowing without high winds n = Fine with high winds n = Raining with high winds n = Snowing with high winds n = Mist/fog n = Unknown/Other n =	Passenger car n = Light goods vehicle/van n = Truck n= Bus n = PTW n = Bicycle n= Unknown/other n=	Stationary n = Going straight ahead n = Crossed path of collision partner n = Veered into path of n = PTW rider fell off in path of collision partner n =	Helmet used n = Helmet not used n = Other/unknown n =	Protective clothing worn n = Protective clothing not worn n = Other/unknown n =
PTW3. Vehicle and PTW heading in oppo-site directions, vehicle turns across path 	N=			Motorway n = Non-motorway urban n = Non-motorway rural n = Mixed n= Other/Unknown n =	Signalised n = Non-signalised n = Unknown n = Not applicable n =	30 n= 40 n= 50 n= 60 n= 70 n= 80+ n=	00.001am to 06.00am n= 06.01am to 12.00pm n = 12.01pm to 18.00pm n= 18.01pm to 00.00am n= unknown n =	Mon n= Tues n= Wed n= Thu n= Fri n= Sat n= Sun n= unknown n =	Jan n= Feb n= Mar n= Apr n= May n= Jun n= Jul n= Aug n= Sep n= Oct n= Nov n= Dec n= unknown n =	Darkness no lighting n = Darkness lighting on n = Daylight n = Twilight n= Unknown/Other n =	Fine without high winds n = Raining without high winds n = Snowing without high winds n = Fine with high winds n = Raining with high winds n = Snowing with high winds n = Mist/fog n = Unknown/Other n =	Passenger car n = Light goods vehicle/van n = Truck n= Bus n = PTW n = Bicycle n= Unknown/other n=	Stationary n = Going straight ahead n = Crossed path of collision partner n = Veered into path of n = PTW rider fell off in path of collision partner n =	Helmet used n = Helmet not used n = Other/unknown n =	Protective clothing worn n = Protective clothing not worn n = Other/unknown n =

PTW 4. Vehicle and PTW heading in opposite directions, PTW turns across path 	N=	Motorway n = Non-motorway urban n = Non-motorway rural n = Mixed n= Other/Unknown n =	Signalised n = Non-signalised n = Unknown n = Not applicable n =	30 n= 40 n= 50 n= 60 n= 70 n= 80+ n=	00.001am to 06.00am n= 06.01am to 12.00pm n = 12.01pm to 18.00pm n= 18.01pm to 00.00am n= unknown n =	Mon n= Tues n= Wed n= Thu n= Fri n= Sat n= Sun n= unknown n =	Jan n= Feb n= Mar n= Apr n= May n= Jun n= Jul n= Aug n= Sep n= Oct n= Nov n= Dec n= unknown n =	Darkness no lighting n = Darkness lighting on n = Daylight n = Twilight n= Unknown/Other n =	Fine without high winds n = Raining without high winds n = Snowing without high winds n = Fine with high winds n = Raining with high winds n = Snowing with high winds n = Mist/fog n = Unknown/Other n =	Passenger car n = Light goods vehicle/van n = Truck n= Bus n = PTW n = Bicycle n= Unknown/other n=	Stationary n = Going straight ahead n = Crossed path of collision partner n = Veered into path of n = PTW rider fell off in path of collision partner n =	Helmet used n = Helmet not used n = Other/unknown n =	Protective clothing worn n = Protective clothing not worn n = Other/unknown n =
PTW 5. Vehicle and PTW both going straight ahead at intersection, neither yield 	N=	Motorway n = Non-motorway urban n = Non-motorway rural n = Mixed n= Other/Unknown n =	Signalised n = Non-signalised n = Unknown n = Not applicable n =	30 n= 40 n= 50 n= 60 n= 70 n= 80+ n=	00.001am to 06.00am n= 06.01am to 12.00pm n = 12.01pm to 18.00pm n= 18.01pm to 00.00am n= unknown n =	Mon n= Tues n= Wed n= Thu n= Fri n= Sat n= Sun n= unknown n =	Jan n= Feb n= Mar n= Apr n= May n= Jun n= Jul n= Aug n= Sep n= Oct n= Nov n= Dec n= unknown n =	Darkness no lighting n = Darkness lighting on n = Daylight n = Twilight n= Unknown/Other n =	Fine without high winds n = Raining without high winds n = Snowing without high winds n = Fine with high winds n = Raining with high winds n = Snowing with high winds n = Mist/fog n = Unknown/Other n =	Passenger car n = Light goods vehicle/van n = Truck n= Bus n = PTW n = Bicycle n= Unknown/other n=	Stationary n = Going straight ahead n = Crossed path of collision partner n = Veered into path of n = PTW rider fell off in path of collision partner n =	Helmet used n = Helmet not used n = Other/unknown n =	Protective clothing worn n = Protective clothing not worn n = Other/unknown n =
PTW6. PTW hits parked car in road 	N=	Motorway n = Non-motorway urban n = Non-motorway rural n = Mixed n= Other/Unknown n =	Signalised n = Non-signalised n = Unknown n = Not applicable n =	30 n= 40 n= 50 n= 60 n= 70 n= 80+ n=	00.001am to 06.00am n= 06.01am to 12.00pm n = 12.01pm to 18.00pm n= 18.01pm to 00.00am n= unknown n =	Mon n= Tues n= Wed n= Thu n= Fri n= Sat n= Sun n= unknown n =	Jan n= Feb n= Mar n= Apr n= May n= Jun n= Jul n= Aug n= Sep n= Oct n= Nov n= Dec n= unknown n =	Darkness no lighting n = Darkness lighting on n = Daylight n = Twilight n= Unknown/Other n =	Fine without high winds n = Raining without high winds n = Snowing without high winds n = Fine with high winds n = Raining with high winds n = Snowing with high winds n = Mist/fog n = Unknown/Other n =	Passenger car n = Light goods vehicle/van n = Truck n= Bus n = PTW n = Bicycle n= Unknown/other n=	Stationary n = Going straight ahead n = Crossed path of collision partner n = Veered into path of n = PTW rider fell off in path of collision partner n =	Helmet used n = Helmet not used n = Other/unknown n =	Protective clothing worn n = Protective clothing not worn n = Other/unknown n =
PTW7. Vehicle occupant opens car door in path of PTW 	N=	Motorway n = Non-motorway urban n = Non-motorway rural n = Mixed n= Other/Unknown n =	Signalised n = Non-signalised n = Unknown n = Not applicable n =	30 n= 40 n= 50 n= 60 n= 70 n= 80+ n=	00.001am to 06.00am n= 06.01am to 12.00pm n = 12.01pm to 18.00pm n= 18.01pm to 00.00am n= unknown n =	Mon n= Tues n= Wed n= Thu n= Fri n= Sat n= Sun n= unknown n =	Jan n= Feb n= Mar n= Apr n= May n= Jun n= Jul n= Aug n= Sep n= Oct n= Nov n= Dec n= unknown n =	Darkness no lighting n = Darkness lighting on n = Daylight n = Twilight n= Unknown/Other n =	Fine without high winds n = Raining without high winds n = Snowing without high winds n = Fine with high winds n = Raining with high winds n = Snowing with high winds n = Mist/fog n = Unknown/Other n =	Passenger car n = Light goods vehicle/van n = Truck n= Bus n = PTW n = Bicycle n= Unknown/other n=	Stationary n = Going straight ahead n = Crossed path of collision partner n = Veered into path of n = PTW rider fell off in path of collision partner n =	Helmet used n = Helmet not used n = Other/unknown n =	Protective clothing worn n = Protective clothing not worn n = Other/unknown n =
PTW8. Vehicle runs into rear of stationary PTW 	N=	Motorway n = Non-motorway urban n = Non-motorway rural n = Mixed n= Other/Unknown n =	Signalised n = Non-signalised n = Unknown n = Not applicable n =	30 n= 40 n= 50 n= 60 n= 70 n= 80+ n=	00.001am to 06.00am n= 06.01am to 12.00pm n = 12.01pm to 18.00pm n= 18.01pm to 00.00am n= unknown n =	Mon n= Tues n= Wed n= Thu n= Fri n= Sat n= Sun n= unknown n =	Jan n= Feb n= Mar n= Apr n= May n= Jun n= Jul n= Aug n= Sep n= Oct n= Nov n= Dec n= unknown n =	Darkness no lighting n = Darkness lighting on n = Daylight n = Twilight n= Unknown/Other n =	Fine without high winds n = Raining without high winds n = Snowing without high winds n = Fine with high winds n = Raining with high winds n = Snowing with high winds n = Mist/fog n = Unknown/Other n =	Passenger car n = Light goods vehicle/van n = Truck n= Bus n = PTW n = Bicycle n= Unknown/other n=	Stationary n = Going straight ahead n = Crossed path of collision partner n = Veered into path of n = PTW rider fell off in path of collision partner n =	Helmet used n = Helmet not used n = Other/unknown n =	Protective clothing worn n = Protective clothing not worn n = Other/unknown n =
PTW9. PTW rider falls off into path of vehicle 	N=	Motorway n = Non-motorway urban n = Non-motorway rural n = Mixed n= Other/Unknown n =	Signalised n = Non-signalised n = Unknown n = Not applicable n =	30 n= 40 n= 50 n= 60 n= 70 n= 80+ n=	00.001am to 06.00am n= 06.01am to 12.00pm n = 12.01pm to 18.00pm n= 18.01pm to 00.00am n= unknown n =	Mon n= Tues n= Wed n= Thu n= Fri n= Sat n= Sun n= unknown n =	Jan n= Feb n= Mar n= Apr n= May n= Jun n= Jul n= Aug n= Sep n= Oct n= Nov n= Dec n= unknown n =	Darkness no lighting n = Darkness lighting on n = Daylight n = Twilight n= Unknown/Other n =	Fine without high winds n = Raining without high winds n = Snowing without high winds n = Fine with high winds n = Raining with high winds n = Snowing with high winds n = Mist/fog n = Unknown/Other n =	Passenger car n = Light goods vehicle/van n = Truck n= Bus n = PTW n = Bicycle n= Unknown/other n=	Stationary n = Going straight ahead n = Crossed path of collision partner n = Veered into path of n = PTW rider fell off in path of collision partner n = Other/unknown n =	Helmet used n = Helmet not used n = Other/unknown n =	Protective clothing worn n = Protective clothing not worn n = Other/unknown n =

PTW10. Vehicle overtakes PTW but doesn't leave enough room 	N=	Motorway n = Non-motorway urban n = Non-motorway rural n = Mixed n= Other/Unknown n =	Signalised n = Non-signalised n = Unknown n = Not applicable n =	30 n= 40 n= 50 n= 60 n= 70 n= 80+ n=	00.001am to 06.00am n= 06.01am to 12.00pm n = 12.01pm to 18.00pm n= 18.01pm to 00.00am n= unknown n =	Mon n= Tues n= Wed n= Thu n= Fri n= Sat n= Sun n= unknown n =	Jan n= Feb n= Mar n= Apr n= May n= Jun n= Jul n= Aug n= Sep n= Oct n= Nov n= Dec n= unknown n =	Darkness no lighting n = Darkness lighting on n = Daylight n = Twilight n= Unknown/Other n =	Fine without high winds n = Raining without high winds n = Snowing without high winds n = Fine with high winds n = Raining with high winds n = Snowing with high winds n = Mist/fog n = Unknown/Other n =	Passenger car n = Light goods vehicle/van n = Truck n= Bus n = PTW n = Bicycle n= Unknown/other n=	Stationary n = Going straight ahead n = Crossed path of collision partner n = Veered into path of n = PTW rider fell off in path of collision partner n =	Helmet used n = Helmet not used n = Other/unknown n =	Protective clothing worn n = Protective clothing not worn n = Other/unknown n =
PTW11. PTW rider overtakes vehicle but in path of oncoming vehicle 	N=	Motorway n = Non-motorway urban n = Non-motorway rural n = Mixed n= Other/Unknown n =	Signalised n = Non-signalised n = Unknown n = Not applicable n =	30 n= 40 n= 50 n= 60 n= 70 n= 80+ n=	00.001am to 06.00am n= 06.01am to 12.00pm n = 12.01pm to 18.00pm n= 18.01pm to 00.00am n= unknown n =	Mon n= Tues n= Wed n= Thu n= Fri n= Sat n= Sun n= unknown n =	Jan n= Feb n= Mar n= Apr n= May n= Jun n= Jul n= Aug n= Sep n= Oct n= Nov n= Dec n= unknown n =	Darkness no lighting n = Darkness lighting on n = Daylight n = Twilight n= Unknown/Other n =	Fine without high winds n = Raining without high winds n = Snowing without high winds n = Fine with high winds n = Raining with high winds n = Snowing with high winds n = Mist/fog n = Unknown/Other n =	Passenger car n = Light goods vehicle/van n = Truck n= Bus n = PTW n = Bicycle n= Unknown/other n=	Stationary n = Going straight ahead n = Crossed path of collision partner n = Veered into path of n = PTW rider fell off in path of collision partner n = Other/unknown n =	Helmet used n = Helmet not used n = Other/unknown n =	Protective clothing worn n = Protective clothing not worn n = Other/unknown n =
PTW12. Single vehicle PTW accident - PTW runs off road into roadside object 	N=	Motorway n = Non-motorway urban n = Non-motorway rural n = Mixed n= Other/Unknown n =	Signalised n = Non-signalised n = Unknown n = Not applicable n =	30 n= 40 n= 50 n= 60 n= 70 n= 80+ n=	00.001am to 06.00am n= 06.01am to 12.00pm n = 12.01pm to 18.00pm n= 18.01pm to 00.00am n= unknown n =	Mon n= Tues n= Wed n= Thu n= Fri n= Sat n= Sun n= unknown n =	Jan n= Feb n= Mar n= Apr n= May n= Jun n= Jul n= Aug n= Sep n= Oct n= Nov n= Dec n= unknown n =	Darkness no lighting n = Darkness lighting on n = Daylight n = Twilight n= Unknown/Other n =	Fine without high winds n = Raining without high winds n = Snowing without high winds n = Fine with high winds n = Raining with high winds n = Snowing with high winds n = Mist/fog n = Unknown/Other n =	Passenger car n = Light goods vehicle/van n = Truck n= Bus n = PTW n = Bicycle n= Unknown/other n=	Stationary n = Going straight ahead n = Crossed path of collision partner n = Veered into path of n = PTW rider fell off in path of collision partner n = Other/unknown n =	Helmet used n = Helmet not used n = Other/unknown n =	High visibility clothing worn n = High visibility clothing not worn n = Other/unknown n =
PTW88 Other	N=	Motorway n = Non-motorway urban n = Non-motorway rural n = Mixed n= Other/Unknown n =	Signalised n = Non-signalised n = Unknown n = Not applicable n =	30 n= 40 n= 50 n= 60 n= 70 n= 80+ n=	00.001am to 06.00am n= 06.01am to 12.00pm n = 12.01pm to 18.00pm n= 18.01pm to 00.00am n= unknown n =	Mon n= Tues n= Wed n= Thu n= Fri n= Sat n= Sun n= unknown n =	Jan n= Feb n= Mar n= Apr n= May n= Jun n= Jul n= Aug n= Sep n= Oct n= Nov n= Dec n= unknown n =	Darkness no lighting n = Darkness lighting on n = Daylight n = Twilight n= Unknown/Other n =	Fine without high winds n = Raining without high winds n = Snowing without high winds n = Fine with high winds n = Raining with high winds n = Snowing with high winds n = Mist/fog n = Unknown/Other n =	Passenger car n = Light goods vehicle/van n = Truck n= Bus n = PTW n = Bicycle n= Unknown/other n=	Stationary n = Going straight ahead n = Crossed path of collision partner n = Veered into path of n = PTW rider fell off in path of collision partner n = Other/unknown n =	Helmet used n = Helmet not used n = Other/unknown n =	High visibility clothing worn n = High visibility clothing not worn n = Other/unknown n =
PTW99. Unknown	N=	Motorway n = Non-motorway urban n = Non-motorway rural n = Mixed n= Other/Unknown n =	Signalised n = Non-signalised n = Unknown n = Not applicable n =	30 n= 40 n= 50 n= 60 n= 70 n= 80+ n=	00.001am to 06.00am n= 06.01am to 12.00pm n = 12.01pm to 18.00pm n= 18.01pm to 00.00am n= unknown n =	Mon n= Tues n= Wed n= Thu n= Fri n= Sat n= Sun n= unknown n =	Jan n= Feb n= Mar n= Apr n= May n= Jun n= Jul n= Aug n= Sep n= Oct n= Nov n= Dec n= unknown n =	Darkness no lighting n = Darkness lighting on n = Daylight n = Twilight n= Unknown/Other n =	Fine without high winds n = Raining without high winds n = Snowing without high winds n = Fine with high winds n = Raining with high winds n = Snowing with high winds n = Mist/fog n = Unknown/Other n =	Passenger car n = Light goods vehicle/van n = Truck n= Bus n = PTW n = Bicycle n= Unknown/other n=	Stationary n = Going straight ahead n = Crossed path of collision partner n = Veered into path of n = PTW rider fell off in path of collision partner n = Other/unknown n =	Helmet used n = Helmet not used n = Other/unknown n =	High visibility clothing worn n = High visibility clothing not worn n = Other/unknown n =

D3: Infrastructure

Project/website	Ending date	Final report	Relevant Deliverables
2-BE-SAFE	1/09/2011	http://www.2besafe.eu/sites/default/files/deliverables/2BES_D35_FinalReport.pdf	• 1.2 Road Infrastructure and Road Safety for PTWS
APROSYS	1/12/2009	http://www.transport-research.info/Upload/Documents/201203/20120313_143223_50861_Final%20APROSYS%20Report.pdf	• Final report for the work on 'Motorcyclist Accidents'
DaCoTA	30/06/2012	http://www.dacota-project.eu/Deliverables/DaCo	• Roads report

		TA_Final_Report.pdf	
EURORAP I and II	?	-	• Road Safety Toolkit
MAIDS	1/12/2002	Final report : http://www.fema-online.eu/riderscan/IMG/pdf/maids2-2.pdf	
PILOT4SAFETY	31/05/2012	-	• New Curriculum for Road Safety Experts • Safety Prevention Manual for secondary road
PROMISING	1/01/2001	http://www.transport-research.info/Upload/Documents/200310/promisingrep.pdf	• Deliverable 3
RISER	1/12/2005	• https://dspace.lboro.ac.uk/dspace-jspui/bitstream/2134/14367/3/PUB503%20Riser%20-%20roadside%20infrastructure.pdf	
ROSA	31/03/2011	http://ec.europa.eu/transport/road_safety/pdf/projects/rosa_handbook_en.pdf	• European Handbook on Good Practices in Safety for Motorcyclists - Epigraph: INFRASTRUCTURE -
SAFETYNET	1/12/2008	http://erso.swov.nl/knowledge/Fixed/45_PoweredTwoWheelers/powered%20two%20wheelers.pdf	• Guardrails
Smart RRS	1/12/2011		• D1.3 - Main findings of the State of the Art • D.2.1a – Report on revision of regulation UNE135900 • D.2.1b – Report on revision of regulation EQUS9910208C • D.2.2 – REPORT ON REVISION OF STATE OF THE ART ON ROAD RESTRAINT SYSTEMS
SUNFLOWER +6	1/12/2005	http://www.20splentyforus.co.uk/UsefulReports/SUNflower%2B6_Final_Report.pdf	• Final report (p.344)
WHITEROADS	31/10/2012	http://www.whiteroads.eu/images/Final_conference/D0.3_Final_Report_3VERSION.pd	• Comparative checklist for determining the characterists of WhiteRoads in the TEN-T

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- **2BESAFE project (2011) – Deliverable 1.2**

State of the Art:

- Roadway design defects
    - Negative sequence of curve radii
    - Critical curve radii
    - Disharmonic trace geometry
- Road maintenance defects
- Insufficient visibility along road sections
    - Descent (diving) of the carriageway behind a crest (summit)
    - Diffuse light conditions in woodlands
    - Cut slopes or bushes lining the inner curve
- Insufficient or negative crossfall
- Roadside obstacles (e.g. unprotected posts of guard rails)
- Insufficient road surface condition
    - Poor skid resistance, unevenness, potholes, manholes, accumulation of bituminous binders, dirt
- Critical intersection design (e.g. missing left turn lane)

Macroscopic analysis:

Basic Results:

- Most PTW accident occur inside urban areas, however, accident severity is higher outside urban areas
- Most PTW accidents inside urban areas occur at intersections (angle collisions, lateral collisions), outside urban areas the most frequent collision type is a single vehicle accident (run-off the road)
- Rear end and head-on collisions are proportionately more common outside urban areas when compared to accidents inside urban areas.
- Dry road surface conditions dominate the accident figures
- Injuries and fatalities in accidents involving a PTW are mostly observed in dry weather conditions
- Skidding is systematically observed in PTW accidents both inside and outside urban areas

Specific Results:

- Critical factors seem to be curves and descending gradients (Greece)
- Over a quarter of narrow passage accidents inside urban areas between motorcycles and moving vehicles are head-on collisions (Greece)
- Lateral collisions inside and outside urban areas are mostly observed in straight roads. In areas outside urban environments, narrow passages are exclusively related to lateral collisions (Greece)
- Roundabouts have a high accident figure given the relative frequencies of these junction types. Older riders are more likely to have an accident at a roundabout (GB)
- Only just under 6% of accidents involve a carriageway object (not including a moving vehicle) being hit (GB)
- Young riders are proportionally more likely to have an accident when the road is wet/damp than older riders (GB)
- Less front to side accidents at roundabout in comparison to other junction types, however more side wipe accidents (Spain)
- Front-to side, run-off-road and rear-end represent nearly 60% of all accidents (Spain)
- Inside urban accidents account for three quarters of all accidents (Spain)
- Accidents on wet and slippery roads are less severe than on dry roads (Italy)
- Taking into account the accident type, the most relevant accident case is head-on side on road with one carriageway and two ways, but the most severe is one carriageway and two ways and collision with an obstacle (Italy)
- Uneven paved roads increase the accident severity (Italy)

Recommendations

Some bullet points regarding improvements of road infrastructure and safety treatments to increase PTW safety:

- Safe/Forgiving Roadside
  - Obstacle free zone
- Protection of obstacle with motorcycle-friendly protective devices (underride guard as well a system to reduce accident severity in case of an impact in an upright position)
- Installation of these systems along sections with:
  - Curves which have a curve radii lower than 100m
  - Negative sequences (crossfall) of curves
  - Outside of left hand descending curves
- Reconstruction of road sections with a high ADT of PTW and a bad road surface condition, especially with a bad unevenness in longitudinal direction
- Signposting of hazardous locations
- Improvement of conspicuity of e.g. roundabouts outside urban areas (e.g. electric lightening, retro reflect materials)
- Less aggressive kerbstones in roundabouts, no obstacles in the central island
- Including PTW safety as specific issue in Road Safety Audits (RSA) and Road Safety Inspections (RSI)

- **The key findings of the analyses in Greece, Spain, Great Britain and Italy show that:**
  - Most of the basic risk factors (trends) regarding road infrastructure are in some points comparable. However lots of critical factors are specific for single countries, because of their rider's habits and behaviour which will be studied within the 2-BE-SAFE project. Also road networks have different qualities in the participating countries. Disharmonic traces and sudden changes of the surface characteristics (road condition and/or road geometry) lead to a higher risk potential for PTW safety.
  - Preventing loss of control of a PTW and mitigating the consequences of the possible accidents are two areas where infrastructure has a key role to play. Through better roads it is possible to avoid altogether accidents that would otherwise cause serious injuries on PTW riders. Also training and awareness of critical factors (especially situations at specific junction types or risky trace geometry of curves) for riders are useful preventative measures.
  - The influence of skid resistance has to be discussed in future PTW safety research from another point of view, as it is expected that the macro texture of the road surface have an higher impact on PTW safety. Specifically a survey regarding risk multiplication due to the occurrence of several critical characteristics at the same area is needed.
  - Detailed analysis with simulation tools (vehicle-infrastructure-interaction simulation), as well as incorporation of data gathered in naturalistic driving studies, should take place in coming PTW related research projects.
  - It also proves that the issue of motorcycle is much more complex than often thought. European wide solutions to decrease PTW accidents by making the road infrastructure "motorcycle friendly", self-explaining and forgiving needs an in-depth understanding of the vehicle-road-interaction and its dynamics. A strong connection of road types, the mileage per year and the purposes of the rides are also feasible, in order to understand the motives of motorcyclists using a specific route.
  - Especially the microscopic analyses of specific road sections has shown a strong need for further research regarding the interaction between motorcycle tyres and road surface condition.
  - Characteristics of PTW accidents spots are in some points comparable within the European context, but other black spots specifications are even in one country unique – statistically insignificant, but highly dangerous.

- **APROSYS project (2009) – Final report for the work on "Motorcyclist Accidents"**
  - ✓ Motorcyclists have not been explicitly addressed neither in the development, testing and installation of roadside barriers nor in the different roadside features regulations (EN 1317, EN 12767). Although experience indicates that conventional barriers systems are quite effective to restraint a vehicle, the effects on motorcycle safety is somewhat problematic. Thus, it is always necessary to bear in mind motorcyclists when road infrastructure is designed.

- **DACOTA (2012) – Motorcycles & Mopeds report**
  - ✓ Existing rails have not been designed for collisions by PTWs and may cause severe injuries to their riders. The costs of fitting these devices can be reduced by selecting road sections where collisions by motorcycles are more frequent, i.e. in tight curves in rural areas (Domhan, 1987)
  - ✓ Measures aimed at the road environment may directly prevent crashes or act through their influence on the behaviour of road users. Variations in road surface can cause particular problems for PTW riders.
  - ✓ The principles of self-explaining and forgiving road environments should be applied to all road users, with special care for PTW safety issues
  - ✓ The quality of the road surface is much more important for the safety of PTWs than for cars. Poor condition of the road surface or small objects on the road are likely to cause loss of control of a two-wheeled vehicle
  - ✓ All kinds of speed inhibitors in urban areas with different types of road surface, speed humps, lane narrowing's etc. Traffic calming schemes, although beneficial for all road users, may raise motorcycle safety concerns due to the road surface interventions involved
  - ✓ Use of raised lane markings and lane dividers, as well as barriers and guardrails; these are designed to increase protection of passenger cars, but may have detrimental effects on PTW safety
- **DACOTA (2012) - Road report**
  - ✓ Road infrastructure should be designed taking account of the same injury tolerance criteria as those developed for vehicle occupant protection and pedestrian impacts, so that roads and vehicles together provide an effective safety system.
  - ✓ Roads need to cater safely for all road users: Risk for motorized two wheelers is particularly high and solutions are needed to minimize the severity of injuries resulting from their impact with roadside furniture.
  - ✓ Road design should take into account the special needs of riders of mopeds/motorcycles in terms of both the design and maintenance of the road. These riders are much more vulnerable to imperfections of the road surface than car drivers, and special requirements have to be recognized for road markings, road surface repairs, longitudinal grooves, drainage etc.
- **EURORAP I & II – Toolkit/Motorcycles**
  - ✓ Certain manoeuvres and road conditions carry a higher risk to motorcyclists than to drivers. For example, motorcycles are less stable, and so riders are more likely to lose control of their vehicle when cornering.
  - ✓ Motorcycles have very different road performance characteristics than other types of vehicles. Motorcyclists can accelerate much more rapidly than other vehicles. They may appear in positions where other road users do not expect them. Motorcycle riders may also suddenly change their lane position to avoid a pavement hazard.

- ✓ The road environment has a significant influence on the risk of crashes involving motorcyclists. Contributing factors include:
  - Interaction with larger vehicles (cars, trucks)
  - road surface issues (such as roughness, potholes or debris on the road)
  - water, oil or moisture on the road
  - excessive line marking or use of raised pavement markers
  - poor road alignment
  - presence of roadside hazards and safety barriers
  - number of vehicles and other motorcyclists using the route.
- ✓ Road design and safety engineering countermeasures aimed at the specific needs of motorcyclists is, in part, being addressed with guideline documents produced by motorcycle user and industry groups. Aimed at road engineers, such guidelines recognise that measures that can protect vehicle occupants from serious injury in the event of a crash may have a negative impact on motorcyclists. By far the most contentious area of debate in this field regards crash barriers. Typically, standard safety barriers are not tested for their impact on motorcyclists, but research suggests that the exposed vertical support posts are particularly aggressive, irrespective of the barriers' other components. Secondary rails, such as the BikeGuard, BASYC or Moto.Tub systems, that protect riders from the posts and present a continuous surface, and impact attenuators that cover the support posts themselves are being increasingly implemented.

- **MAIDS (2002)**
  - The environment for the PTW rider is quite different when compared to other forms of road transportation because PTWs and PTW riders are more sensitive to roadway conditions within the transportation environment.
  - The majority of accidents (666 cases, 72%) within the MAIDS database took place in an urban area. Approximately 25% of the remaining accidents took place in a rural area. The greatest number of accidents occurred on minor arterial roadways (51.6%)

Table 6.1: Roadway type

	Frequency	Percent
Motorway	39	4.2
Major arterial	192	20.9
Minor arterial	475	51.6
Non-arterial, sub-arterial	126	13.8
Parking lot, parking area	4	0.4
Driveway	3	0.3
Round about or traffic circle	6	0.7
Overpass	2	0.2
Underpass	5	0.5
Dedicated bicycle or moped path separated from traffic roadway	51	5.5
Dedicated bicycle or moped path not separated from traffic roadway	3	0.3
Other	14	1.5
Unknown	1	0.1
Total	921	100.0

* Definitions: “minor arterial”: *Streets or roads designed for intermediate volumes of traffic and/or intermediate permissible speeds relative to all streets or roads in a given urban or rural area* as opposed to “Major arterial”, *Streets or roads designed for the greatest volumes of traffic and/or the highest permissible speeds in a given urban or rural area*.

- Surface deterioration or damaged bitumen (i.e., broken or separated asphalt, cracks, etc.) was found on 26% of all roadways (14.1%+ 11.9%).

Table 6.6: Roadway condition and defects

	Frequency	Percent
Normal/ no defects	648	70.4
Surface deteriorated	130	14.1
Bitumen	110	11.9
Tram/ train rails	9	1.0
Other interfering defects	23	2.5
Unknown	1	0.1
Total	921	100.0

Note: an optimal coding was given to any roadway which was smooth and without significant bumps, dips, cracks or any condition which might affect the proper handling of a PTW.

- A total of 60 PTW rider injuries were associated with barrier contact. Twelve of these injuries were to the head and eight of these head injuries were categorised as severe or higher (e.g., AIS >3). One quarter of the injuries were found to be to the lower extremities and the majority of these lower extremity injuries were found to be minor and moderate in severity (e.g., abrasions, minor lacerations and contusions). There were five serious lower extremity injuries due to roadside barrier contact.

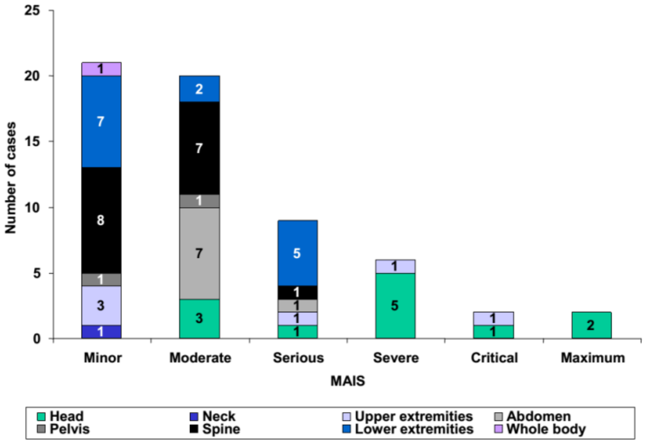


Figure 6.1: Roadside barrier injury summary

- Findings on environmental factors
  - 89.9% of the accidents took place on dry days.
  - 84.7% of the time the roads were dry at the time of the accident;
  - Road surfaces had defects in 30% of cases;
  - Road surfaces were considered optimal in 61.4% of cases;
  - Roadside barriers accounted for 60 PTW rider injuries;
  - Where there was a traffic control, it was violated in 29.8% of cases by the PTW riders and in 45.6% of cases by the OV driver.

Table 19: Predominant types of visual obstruction in PTW involved accidents taken from MAIDS data

	PTW	Other vehicle
Stationary view obstructions (Vegetation, walls and parked cars)	18.0%	20.5%
Mobile view obstructions (Cars, trucks and buses)	9.5%	11.6%

- **Pilot4Safety (2012)**
  - In the EU, around 32% of people killed on rural roads are VRU: 10% pedestrians, 5% cyclists and 17% riders of mopeds or motorcycles. Their share varies between countries. In Switzerland, Luxembourg, Italy, Slovenia, France, Austria, the UK, Greece, Cyprus, Germany and Spain, the share of PTW deaths is higher than in other countries and can only be partly explained by a higher share of motorcyclist riders. In the Netherlands, and to a lesser extent also in Belgium, the share of cyclists is higher than in other EU countries. Since 2001, deaths have been falling in all categories of road users, except for motorcyclists (ETSC Pin Report, 2010).

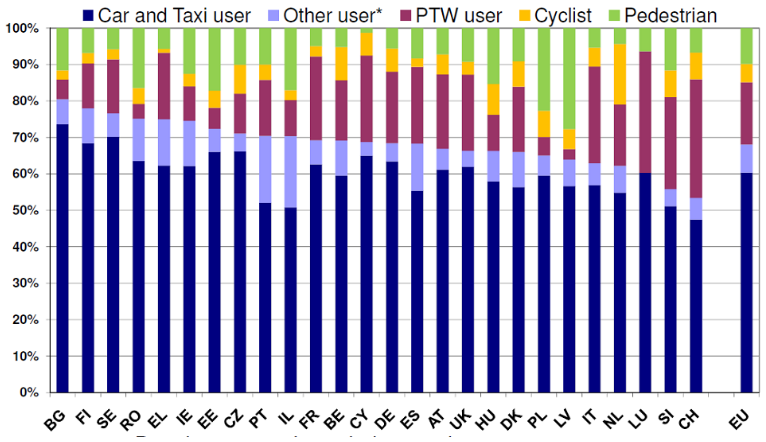


Figure 27: Deaths on rural roads by road user groups (2007-2009 average), source: ETSC, 2010

  - Since PTW have a difference in speed to other VRU, they are often only on second thought regarded as vulnerable. On one hand, PTWs are much faster than pedestrians or cyclists; on the other hand, such speed becomes a higher risk, e.g. in the presence of roadside obstacles. Another risk factor is the difference in mass between the colliding opponents.
  - There is no place for large mass and/or speed differences in an actual safe road because this emphasises the vulnerability differences between the various types of road user; even if the complete separation of unequal road user types is of course the best solution, in the majority of the cases this is not possible. One alternative solution is for the driving speed to be limited to a safe speed. Other possible treatments are a less aggressive road design, which means more self-explaining and more forgiveness. Safe roads are those where the road alignment reduces the risk of having crashes, as well as reducing the negative effects of the crash.
  - It should become common practise within the holistic approach of road safety management to include VRU safety; or to use (separate) checklists for VRU e.g. in RSI or RSA, to guarantee the specific focus on that road user group.

- **PROMISING (2001) – Delivrable 3**
  - Both mopeds and motorcycles have some special characteristics which directly or indirectly contribute to their relatively high number of accidents. They are single track vehicles, without bodywork. The fact that they are single track vehicles means that the rider has difficulty controlling the vehicle, *in particular when cornering* or braking and even more so in emergency situations. Even though modern mopeds/motorcycles have good brakes and tyres, the control of the vehicle in all kinds of situations requires special training and experience. The single track character also implies that riders have more difficulty coping with imperfect road surfaces and obstacles on the road. This does not seem to be fully recognised by road authorities.
  - The present road network has primarily been designed for the use by cars. Road authorities have to become aware of the special needs of riders of mopeds/motorcycles in terms of the design and maintenance of the road. These riders are much more vulnerable to imperfections of the road surface than car drivers and special requirements have to be recognised for road markings, roadsurface repairs, longitudinal grooves, drainage etc.
  - Although many improvements to the design of roads and traffic control will have the same positive effect on the safety of riders of mopeds/motorcycles as of other road users, this is not the case with all speed reducing measures. These measures may pose special problems for mopeds/motorcycles and should be tested to prevent these. The same applies to the design and location of guard rails which may add to the injuries of riders of motorcycles/mopeds in case of a collision with them.
  - In the future, cars and roadside obstacles have to be designed to provide better protection for riders of mopeds/motorcycles who collide with them.

Project recommendations for infrastructure include:

- ✓ Road authorities seem to have neglected the special needs of riders of motorcycles/mopeds in terms of the design and maintenance of the road surface and fixed roadside objects. These authorities have to be informed on these special needs and special requirements have to be developed based on these needs for road markings, road surface repairs, longitudinal grooves, drainage, timing of traffic lights (for longer braking distances on wet surface) etc.
- ✓ Infrastructural measures to reduce speeds (such as humps or lane narrowing) have to be re-evaluated from the point of safety for riders of mopeds/ motorcycles.
- ✓ Guardrails have been designed for car collisions, but have adverse consequences in case of motorcycle collisions. Special studies from the point of motorcycle safety have to be done to result in special requirements for the design and location of guardrails.

- **RISER (2005)**
  - The accident analysis performed out of the project partner data (273 645 accidents from 7 EU countries - Austria, Finland, France, Spain, Sweden, The Netherlands, United Kingdom) showed that:

- o Comparing road side furniture there are great differences in the frequency, fatality and injury risk but the trend shows a high fatality risk on tree and pole impacts;
- o Regarding the vehicles involved in single vehicle accidents the research showed that this accident type mainly occurs for cars, vans and trucks. Motorcycle and moped crashes are minor important. Although motorcycle accidents have not a relevant influence on the accident statistics there is an high fatality rate within these kind of accidents.
- o Collisions with fixed objects and noncollisions accounted for only 18 percent of all crashes, but they accounted for 43 percent of fatal crashes.
- o Regardless of crash severity, the majority of vehicles in single- and two vehicle crashes were going straight prior to the crash. The next most common vehicle manoeuvre differed by crash severity: negotiating a curve for fatal crashes, turning left for injury crashes, and stopped in traffic lane for property-damage-only crashes
- o Motorcycles in fatal crashes had the highest proportion of collisions with fixed objects (28.2 percent)

✓ **Conclusions/Recommendations:**

- Other factors that affect road safety should not be neglected (regional parameters have influence on safety)
- Regarding road side furniture great differences in the frequency, fatality and injury risk
- Factor driver (human factors), visualization, barriers can also have a leading function
- Need for harmonization of data collection in the countries
- Barriers can be hazardous to riders of motorcycles if the barriers are not designed for motorcycle.

- **ROSA (2011) - Handbook on Good Practices in Safety for Motorcyclists - Epigraph: INFRASTRUCTURE**
  - o Powered Two Wheelers (PTW) belong to the European transport system. They provide the opportunity to make better use of the existing road system. In many circumstances, PTWs offer an efficient form of transport reducing congestion and allowing easy access to crowded cities and streets. However, despite these positive characteristics, PTWs have their weaknesses as any other transport mode. The number of accidents, in which PTWs are involved, is a major concern. Convergent studies allow us today to state that significant number of accidents results from infrastructure shortcomings. Road planners need to ensure, in fact, that when the design of the road is finalised, this encompasses all the latest safety measures for all types of users, such as heavy good vehicles, passenger cars or PTWs. Furthermore, the infrastructure also needs to be well-designed so that it is self-explaining, as studies have demonstrated the increased risk of accident on road sections presenting unexpected features or layout.
  - o Identified problems related to infrastructure:

- Lack of consideration of motorcycles and motorcyclists during road design from a road safety point of view;
- Lack of road design guidelines for roundabouts;
- Lack of road design guidelines for intersections.
- Lack of interaction with infrastructure in intersections.
- Lack of guidelines for traffic calming systems.
- Lack of anti-skid properties and lack of reflectivity.
- Excessive line-marking.
- Continuous change of the road surface state
- Lack of anti-skid properties.
- Lack of knowledge about general recommendations related to road surfaces maintenance and skid resistance.
- Lack of knowledge about interaction between potholes and road safety
- Lack of knowledge about interaction between dry goods, dusts and oil and road safety
- Harmful design of roadsides.
- Poor maintenance of shoulders
- Lack of information about existing products and current standards.
- Lack of recommendations about vertical signs and traffic lights
- Lack of definition of road safety audits from motorcyclist point of view
- Interaction among motorcyclists and the rest of road users.
- The problem of blackspots and allocation of accidents.
- The problem of road work: signaling
- Intelligent transport systems (infrastructure) and motorcycle safety.

o Collected good practices include:
  - Involvement of motorcycle groups during road design (UK, Sweden, Belgium)
  - Road design guidelines considering motorcycling road safety (several countries)
  - Advanced Stop Lines
  - iRAP Toolkit v2
  - Road Surface Monitoring Systems (e.g. http://monash.edu.au/muarc/reports/muarc260.pdf)
  - Skid Resistant Safer Inspection Cover
  - General recommendations about road surface

- Recommendations about forgiven roadside: http://www.dgt.es/portal/es/la_dgt/sesiones_tecnicas/sesion_tecnicas034.htm
- ‘Softening’ the Highway Infrastructure. Kensington High Street Royal.
- RV32 Vision Zero Road v2 - www.fema.ridersrights.org/news/show_news.php?subaction=showfull&id=1210259270&archive=&template=
- List of existing motorcycle protective devices: http://www.carreteros.org/normativa/barreras/barreras.htm ; http://epubl.ltu.se/1402-1617/2005/233/LTU-EX-05233-SE.pdf ; http://www.monash.edu.au/muarc/reports/atsb201.pdf
- List of current standards on roadside protective systems
- Official recommendations on where to install the roadside protective devices
- ‘Softening’ the Highway Infrastructure. ‘Frangible’ and ‘Flexible’ Street Furniture
- Road Safety Audit Guidelines
- Moving mopeds from cycle lanes onto the carriageway.
- Motorcycles in Bus lanes v2 - http://www.mcia.co.uk/downloads_temp/189e054c-0e5b-45ac-883a-0bfaef951b7b_Imported_File.PDF ; http://www.dft.gov.uk/pgr/roads/tpm/tal/trafficmanagement/trafficadvisoryleaflet207.pdf
- Motorcycle Only Lane, Route R2 Malaysia; http://www.miros.gov.my/publications/TheValueOfExclusiveMotorcycleLanesToMotorcycleLanesToMotorcycleAccidentsAndCasualitiesInMalaysia.pdf
- ‘Softening’ the Highway Infrastructure. Shared Space Schemes: Home zone. http://www.local-transportprojects.co.uk/files/BP6%20003%20Shared%20Space%20Schemes%20%28v1%29.pdf
- Victoria Motorcycle Blackspot Program. http://www.msf-usa.org/imsc/proceedings/b-AndreaStrategicMotorcycleSafetyPrograminVictoriaAustralia.pdf
- A guide for Addressing Collisions Involving Motorcycles http://144.171.11.107/Main/Public/Blurbs/160626.aspx
- http://www.motorcycleguidelines.org.uk/furniture/documents/guidelines/live/MG%20Chapter%206%20Road%20Maintenance%20v1.0.pdf

✓ **Project recommendations include:**

- Current standards related to road marking cover some aspects (products, durability tests, performance parameters,…), and these standards must be applied by the road marking manufacturers. Nevertheless, some of these standards should be improved from the motorcyclist’s safety point of view of view;

- A handbook would be a practical instrument for improving road safety for PTWs, just by emphasising the engineering-maintenance brigades to consider state of road surface
- Research projects about accident scenarios and accident biomechanics;
- recommendations about road signs would be a practical instrument for
- Improving road safety for PTWs, just by emphasising the engineering items to consider during the design and maintenance of the infrastructure.

- **SMART RRS (2011) – Deliverable 1.3**
  - The analysis of the literature and the successive in-depth accident study show that there is a lack of data and there is a need for more in-depth PTW's accident studies.
  - Another important aspect is that in about 50% of the PTW accidents against a road restrain system, the rider is still in an upright riding position when the impact occurs, with the associated risks of being thrown on or over the barrier. Currently, this scenario is not considered in existing standard and is not included in the draft standard for protective road restraint systems approved by Technical Group 1 of CEN (European Committee for Normalisation). Moreover, very few studies have been performed to assess this scenario up to now. This configuration represents a scenario to be considered in future work.
  - The available studies show that the impact of motorcyclists against a fixed object occurred in 4% of the cases in urban areas while it varies between 10% and 20% in rural areas which can seems a small figure. However, a fatal outcome is 2to 5 times more likely for an impact with a crash barrier than for motorcycle accidents in general.
  - According to the literature review, most motorcycle collisions with crash barriers occurred at shallow angles (typically between 10° and 45°) with the rider typically sliding into the barrier at a bend. However, the in-depth study has demonstrated that larger impact angle are also possible and must be taken into account
  - For sliding motorcyclist, it appears clear that discontinuous systems are worse than continuous. In this scenario, post modifications together with post envelopes shows a positive approach in decreasing risks for motorcyclists. The best solution seems to be the addition of a lower rail. As this provides better energy absorption than concrete solutions or wire rope safety barriers.
  - Wire Rope Safety Barriers are viewed by motorcyclists as the most aggressive form of RRS. This view is supported by computer simulations and tests, which indicate that injuries will be severe if a rider hits the cables or the support.
  - In the majority of accidents the PTW's speed tend to be very high, especially in the case of the fatal ones.
- **SMART RRS (2011) – Deliverable 2.1a**
  - When it comes to road infrastructures designed for safety of the users, all the road users must receive the same degree of importance

- In several accident configurations the motorcyclists really do not receive the same attention as other vehicles: the impacts into guardrails which prevent the vehicles from running out the road and impact into road side objects are especially aggressive to motorcyclists
- Road restraint systems are 4 times more aggressive to motorcycle riders and therefore require more attention than other systems. These systems are generally installed on rural roads, where the highest percentage of fatal and severely injured outcomes occurs.
- Data about motorcyclist accidents is relatively hard to find and we have seen that accidents reports are still limited to fatal accidents, and sometimes difficult to interpret.

✓ **Recommendation:** contribution could then be brought by implementing the accident reports with new information and also extend the reports to non fatal accidents, which could allow a better understanding of the crashes

- **SMART RRS (2011) – Deliverable 2.2**
  - The review on the state of the art of motorcyclist protection systems shows some clear evidence that the governments and private companies are starting to look for a solution to the serious injury problem.
  - Some of the actions taken are governmental initiatives that impulse the development of new technologies within the entrepreneurial sector, which is the sector with the capability to develop such products
  - The problem is that the selection and adaptation of motorcycle friendly security systems, which are not harmonized on a European level and are manufactured by indistinct companies with different performances.
  - Despite the fact that some countries have already established their own regulations for testing motorcyclist protection systems (France, Spain, Portugal), existing systems still have very different designs and effectiveness, and the development path needs to be increased
  - Two basic protection systems need to be improved and designed according to unified regulations: the punctual and the continuous protection devices
  - For punctual systems, punctual energy absorbing systems provide interesting characteristics such as kinetic energy absorption, deformation, ease of installation and manufacturing that should be considered relevant for their development
  - an added problem is that the black spots for motorcycle accidents are unclear, as they are wide spread through the road network
  - For continuous systems, their main focus relies on avoiding the rider to go underneath the guardrail and impact the posts or other hazardous obstacles that produce severe injuries
  - The trend to follow is to design a polyvalent system that can provide protection in all senses to the rider, by attenuating the impact energy and redirecting him to a safe area

- most severe injuries come from the contact with obstacles or by harsh falls, when a rider impacts in an upright position. These injury mechanisms need to be taken in count when designing a motorcycle friendly device

- **WHITEROADS**
  - In regional or local road networks, it is particularly important to carefully consider safety requirements of vulnerable road users, such as pedestrians, cyclists or motorcyclists; while pedestrians and cyclists are not so common in the Trans European Road Network in some EU Member States, motorcyclists traffic is representative in all road networks of some EU Member States.
  - Although the White Roads project has been developed for the Trans European Road Network, it could be easily applied to other road networks. In this context, and considering that tools included in Directive 2008/96 (safety impact assessment, safety audit, safety inspection and safety management of the network) are only compulsory for the Trans European Road Network, at least a road safety inspection should be conducted; the White Road checklist should be considered as a complementary tool, after the road safety inspection has been done. In regional or local road network, it is particularly important to carefully consider safety requirements for vulnerable road users, such as pedestrians, cyclists or motorcyclists, which are not so common in the Trans European Road Network in some EU Member States.

Photo 6. Cable barrier or wire rope barrier

Photo 4. Steel barrier

Photo 5. Motorcyclist protection system on a steel barrier

  - Checklist to review key aspects related to White Roads includes:

Vulnerable road users	Pedestrians should not be allowed; check that they are clearly informed by signs and physical barriers are provided, in order to avoid their entrance to the road area.			
	If cyclists are allowed, is their safety guaranteed? If not, it is reasonable to prohibit their access to the infrastructure, in order to preserve their safety.			
	Check that motorcyclist's protection systems are installed in safety barriers in road sections with high risk for this type of users.			
Vehicle restraint systems	Ensure that containment level of vehicle restraint systems fulfils with safety requirements of all expected users, including motorcyclists and heavy vehicles along the whole road.			

- Because of the nature of their construction, Vehicle Restraint Systems are viewed by motorcyclists as an aggressive means of retention. Wire rope barrier system is viewed by motorcyclists as the most aggressive form of Vehicle Restraint Systems causing the most injuries to riders. For this reason Vehicle Restraint Systems should be designed with the majority of road users in mind.

D4: Accident reporting

Project/website	Ending date	Final report	Relevant Deliverables
2-BE-SAFE	1/09/2011	http://www.2besafe.eu/sites/default/files/deliverables/2BES_D35_FinalReport.pdf	• 6.4 Guidelines, policy recommendations and further research priorities
SUPREME	1/06/2007		• Best Practices Handbook
WATCH-OVER	31/12/2008	Final Report not for public	• D2.1 Requirements and Use Cases (pp. 33 on)

- **2BESAFE – deliverable 6.4**
  - There is a lack of comprehensive data and research evidence about PTWs from a road safety perspective and as a sustainable form of transport. This ranges from limitations in crash data reporting and collection, to the uncertainty about the effectiveness of a range of safety related activities. There is also a need for a better understanding of the growth in PTW use, through research into the types and destinations of trips taken, reasons for these (e.g. for commuting and/or recreation) and the socio-demographic characteristics of riders and pillion passengers.
  - It has been shown that the travel patterns of motorcycle riders, with respect to rider age, are quite different from other road users, both in the number of annual miles driven as well as the average trip duration. This strongly suggests that special attention needs to be given to the collection of accurate motorcycle rider exposure data.
  - ERF – IRF BPS suggests that a new statistical tool should be developed, which is specifically aimed at gathering information on PTW accidents to ascertain the different factors which play a role in real-life conditions.
  - Accident Research incorporates the study of macro and micro accident databases studies with respect to the casualty population. Macro studies record and investigate road accidents at a national and international level, whereas micro studies utilize in-depth and forensic investigation techniques to examine a much smaller number of crashes, but to a much greater level of detail. To successfully tackle the future motorcycle casualty problem it will be necessary to combine the macro and micro data to formulate strategies. There is reasonable

recording across Europe at a macro level with police gathering data on injury collisions, but there is very little in-depth or micro data collected. The only large on-going programme in Europe that investigates all injury severity accidents at the scene and collects micro data is the German In Depth Accident Study (GIDAS). The dearth of micro data means that it is very difficult to make scientific judgments based on real-world accidents where detailed knowledge of their characteristics and causes are needed. There is very little good quality exposure data across Europe that describes motorcyclists travel patterns and behaviours.

  - When the magnitude of data collection 'problems' are considered, there are arguably two parts to discuss: firstly, there is always scope to improve the quality of the data that is currently collected, primarily by the police (macro); and there is a scientific need for more information that describes what actually occurs before, during and after collisions in a very detailed way – more in-depth data collection (micro).
  - Road conflict investigations are not universally carried out across Europe and there are different criteria under which a police officer or another official would instigate such an enquiry. In the UK, only life threatening or fatal crashes would trigger an in-depth forensic investigation involving detailed photographs of the scene, mapping of the crash partners and environment (scene plan), collection of witness statements and a detailed reconstruction of events. For motorcycle collisions there are further complications when it comes to the reconstruction, as specialist techniques are required to account for the motorcycle and riders characteristics.

  ✓ Acquisition of additional and better data about PTW accidents, mobility and other issues should receive top priority. It has to be highlighted that research and data acquisition are not an end in itself; there are a necessary prerequisite for development and implementation of effective and efficient injury countermeasures.

- **SUPREME (2007) – Best practice Handbook**
  - For a good understanding of road safety developments and road safety problems, exposure data are indispensable. Exposure data provide information about how, where and how far people travel and who these people are. Together with crash information, this information allows for calculating the relative risk of travelling in general, or for particular transport modes, particular types of road or particular groups of people. All over Europe, the number of road crashes has decreased in the last couple of decades, despite the huge increase in mobility. This means that the risk of getting involved in a road crash, e.g. per kilometre travelled, has declined substantially. But this decline is neither equally distributed over transport modes, nor over road types or road user types. If the risk of some types of travel stays behind, it might be needed to take specific measures to catch up or to prevent that the number of crashes will increase if a risky type of travel is likely to increase in the future. To assess differences in risk and risk developments, it is necessary to monitor exposure on a regular basis.

  ✓ Best practices in the UK: The National Travel Survey (NTS) provides information about personal travel within Great Britain and monitors trends in travel behaviour. The NTS gathers information about several different aspects of travel including purpose of travel, travel mode (walk, car, bus etc.), origin and destination of trips, time travelling and distance, as well as information about individuals, vehicles and households.

- **WATCH OVER (2008) – Deliverable 2.1**

N.	PARAMETER	DESCRIPTION
1	Accident configuration	The first aspect considered is the accident configuration. It gives an immediate overview of the situation where the accident happened. From this variable it is possible to gather the percentages of accidents that occurred with similar geometric characteristics.
2	Collision opponent	It tells about the main actors involved in an accident.
3	Collision speed	Collision speed is the recognised velocity registered before the impact. It can be represented with an absolute speed (one moving opponent and a static one) or a relative velocity (both the opponents moving). Even if the WATCH-OVER target speed is 50 km/h, this aspect is important to discover the velocities at which the accident occurs more often.
4	Time of day	It gives the percentages of when an accident between a vehicle and a VRU happens. It is possible to gather when the fatalities or injuries occur more often, and the most proper scenario lighting.
5	Road conditions	Road condition is referred to the road surface status at the time of the incident. It is partially related to the weather conditions, as for example the rain makes the road more slippery. The percentages of most commonly occurring road conditions should be used for scenarios' prioritisation.
6	Accident location	It highlights where the accident happened. It is an important input to distinguish events occurred in an urban area or on a rural/sub-urban road.
7	First contact point	Whenever an accident occurs the first contact point tells about the visibility of the collision opponent at the time of the event. From this information it is possible to understand if the VRU should have been visible by the camera sensor and how much the communication technology can help to increase the recognition of the VRU.
8	Age group of user	It indicates the percentages of accidents occurred to different road users, dividing them in different age groups. This variable gives an idea about the typology of people involved in the event, and so it is possible to derive the range of speeds of the pedestrians mostly related to road accidents.

Table 1: Parameters considered in accident statistical survey

D5: Research

Project/website	Ending date	Final report	Relevant Deliverables
2-BE-SAFE	1/09/2011	http://www.2besafe.eu/sites/default/files/deliverables/2BES_D35_FinalReport.pdf	• 6.4 Guidelines, policy recommendations and further research priorities

SARTRE 1-4		http://www.attitudes-roadsafety.eu/index.php?eID=tx_nawsecuredl&u=0&file=fileadmin/Results/SARTRE%203%20results/S3_reports/Part%201_Report%20on%20principal%20results.pdf&t=1426947005&hash=37ce58463fddcf23253e64977ec9e93f	• Sartre 4 - European road users' risk perception and mobility
PROMISING	1/01/2001	http://www.transport-research.info/Upload/Documents/200310/promisingrep.pdf	• Deliverable 3

- **2BESAFE**
  - Statistics show that PTW users are increasingly "over-represented" in fatal crashes. The main cause of accidents with PTWs is the failure of other drivers to perceive them, but their own errors are also a contributing factor in many crashes. To learn more about why accidents happen, investigations in the natural surround of the driver – called Naturalistic Driving Studies – are conducted. These studies thus do not have an experimental approach but try to collect descriptive mass data concerning common driving behaviour. Naturalistic Driving Studies are an important part of driver-based data. Naturalistic Driving Studies generate a huge amount of raw data concerning the behaviour of motorcycle and moped drivers. Science will be given a unique and extremely valuable database. Certainly, creating such a database is not an end in itself. Scientists aim at gaining a deeper understanding of PTW riders' behaviour in able to develop a new generation of safety measures.
  - In the course of 2BESAFE, a Naturalistic Riding pilot study was carried out. PTWs were fitted with special equipment and sensors in the UK, France, Italy and Greece. In 2011, another Naturalistic Driving Study started in the United States of America.
  - ✓ **Recommendation:** Conducting Naturalistic Riding Studies. As a research tool, benefits across the areas can be obtained. No direct impact can be expected, besides a better understanding of the problems being addressed. A naturalistic riding study would pay in the long run, providing evidences for supporting policy decisions or to accept vs. reject the introduction of a specific technology.
- **SARTRE 4**
  - ✓ **Recommendations:** Development and implementation of safety equipment adapted to countries with hot weather
- **PROMISING (2001) – Deliverable 3**
  - From research into learning to ride a moped/motorcycle, there is no clear answer to such obvious questions as

- What should a learner rider learn as a minimum to be able to safely ride a moped/motorcycle?
- How can this be learned effectively and efficiently, in how much time and in which sequence?
- In what way is learning to ride a moped different from learning to ride a motorcycle or is learning to ride a low performance motorcycle different from learning to ride a high performance one?

In fact 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.

- Apart from the recently introduced higher age limit for riding an unlimited motorcycle, the requirements for motorcyclists are roughly similar to those for car drivers. The same age limit applies to both cars and motorcycles and the duration and content of compulsory training programs and/or testing are roughly the same. For riders of a light weight motorcycle the age limit is lower and still lower for moped riders. The reason for a lower age limit than for car drivers may be that the higher accident rate is mostly a higher rate of injury/death for the riders themselves and not for the other road users with whom they collide. The effects of this legislation have not been thoroughly evaluated. It is obvious, however, that legislation only gives minimal requirements and that training on a voluntary basis is highly desirable.
- In general riders of mopeds and motorcycles follow the same traffic rules as car drivers, with the exception of a lower speed for mopeds. It might be argued that problems of congestion by cars can be partly solved by replacing cars by mopeds and motorcycles. This can only be done if the safety of the riders is improved. Under this condition, it can even be considered to give riders of mopeds/motorcycles some privileges compared to car drivers, such as overtaking lines of slow moving cars on the left or right, to take position at the head of waiting lines of cars, to ride on lanes, roads or areas with restricted access (such as bus lanes, inner city areas etc.) and to provide special parking facilities. Some of the suggested traffic rules, insofar as they separate motorcycles/mopeds from cars, can also improve the safety of riders, although care should be taken not to introduce other safety problems (e.g. collisions of motorcycles/mopeds with pedestrians or cyclists, or with cars, at places where the motorcycles/mopeds are not expected). Special traffic rules for motorcycles/mopeds have been tried in several places in Europe, but so far no results are known. More explicit rules are supposed to result in more uniform behaviour by riders and better knowledge and acceptance of it by other road users.
- The perception of mopeds/motorcycles is a special problem for other road users. This can only be partly solved by the use of daytime headlights by riders of mopeds/motorcycles. Another part of the problem is that other road users are not prepared to search for mopeds/motorcycles and to take action to avoid a collision. Car drivers have to be made

aware of this and learn to change their behaviour for the safety of riders of mopeds/motorcycles. There are no studies on how to obtain these effects.

- More development and research is needed before other protective devices such as airbags or leg protectors can be introduced.
- In the future, cars and roadside obstacles have to be designed to provide better protection for riders of mopeds/motorcycles who collide with them. Several studies have shown the adverse consequences of a motorcyclist colliding with a guard rail. New studies will lead to the development of better constructions and will identify locations which should get priority treatment.
- Data collection and research are not safety measures by themselves, but serve to study the need for and the effects of such measures. In the case of mopeds and motorcycles there is a strong need for more reliable data and more and better research.

✓ **Project recommendations in relation with research needs:**

- In addition to accident statistics, it is highly desirable to have detailed accident studies in each country with information on both causes and consequences of accidents with motorcycles/mopeds
- more research has to be done on the development and evaluation of such programs
- special studies have to be done on the evaluation of existing and newly introduced legislation
- Controlling a motorcycle/moped is relatively difficult, in particular when cornering or braking. Continuous research is needed on the subject and the introduction of improved, relatively cheap braking systems has to be stimulated.
- Tampering of mopeds to make them go faster is known to be a problem in some countries. All countries are advised to provide information on this subject and to exchange the information on the effectiveness of antitampering measures. The recent introduction of European anti-tampering regulations has to be carefully evaluated
- Infrastructural measures to reduce speeds (such as humps or lane narrowing) have to be re-evaluated from the point of safety for riders of mopeds/motorcycles.
- Special traffic rules (such as overtaking slow-moving lines of cars, to ride on lanes with limited access) could be used to give riders of motorcycles/mopeds some privileges compared to car drivers and, insofar as they separate motorcycles/mopeds from cars, could improve their safety. There is little empirical information on the effects of such rules. Countries are recommended to evaluate such rules where they already exist, and to promote demonstration projects to gain more experience with them.
- Riders of motorcycles/mopeds have little protection against collision impact, but every effort should be made to provide as much protection as possible. For that reason, countries have to be stimulated to participate in in-depth studies of motorcycle/moped accidents to

provide the necessary data on which standards for the design and evaluation of protective devices can be based.

- Research on the design of helmets, rider clothing, motorcycle design elements, and car fronts for the protection of riders has to be supported.

D6: Traffic management

Project/website	Ending date	Final report	Relevant Deliverables
2-BE-SAFE	1/09/2011	http://www.2besafe.eu/sites/default/files/deliverables/2BES_D35_FinalReport.pdf	• D3.1 Social, cognitive and behavioural differences of PTW riders with reference to their attitudes towards risk and safety • 3.3 Relationships between rider profiles and acceptance of Advanced Rider Assistance Systems
DaCoTA	30/06/2012	http://www.dacota-project.eu/Deliverables/DaCoTA_Final_Report.pdf	• Vehicle safety report • Powered Two Wheeler report (ERSO)
PROMISING	1/01/2001	http://www.swov.nl/rapport/d-2001-03.pdf	• Vehicle safety report • Powered Two Wheeler report (ERSO) • Accident Causation Models • eSafety report
ROSA	31/03/2011	http://ec.europa.eu/transport/road_safety/pdf/projects/rosa_handbook_en.pdf	• European Handbook on Good Practices in Safety for Motorcyclists - Epigraph: MOTORCYCLISTS EQUIPMENT – • European Handbook on Good Practices in Safety for Motorcyclists - Epigraph: HUMAN FACTOR – • European Handbook on Good Practices in Safety for Motorcyclists - Epigraph: VEHICLE –
SAFERIDER	1/12/2010		• Benchmarking Database

SARTRE 1-4		http://www.attitudes-roadsafety.eu/index.php?eID=tx_nawsecuredl&u=0&file=fileadmin/Results/SARTRE%203%20results/S3_reports/Part%201_Report%20on%20principal%20results.pdf&t=1426947005&hash=37ce58463fddcf23253e64977ec9e93f	• Sartre 4 - European road users' risk perception and mobility
SIM	31/08/2009		• In-depth Accident analysis
SUPREME	1/06/2007		• Best Practices Handbook
TRACE	30/06/2008		• Deliverable D4.1.1 – D6.2 Review of crash effectiveness of Intelligent Transport Systems • D4.1.3 A-priori evaluation of safety functions effectiveness - Methodologies • D5.1 Analyzing 'human functional failures' in road accidents • D6.1 Common database of existing safety functions (incl. Pictures)
VRUITS	ongoing		• Deliverable 2.1 Technology potential of ITS addressing the needs of Vulnerable Road Users
WATCH-OVER	31/12/2008	Final Report not for public	• D2.1 Requirements and Use Cases (pp. 33 on)

- **2BESAFE project (2011) – Deliverable 3.1**

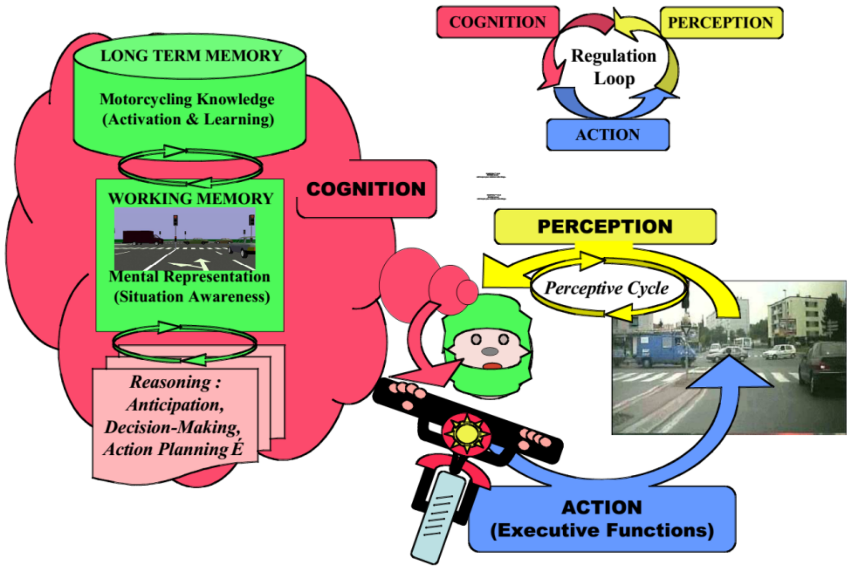


Figure 4: Synthetic overview of the motorcycling activity as a "Perception-Cognition-Action" regulation loop (adapted from COSMODRIVE model; Bellet and al., 2007)

- The figure provides a synthetic overview of this activity considered as an iterative "Perception-Cognition-Action" loop of regulation, between the human rider and the road environment. Indeed, as with any dynamic environment, the road environment requires constant adaptation from the driver. 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. Indeed, from their interaction with the road environment, riders build mental models of the events and objects that surround them (Johnson-Laird, 1983, Norman, 1983). 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. This mental representation provides a meaningful and self-oriented interpretation of the reality, including anticipations of potential evolutions in the current driving situation. They are not copies of objective reality but they potentially diverge from it quite considerably. On the one side, they only contain a tiny amount of the information available in the environment: they focus in priority on useful information in order to act efficiently in current traffic conditions, as a function of the goals pursued by the rider. On the other side, they can also convey much more information than that available in perceptible reality (e.g. keeping in memory information perceived previously but henceforth hidden, formulating inferences of potential future events based on precursive clues, or anticipating the expected effects of an action in progress). From this point of view, it corresponds to the driver's Situation Awareness, according to Endsley (1995) definition of this concept: the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future. Moreover, this mental representation is "action-oriented" (i.e. the rider doesn't passively observe the road scene as a "spectator", but as an "actor"). It constitutes an operative image (i.e. a functionally deformed view of the reality; cf. Ochanine, 1977), a "goal driven" model of the road environment. They are formulated "by" and "for" the action. Therefore they provide interiorised models of the task (Leplat, 2004) constructed for the current activity, but which can be stored in Long Term Memory (LTM) and reactivated later in new situations, for future performances of the same task. Mental representations form the kernel of complex sequences of cognitive processes, ranging from the perception of events to driving behaviours, through intermediate steps of decision-making and activity planning. However, care is required to avoid taking an over-linear and sequential view of this processing string. Although the perception of an unexpected or critical event sometimes triggers the processing sequence, it is more often the action in progress and/or the riders' intention (the aim they seek to attain in the current situation) that directs their perceptive exploration and information processing. More than a linear sequence of perceptive-cognitive processes, riders' mental activities should be described as an iterative "perception cognition action" cycle of regulation, organized around the mental representation of the driving situation. In this control loop, perception is constantly fuelled by mental representation, which in turn constantly fuels perception. Once built, these mental models generate perceptive expectations, guide the road environment exploration and the new information processing, and are also the central components of cognitive cycles involving decision-taking and anticipating functions (i.e. via mental simulation based on the current state of the world). When an appropriate action to the current driving context has been identified, selected, or cognitively planned, it is implemented by the rider on the motorbike (i.e. executive functions) for progressing into the dynamic road environment. From this point of view, mental representations are key elements of the rider's cognition; and an erroneous representation means, potentially, decision-making errors and unsafe driving actions.

- 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.
- *Risk awareness* could be considered as judgement of criticality close to the Threat Appraisal stage.

When a critical event occurs in the road environment, risk awareness is intimately linked with hazard perception (Horswill and McKenna, 2004), as well as including a threat appraisal (Grayson et al., 2003) and a judgement concerning the driving situation criticality (Banet and Bellet, 2008). From this approach, 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.

- Factors influencing *Risk Awareness* at the cognitive level: A number of contributing factors have been identified in the literature on car driving activities as impacting cognitive abilities of situational awareness and risk perception (like gender or age, for example). Several past studies have demonstrated that the risk of motorcyclists having a crash decreases with age and riding experience. Other surveys clearly indicate that the risk of having an accident is higher for inexperienced than for experienced motorcyclists. Moreover, the risks of motorcycle injury and death were found to be higher for young riders, which may be partly due to inexperience, unfamiliarity, or lack of riding exposure. The number of available empirical data concerning riding experience effect on risk awareness is more limited, and primarily focused on hazard perception issues. Recent simulator experiment showed that experienced motorcyclists – in comparison with novice riders - crashed less often, received better performance evaluations, and approached hazards at more appropriate speeds. They also found that some novice riders were overconfident in their riding ability. In another recent paper, Hosking et al (2010) showed that experienced motorcyclists respond to hazards earlier than inexperienced riders, and have more flexible and efficient visual search patterns. Furthermore, motorcycling practice can impact cognitive abilities relevant to risk awareness. For example, a motorcyclist riding a motorbike in urban area for commuting may have different knowledge, expertise inrisk awareness and / or riding skills than a sport rider mainly using the motorbike on rural roads, or than a "rambler" using the motorbike during holidays for long trips travel on motorways.
- Once an individual rider evaluates the level of risk of a situation, a variety of factors will influence the level of risk he/she is comfortable with. The level of risk accepted will be based in part on the riders' beliefs about their own level of skill in successfully avoiding the hazard. Mannering and Grodsky (1995) noted the factors that may tend to bias an individual's perception of risk. These were:

  - *Unwarranted optimism*: those who are more optimistic of their skills and likelihood of accident involvement are more likely to perceive a lower risk.

- *Anchoring bias*: this refers to tendencies to anchor risk estimates around the notion of overall risk based on experiences and general knowledge of overall accident risk. Therefore, involvement in training courses or previous accidents may be likely to affect estimates of perceived risk.
- *Availability bias*: this refers to the assessment of risk based upon disproportionate information. As a result, appropriate probabilities of risk may not be assigned to events which have been disproportionately experienced or recalled.
- *Deliberate under-estimates of risk*: this is the tendency to justify risk-taking behaviour by underestimating risk deliberately.
- *Under-estimate the variance in accident risk*: this is the over-estimation of lower probability events and the under-estimation of higher probability events.

o To improve road safety, engineering measures (which change the physical safety conditions) are introduced. One way of doing this is to minimise the severity of an accident if and when it occurs, for example introducing helmet laws for motorcyclists. However, a problem with this is that motorbike riders may overestimate the safety benefit of the helmet and overcompensate for it by riding in a more risky manner. It has previously been found that motorcycle riders who wore helmets perceived their risk of death as lower and responded with greater risk taking in the form of increased speed (Peltzman 1973; Underwood et al., 1993). Asogwa (1980) investigated motorcyclist fatalities in Anabra State, Nigeria, before and after the introduction of a law mandating the wearing of helmets. Despite high wearing rate (96%), a substantial increase in both fatality rate (17.1%) and injury rate (55%) occurred in a two-year period after the legislation, compared with a two-year period before the legislation. The major reason why this measure had effects in a direction opposite to that intended was that the motorcyclists overestimated the protection afforded by wearing helmets, and then increased their risk taking when wearing them. Wearing a helmet has a safety effect of reducing accident severity in some crashes. However, it has no effect on reducing accident number. This case study indicates that 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 resultin an effect in a direction opposite to that intended.

• **2BESAFE project (2011) – Deliverable 3.3**

o PTW riders are significantly over-represented in crash statistics. Although PTWs represent only 2% of road users in Europe (ETSC, 2009) they represent upto 24% of road fatalities (IRTAD, 2009; Werner, 2005). PTW riders are particularly over-represented in single vehicle loss-of-control crashes and multiple vehicle crashes in which other vehicle drivers fail to detect a PTW. Several factors contribute to this elevated crash risk including the vulnerability of PTWs, conspicuity, and rider characteristics.

o PTW riders are considered vulnerable road users due to their relative lack of protection against impacts with other vehicles, roadside objects and the ground (ETSC, 2008). PTW riders often sustain multiple injuries in a crash, with head injuries the most frequent in fatal crashes (Kraus, 1989). In addition, the inherent instability of PTWs makes them more prone to crashing compared to other vehicles

- PTWs have low sensory conspicuity compared to cars and other vehicles due to their small size, their often dark colours, and their irregular contours (Brenac et al. 2006; Doğan et al., 2004). 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 (Brenac et al., 2006)
- 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 signaling; speeding and riding under the influence of alcohol (Lin et al., 2003; NHTSA, 1999)
- 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).
- 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).
- 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 airbagshave 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.
- 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)
- 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.

- 2BESAFE acceptance survey (6297 respondents from countries including the UK (36%), France (25%), Portugal (8%), Greece (7%), Australia (4%), Finland(3%), Germany (3%) and Austria (1%). Nearly all respondents (93%) were male –

  Overall acceptance of specific systems was relatively low: even among the high acceptance group, all mean scores were below 3 on a 5-point scale, where 1 indicates low acceptance and 5 indicates high acceptance. TCS showed the greatest variance between groups, whereas ISA and GPS showed the smallest difference. For ISA, both clusters showed relatively low acceptance of the system, whereas for GPS both groups showed moderate acceptance. Generally acceptance was higher for systems that do not actively interfere with the riding taskbut work in the “background”. Further, it appears riders trust systems that they already know and/or consider reliable, like ABS and airbags. Adaptive cruise control, lane keeping assistant and ISA received the lowest acceptance levels.

  - Perceived downside of riding (risk) was a significant predictor of acceptance, consistent with Schlag’s (1997) assertion that problem awareness is a necessary precondition for acceptance;
  - The low acceptance group were less likely to report risky behaviours and attitudes. This could mean that riders who are more likely to engage in risk-taking behaviour also display higher acceptance of new safety technology, meaning the systems are likely to be adopted by those who need them most; Alternatively, given the self-report methodology, it could be that riders who have lower acceptance of assistive systems believe that their relative risk of accident is lower.
  - *Perceived usability and satisfaction*. Overwhelmingly, riders objected to systems that interfere with their responsibilities as a rider (e.g., ISA, ACC).
  - *Perceived usefulness.* Riders showed greater acceptance of systems that will provide obvious benefits in emergency situations, such as automatic crash notification.
  - *Perceived effectiveness*. Riders expressed a preference towards established systems, which are known, trusted, considered technologically mature and have demonstrated safety benefits (e.g., ABS). Riders also expressed concern that some systems may lead to de-skilling of riders.
  - *Affordability*. Riders expressed concern that some assistive systems, which are increasingly available on passenger cars, may not be cost-effective for fitment on most PTWs.
- It appears that there is potential to increase acceptance, either through changing riders’ attitudes towards the technology or by changing the technology itself. Most riders do not have direct experience using assistive systems and many believe that rider training would be more beneficial
- Acceptance could be improved in future by educating riders about the benefits of assistive systems and increasing their exposure to such systems

- Overall, there is reasonable evidence to suggest that riders will accept systems that they perceive as useful and effective.
- 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 acceptance studies from passenger cars to PTWs.
- It is worth noting that some systems may have mixed effects on safety.

✓ **Recommendations:**

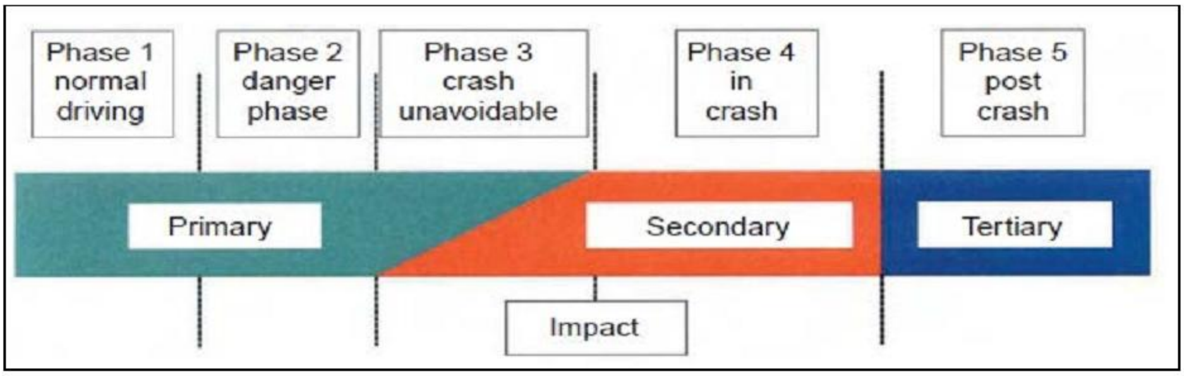
- Overall, there is currently low to moderate acceptance of PTW assistive systems. Future work should continue to assess acceptance
- More empirical research should investigate the respective benefits of both assistive systems and rider training, especially in direct comparison to each other.
- It is worth noting that some systems may have mixed effects on safety. It would be highly beneficial to conduct more extensive on-road research examining the effects of using assistive systems on PTWs. This seems particularly important given that a major concern among riders is that new systems will have negative effects on riding style and skills.

- **DACOTA (2012) – Vehicle Safety report**

Table 1: The role of vehicle safety measures in Safe System intervention

Key system measures		*System use*	*Vehicles*	*Road*	*Emergency Medical System*
		Examples	Examples	Examples	Examples
Pre-crash	crash occurrence and crash mitigation	Speed management Unimpaired road use	Lighting, braking, handling, driver assistance for speed and impairment management	*Safe System* road design, layout, speed limits and user facilities	
Crash	injury during the crash	Use of safety restraints or helmets	Crash protective design	Crash protective medians and roadsides	Links to vehicle and roadside crash notification
Post-crash	Post-crash injury	Early access to care	Evacuation Crash notification equipment	Safety of post-crash sites for safe recovery	Fast emergency medical response, early diagnosis and efficient trauma care

Figure 1: The integrated vehicle safety system ACEA safety model



- Vehicle engineering improvements for safety have been achieved to date by modifying the vehicle to help the driver or rider avoid a crash and by modifying the vehicle to provide protection against injury in the event of a crash for those inside and outside the vehicle. New attention in Europe and globally is being given to ensuring vehicle crash protective design for those outside the vehicle; driver assistance measures which can help to improve safety behaviours; in-vehicle measures aimed at improving post-crash response and the development of integrated approaches linking communication between vehicles and with the road network.

Table 5: Vehicle safety strategies and measures

Crash avoidance or primary safety	Devices to avoid a crash e.g. daytime running lights, electronic stability control, intelligent speed adaptation, alcolocks. EU level developments in safety are focusing much more around new vehicle based primary safety systems that may prevent collisions occurring. Examples include Electronic Stability Control (ESC) (which are already showing substantial road safety returns), lane keeping systems and pedestrian detection and auto braking systems (OECD, 2003). There are high expectations that these new systems will provide the largest reductions in casualties into the future though the evidence in many cases remains weak (VSRC, 2011).
Crash mitigation systems	Examples are intelligent speed assistance or advanced braking systems which actively aim to lessen crash severity before the crash occurs.
Crash protection or secondary safety or passive safety	Protection in the event of a crash e.g. seat belts, airbags, front and side impact protection. Opportunities exist for further important improvements at EU level such as in vehicle to vehicle compatibility, the protection of side impact occupants on the far side of the vehicle, prevention of whiplash injuries and the protection of more vulnerable car occupants such as elderly drivers and passengers.
Active safety	The term *active safety* is often used to mean crash avoidance but care should be taken in its use since it is also used to denote deployable systems such as crash-protective pop-up bonnets for pedestrian protection or seat belt reminders.
Integrated technologies and co-operative systems	In recent years there has been a move away from traditional approaches towards crash avoidance and crash protection towards holistic in-vehicle approaches. The aim here is to achieve a truly integrated technological vehicle response to the risk of crash and better outcomes before, during and following the crash event. Accordingly, more advanced technologies are under development and testing which support information connectivity between vehicles and with road infrastructure. These are known as co-operative systems (Euro NCAP 2009).

   - 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 (2012) – PTWs report**
   - Lane filtering by motorcyclists is defined as moving between traffic when other surrounding traffic is stationary. Lane splitting is defined as moving through traffic when other traffic is in motion. The first case is standard motorcycle practice and necessary for efficient motorcycle travel, however there are safety concerns on which the existing literature is not conclusive. The second case, however, is not allowed in most European countries almost no systems are available for motorcyclists, and that very little evaluative studies exist

• **DACOTA (2012) – Accident Causation Models**

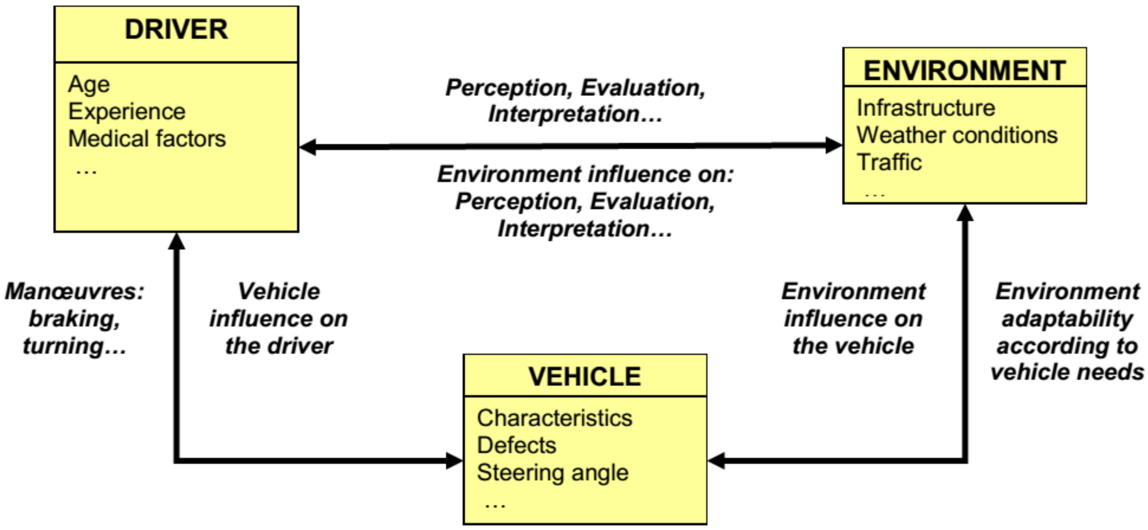


Figure 4: The DVE model

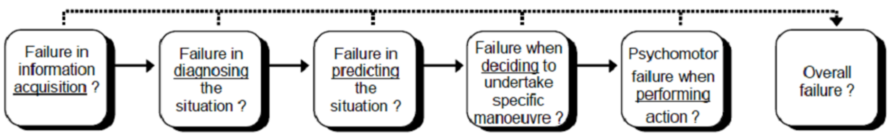


Figure 5: Stages of Human Function failure

Each functional stage is associated with a certain number of potential failures (see Figure 6). For instance, the detection category can be derived in 5 specific human functional failures: a failure to detect in visibility constraints, a focalised or a cursory acquisition of information which led to a problem of detection, etc.

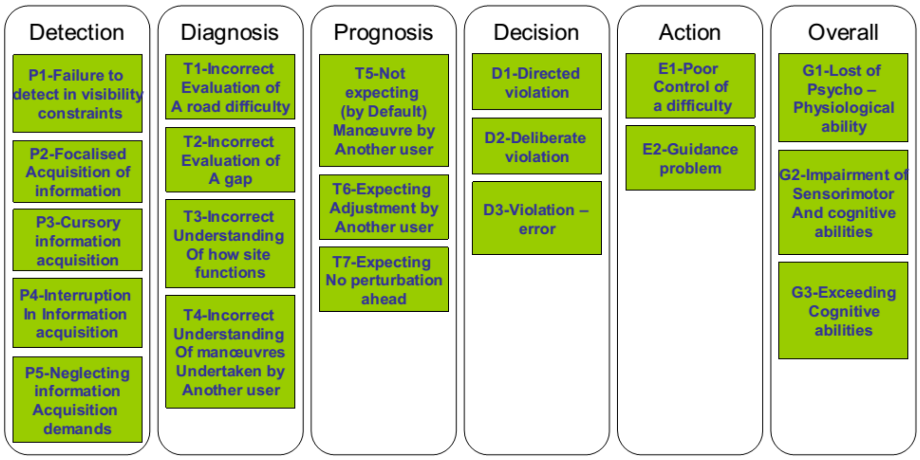


Figure 6: Human functional failures per stages (the capital letters combined with the number ahead are the code used, in the whole report, for each human functional failure)

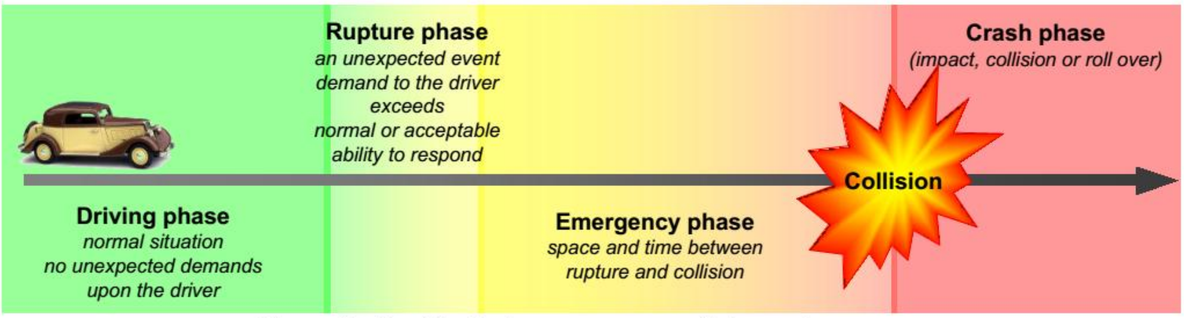


Figure 9: Accident view as a sequential event

- **DACOTA (2012) – eSafety report**
  - Drivers' needs analysis allows to identify:
  - Safety needs for different kinds of drivers, reflecting their accident-generating failures at the different stage of the process;
  - The potential capacity of safety functions to meet these needs;
  - The potential lacks in the functions efficiency.
  - Assessment methods need to be improve to take into account the new challenge brought by future technology. These improvements will Identify the lacks of a methodological point of view and not content with making what we know how to make with the data that we have. They will go through the development and the availability of accident data (today one of the weak points of the methods), by the consideration of the human factor in the evaluation loop and the development of the statistical tools
  - Today it is not rare to find several studies of evaluation of the same safety system with sometimes results which can to be different even contradictory. These differences are understandable most of the time by the taken hypotheses, the used method or the selected sample.
  - Main issues regarding "technology":
    - 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
    - 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
    - Is it reliable? The challenge is to find the best compromise between the detection of all the aimed situations and the false alarms.

- 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
  - *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
  - *Automation*: this step will represent a real jump forward and will imply numerous changes in our relation with the car. The autonomous vehicle which will circulate on any road is not for tomorrow because it will require at first the acquisition of knowledge related to the travel, to the traffic and to the road environment. The first vehicles will circulate in a restricted and controlled environment or will make simple manoeuver such as the car park for example.

- **PROMISING (2001) – deliverable 3**
  - Training and experience of riders are important to control the moped/motorcycle in all kinds of situations, to cope with imperfect road surfaces and obstacles on the road, to recognise situations in which other road users may not react adequately to their presence and to learn the consequences of behaviour which is different from that of car drivers and how to cope with these consequences. This is all in addition to what all road users or car drivers have to learn about safe behaviour. In other words, learning to ride a motorcycle safely may take longer and to a certain extent is different from learning to drive a car. Since mopeds have a lower speed, this is only partly true for learning to ride a moped.
  - From research into learning to ride a moped/motorcycle, there is no clear answer to such obvious questions as
    - What should a learner rider learn as a minimum to be able to safely ride a moped/motorcycle?
    - How can this be learned effectively and efficiently, in how much time and in which sequence?
    - In what way is learning to ride a moped different from learning to ride a motorcycle or is learning to ride a low performance motorcycle different from learning to ride a high performance one?

  In fact 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.

  - Special traffic rules (such as overtaking slow-moving lines of cars, to ride on lanes with limited access) could be used to give riders of motorcycles/mopeds some privileges compared to car drivers and, insofar as they separate motorcycles/mopeds from cars, could improve their safety. There is little empirical information on the effects of such rules. Countries are recommended to evaluate such rules where they already exist, and to promote demonstration projects to gain more experience with them.

- **ROSA (2011) – European Handbook PROTECTIVE EQUIPMENT**
  - Identified problems related to protective equipment:
    - Helmet
      - Lack of information about how to choose a helmet
      - Incorrect use of helmet
      - Lack of awareness about the use of helmet
      - Improvement of the safety behaviour of the helmet
    - Clothing
      - Lack of information about the clothing the riders need
      - Improvement of the safety behaviour of clothing
      - Injuries in the trunk part of the riders: Trunk protectors
      - Injuries in the neck part of the riders: Neck protectors
      - Lack of acceptance
    - Others
      - How to know the correct homologation of the products
      - Lack of homologation procedures for all the clothing sold related to riders
      - Lack of conspicuity
  - Collected good practices include:
    - Electronic safety system in helmets for avoiding the PTW starting in case of incorrect use
    - Helmet with airbag integrated: http://www.race.es/opencms/opencms/system/galleries/webrace/downloads/informes_segvial/informe_2010_10_airbag_motociclistas.pdf
    - Airbags on jackets: www.munimadrid.es
    - Helmet Brake Light System: http://www.safedriving.com/Helmetbrakelight.htm

- ✓ **Project recommendations include:**
  - European administration should define a standard in which several aspects should be defined: certain colours, brightness, surface area or location of the brake lights on the helmet

- **ROSA (2011) – European Handbook HUMAN FACTORS**
  - Identified problems related to human factors:
    - Socio-demographic aspects of riders: age, gender and experience
      - The tendency of the young riders to violate the rules of safe riding and towards negligence of potential risk. The same way as the lack of superior cognitive skills for riding due to the lack of experience
    - Perception of riders/human errors
      - The tendency to ever-rate their own abilities and chances of positive outcomes due to the psychological construction of unrealistic optimism.
      - Low hazard perception skills to detect dangerous traffic situations and a lack of abilities to respond appropriately in the face of the hazard.
    - Riding/ Driving Attitudes and Patterns
      - Risky attitudes carried out by motorcyclists in group riding at weekends and holidays
      - Risky behaviour associated to personality features, sensation seeking, and risk-taking decisions of some riders
      - Attitudes and risky behaviours associated to riders with aggressive personality or anti-social features
    - Psycho-physiological state of the motorcyclist
      - The effects of fatigue on motorcyclists reaction time and decision making ability
      - Alcohol consumption in motorcycling rallies and weekends
    - Perception of drivers/human errors
      - Fail to detect the motorcycle by the other road users, despite its presence in the driver's field of view, referred to this as the conspicuity hypothesis
    - Attitudes and sociological consideration
      - The motorcyclist's image among the other road users
  - Collected good practices include:
    - Red Light Jumper Cameras: http://www.local-transportprojects.co.uk/files/BP3%20010%20Red%20Light%20cameras%20%28v1%29.pdf
    - Safety Cameras in London: www.lscp.org.uk/

        - Ignition interlocks devices on motorcycles: http://www.interlockstl.com/motorcycles.html
        - Blind Spot Information Systems: http://www.gizmag.com/go/2937/

- **ROSA (2011) – European Handbook VEHICLES**
    - Identified ITS solutions for motorcycle:
        - Preventive Safety
            - ARAS-OBIS Systems (ARAS: Advanced Rider Assistance Systems – OBIS: On-Bike Information Systems): During the last decades ADAS (Advanced Driver Assistance Systems) and IVIS (In-Vehicle Information Systems) development has been one of the main research areas of the automotive industry in order to increase safety and comfort for four-wheel vehicles. These technologies have already been explored for passenger cars, whereas the application of these devices on PTW (so-called ARAS - Advanced Rider Assistance Systems - and OBIS - On-Bike Information Systems -), in order to increase the safety and comfort of riders, is still at the primary stages of development. It is therefore necessary to estimate the potential benefits of these technologies when applied on PTW.
                - Maintenance.
                - Inter-vehicles communications.
                - Implementation of e-call (OBIS) on PTW.
                - Implementation of Telediagnostic Module (OBIS) on PTW.
                - Design guidelines of HMI to be used together with ARAS/OBIS.
                - To incorporate "Adaptive Light control" systems
                - Intelligent transport systems (vehicle) and motorcycle safety
                - Implementation of Speed Alert (ARAS) on PTW
                - Implementation of Curve Warning (ARAS) on PTW
                - Implementation of Lane Change Support (ARAS) on PTW
                - Implementation of Frontal Collision Warning (ARAS) on PTW
                - Implementation of Navigation and Route Guidance (OBIS) on PTW
                - Implementation of Weather traffic & Black spot info (OBIS) on PTW.
                - Lighting systems. Daytime running lights (DRLs) are bright white or yellow forward-facing lights that improve the forward conspicuity of vehicles (any type of vehicles) in the daytime. They are intended to increase the chance of other road users seeing the approach of the vehicle.
                - AHO. "Automatic headlights on"
                - Incorporate different headlights.
                - Different lighting at day/night: Dedicated lights
                - Different lighting at day/night: Bright yellow turn signal DRLs.
                - To incorporate "Adaptive Light control" systems

- Active Safety:
  - ABS (Antilock Brake System). The progressive introduction of ABS systems as optional equipment on top of the range motorcycles has been welcome by the riding community as an aid in braking, and manufacturers are progressively optionally fitting these systems also on mid-range models as an answer to the market's demand. These advanced braking systems are recommended such as ABS to become progressively available as optional equipment on all PTWs at affordable prices through voluntary commitments with the motorcycle industry and in parallel with an appropriate revision of the rider training schemes.
    - Training in ABS operation
    - ABS mandatory for all motorcycles
  - Brake Assistance Systems. Riders had some concerns regarding the potential for the system to operate in a manner the rider did not expect, disrupting the rider's braking routine. Rider opinion about advanced braking systems was not based on practical experience with the systems, very few riders actually having ridden motorcycles with any of these features and only two having any form of advanced braking on the machine they rode regularly. Riders thought that whether or not advanced braking systems appeared to be good value for money depended on the value of the motorcycle. At current costs, it was reasonable value on expensive motorcycles, but unrealistically high for the smaller motorcycles and scooters that learners were most likely to buy. The main barrier to uptake was the belief of experienced riders that they were able to brake as efficiently as any of the advanced braking systems. It was the opinion of many participants that they did not require assistance with braking.
    - Training in ABS operation
    - Campaigns
    - To encourage riders to experience brake assistance systems: Simulators.
  - New systems:
    - Automatic Stability Control
    - Electronic Stability Programme
    - Electronic Suspension Adjustment
    - Tyre Pressure Control
    - Motorcycle Integral Braking system
- Passive Safety.
  - Airbags. *Passive safety systems are those that take effect during or immediately after a crash in order to minimise harm to the vehicle occupant. Airbags inflate when are triggered by impact sensors in the front wheel/s, and are relevant to all frontal impact crashes. However, unique issues concern motorcycle airbags since they must be designed to take into account that the position of the rider is not always upright such that there may be smaller distances between the rider's face and the airbag than that typical for car drivers, and that the presence of pillion passengers will affect the forward force of the rider. Experiments with airbags show that the speed of the PTW*

rider who departs from the PTW during a frontal collision can be considerably reduced.

        - Development of chest airbags
        - Development of leg protectors

    - Crash tests: To improve motorcycle behaviour based on safe criteria, analysing different biomechanics parameters from the respective test dummy during the impact. This behaviour would be evaluated based on a protocol.

        - Star rating for motorcycle crash tests

    - Crash notification systems. Taking into account that single vehicle accidents is one of the most common accident scenarios for motorcyclist (MAIDS European Project), it is important to consider that in this type of accidents, riders could be not able to notify the accident and injuries could be worse if they are not located by emergency services.

        - Emergency Hazard Light

- Maintenance. The European MAIDS (Motorcycle Accidents In Depth Study) project found that a tyre or wheel problem (usually a puncture) was a cause in 3.7% of all the motorcycle accidents they studied. An estimate based on replacement of punctured tyres suggests that 11% of all tyres sold are to replace punctures. Any tyre, no matter how well constructed, may fail in use as a result of punctures, impact damage, improper inflation, overloading, or other conditions resulting from use or misuse. Tyre failure may create a risk of property damage, serious personal injury or death. To reduce the risk of tire failure, it is strongly recommended to follow all safety information about it (tyre inflation, tyre loading, tyre damage, tyre size selection,…). The good maintenance of the motorcycle and the diagnosis of the motorcycle will avoid possible unsafe moments.

    - Campaign: Consumer information programme.
    - Check on tyre approval mark.
    - Replacement brake linings

✓ **Project recommendations include**:

- It is important to make widespread the knowledge of these new systems to stimulate its demand.
- To train properly to PTW users in the use of ABS and to make widespread this system: the necessity of knowing how the Anti-lock Braking system (ABS) works: Training in ABS operation: Initial Rider Training, websites, Post-license training programmes.
- The need of assistance during an emergency braking: training and website to inform riders on how to reach in case of emergency braking.
- To evaluate and to address every deficiency of the airbag system.
- Define a test protocol through which the behaviour of the motorcycles (from a safety point of view) could be rated. The process would be similar to the situation for passenger cars and the obtaining of "stars" through crash test defined in test protocols as "EuroNCAP".

- **SAFERIDER (2010) – Benchmarking database**

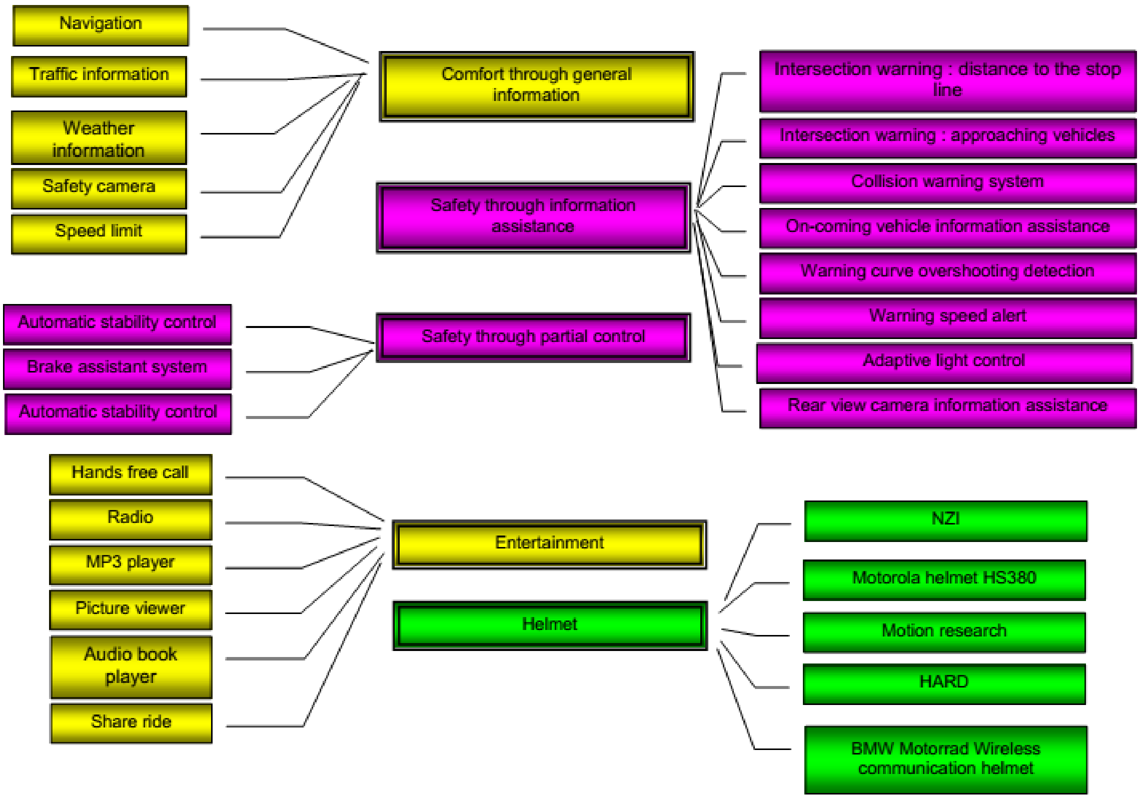
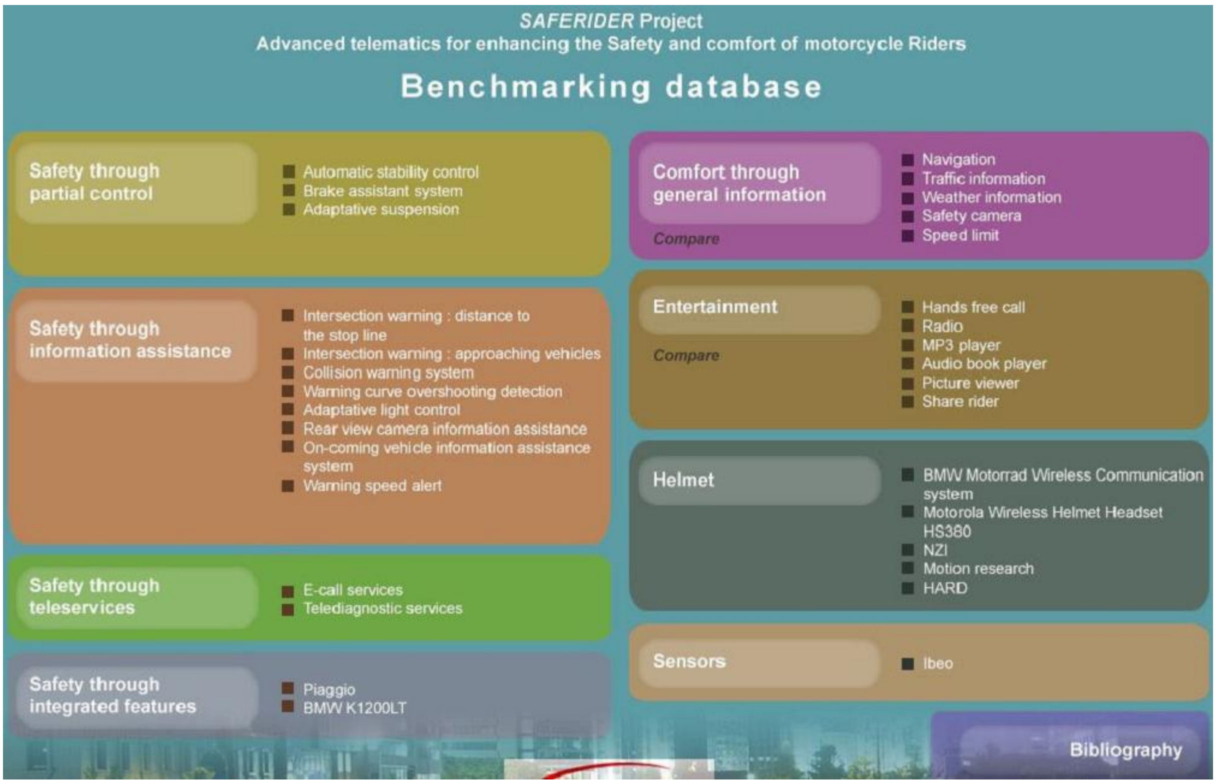


Figure 1 : Benchmarking functionalities



- The systems covering assistive functions are at a very prototyping state. None of them are available on the market in Europe today. Some examples such as warning about on-coming vehicles are today available only in Japan. This review allowed to point out that this type of "ADAS functions" are under construction nowadays in several European projects (watchover, Pisa, etc.)
- Several "IVIS functions" functions are nowadays available for riders on the market: Entertainment such as music listening, audio book player, pictures viewing are functions made available for riders. Nothing on the literature indicates that riders are really using these functions.
- Navigation, giving instructions to the user for directions to follow to reach a pre-defined destination. It has been showed in previous studies in the automotive context that the concept can have positive impact on road safety, as long as the interface and interaction do not interfere with the activity. From this point of view, the modalities of optimised navigation HMI for riders are not well known at this stage, very few studies have been conducted on this topic. The products available on the market have diversified HMI. For the dialogue between rider and system, the access for the user can be more or less direct according to the choice of the product manufacturer (for example, possibility of hardware buttons in addition to tactile screen inputs for some expansive product). The way to communicate auditory inputs to the rider is also quite diversified: some product relied on the mobile phone with blue tooth connection to transmit information to the rider, some other have just plain wired earphones connected to the system;

- **SARTE 4**
  - 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.

Table 1: Percentage of motorcyclists that often, very often or always display the behaviour (except for giving way to pedestrians for which percentage of never, rarely and sometimes is given, cf. *).

	Follow the vehicle in front too closely	Give way to pedestrians at pedestrian crossings*	Drive through traffic light on amber	Overtake when you can just make it	Flash lights or use the horn in anger	Use a helmet phone	Use an electronic tag to pay toll	Risky behavior index (mean of columns 2,4,5,6)
Cyprus	46%	24%	54%	68%	39%	14%	5%	52%
Greece	45%	18%	29%	50%	11%	7%	2%	34%
Serbia	20%	26%	24%	58%	27%	20%	21%	32%
Israel	20%	11%	21%	16%	31%	16%	--	22%
Austria	15%	36%	29%	22%	17%	16%	11%	21%
Poland	10%	31%	15%	44%	9%	3%	1%	20%
Czech Rep.	9%	17%	18%	47%	3%	7%	3%	19%
Estonia	24%	4%	23%	16%	12%	8%	4%	19%
Italy	16%	22%	35%	11%	9%	16%	13%	18%
Spain	6%	11%	32%	19%	7%	7%	6%	16%
France	14%	14%	15%	12%	12%	2%	3%	13%
Sweden	15%	8%	25%	7%	5%	4%	2%	13%
Hungary	18%	8%	17%	9%	4%	7%	0%	12%
Belgium	16%	15%	13%	11%	5%	2%	3%	11%
Netherlands	9%	6%	13%	13%	7%	13%	4%	11%
Finland	9%	12%	11%	4%	16%	5%	1%	10%
Slovenia	15%	15%	16%	2%	6%	4%	10%	10%
Ireland	5%	17%	16%	10%	5%	5%	6%	9%
Germany	9%	16%	17%	6%	2%	5%	--	9%
Total	**16%**	**17%**	**22%**	**23%**	**11%**	**8%**	**5%**	**18%**

- **SIM**
  - The ISO configurations are diverse and no clear main scenario can be distinguished
  - 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
  - Navigation instructions and phone conversations need to be managed together with the vehicle status messages.
- **SUPREME (2007) – Best practice Handbook**
  - Vehicles and vehicle safety devices play an important role in traffic safety, since they can generate an enduring, sustainable effect. The design of a vehicle affects the protection of occupants in case of a crash and the chance of serious injury to unprotected, vulnerable road users. For two-wheelers, protective clothing and helmets help to mitigate the consequences of a crash. Intelligent driver support systems, including in-vehicle, between-vehicle and road vehicle technologies, help the driver to perform his task safely, preventing errors and violations which may otherwise have resulted in a crash.

- For road safety it is important that the presence of other road users can be detected in time. Better and earlier detection of other traffic will lead to earlier action to avoid a collision or to decrease the severity of a crash because of lower impact speed.

- **TRACE (2008) – Deliverable 4.1.1**
  - ITS are technologies applied to the transport domain that may enhance mobility, efficiency and safety, among other benefits. The potential for ITS to improve road user safety has been widely explored, and this report presents a review of what is known about the effectiveness of safety-relevant ITS. Each system has been classified as in-vehicle, infrastructure-based or cooperative, and further categorised as active, passive, or combined active and passive. Here are the systems that can be applied for motorcycles:
  - In-vehicle systems
    - Active systems
      - Advanced Driver Assistance Systems
      - Alcohol Detection and Interlock
      - Animal Detection Systems
      - Anti-lock Braking System
      - Brake Assist: applied to motorcycle, in could participate in a reduction by 1,3% of fatalities and by 1,5% of injuries.
      - Daytime Running Lights
      - Electronic Licence
      - Emergency Brake Advisory System
      - Heads-Up Display
      - Helmet-Mounted Displays: HUDs may show relevance to crashes where distraction/inattention are factors.
      - Intelligent Lighting Systems
        - Automated Headlights
        - Cornering/Axis Controlled Headlights: In motorcycles, the changing optical axis of the headlight that occurs when the motorcycle tilts when cornering creates reduced visibility, where the beam illuminates the shoulder, not the road. Adaptive headlights ensure that the illumination from the headlight is projected on the motorcycles intended path when banking.
        - Speed Adapting Headlights
        - Auto-dimming Headlights
      - Linked Braking Systems: applied on crashes where braking is applied by the rider.

- Pedestrian Detection Systems
- Rear-View Displays: on motorcycle, this technology may be in-vehicle or helmet mounted.
- Road Surface Condition Monitoring: road surface condition monitors serve to alert the motorcyclist to abnormalities in the road surface ahead.
- Speed Alerting and Limiting Systems
- Tutoring Systems
- Vehicle Diagnostic Systems
- Vision Enhancement: for motorcycle, this may be a display on the consol or a helmet-mounted display.

- Passive systems
  - Airbag Jackets: this is useful when the rider is thrown from the vehicle.
  - Airbags: In motorcycles, the system comprises the airbag mounted on the front of the vehicle below the handlebars, and acceleration sensors and impact sensors located on either side the front wheel suspension. Frontal impact is detected by these sensors, and the airbag is deployed. The airbag acts to cushion the forward propulsion of the rider and prevent them from being thrown from the vehicle. The sensors of the system are calibrated to deploy the airbag in collision impacts only, not in other situations such as riding over potholes or curbs. To increase its stability, straps hold the airbag in place. An issue that must be addressed in the design and evaluation of motorcycle airbag systems is that the position of the rider is not always upright. The rapid deployment of the airbag should not injure the rider if they are in a forward-leaning position.
    - Adaptive Steering Column
    - Buckle Sensors
    - Dual-stage Airbag
    - Inflatable Carpet
    - Inflatable Seatbelt
    - Knee Airbag
    - Radial Deployment Airbag
    - Roofbag
    - Seat Position Sensor
    - Side Airbags
    - Weight and Pattern Recognition Sensor
    - Child Seat Detector

        - Crash Data Recorders
        - Emergency Lighting Systems: This may be especially relevant to single-vehicle motorcycle crashes
        - External Airbags
        - Impact-Sensing Cut-Off Systems
        - Pop-Up Bonnet Systems
    - Combined Active and Passive Systems
        - Pre-Crash Systems
- Infrastructure-Based Systems
    - Active systems
        - Animal Detection Systems
        - Automated Enforcement Systems
            - Breath Testing
            - Electronic Licence Plates
            - Headway Monitoring
            - Laser Speed Detectors
            - Rail Crossing Enforcement
            - Red Light Camera
            - Saliva Testing
            - Tagging and Tracking Systems
        - Bicycle Signal Systems
        - Construction Zone Systems
            - Dynamic Lane Merging
            - Real-time Information Systems
            - Variable Speed Limits
        - Pedestrian Signal Systems
            - Accessible Pedestrian Signals
            - Automatic Pedestrian Detection
            - Countdown Signal
            - Flashing Crosswalk Lights
            - High-intensity Activated Crosswalk

                * Pedestrian Warning Sign
                * Scanning Eyes
                * Smart lighting
                * Wheelchair Detection
            - Speed Feedback Indicators
            - Traffic Control Systems
                * Automated Tolling; Electronic Toll Collection
                * Congestion Tolling
                * Dynamic Lane Control
                * Probe Vehicle; Floating Car;
                * Ramp Control/Ramp Metering
                * Route Diversion
                * Signal Control
                * Traffic Monitoring
                * Tunnel/Bridge Management
            - Variable Message Signs
            - Variable Speed Limits
            - Weather Information and Maintenance Systems
                * Access Control
                * Anti-icing Systems
                * Flood Warning Systems
                * Low Visibility Warning Systems
                * Maintenance Vehicle Management Systems
                * Precipitation/Wind Warnings
                * Wet Condition Warning Systems
                * Weather-related Signal Timing
        - Passive systems
            - Incident Management Systems
    - Co-operative systems
        - Active systems

- Advanced Traveller Information Systems
- Advanced Warning Device: A variant of this technology is motorcycle detection systems. Such systems address motorcycle conspicuity crashes, where the driver fails to perceive the motorcycle. Rather than relying on the auditory and visual warnings from the emergency vehicle, the presence of the motorcycle emits a radio or infrared signal from a transmitter mounted on the vehicle. This signal is detected via receivers on the front and rear of the other vehicles, and the driver is informed of the motorcycles presence through auditory and visual displays.
- Electronic Clearance
  - Credential Checking
  - Border Clearance
  - Safety Screening/Automated Vehicle Safety Inspections
  - Weigh-in-motion
- Fleet Management Systems
  - Automatic Vehicle Location; Computer Aided Dispatch
  - Cargo Monitoring Systems
  - Digital Tachographs
  - Electronic Towbar; Electronic Coupling
  - Hazardous Materials Systems/HAZMAT
  - Smart Cards
- Intelligent Speed Adaptation
- Intersection Collision Avoidance
- Inter-Vehicle Communication Systems
- Navigation Systems
- Pay-As-You-Drive Insurance
- Railway Crossing Systems
  - Advanced Warning for Railroad Delays
  - Automated Horn Warning
  - In-vehicle Warning System; Vehicle Proximity Alert
  - Obstacle Detection Systems
  - Railway Crossing Cameras
  - Second Train Warning

- Road Geometry Warnings
- Rollover Warning Systems
- Vehicle Pre-Emption Systems

- Passive systems
  - Automatic Crash Notification

- **TRACE (2008) – Deliverable 4.1.3**

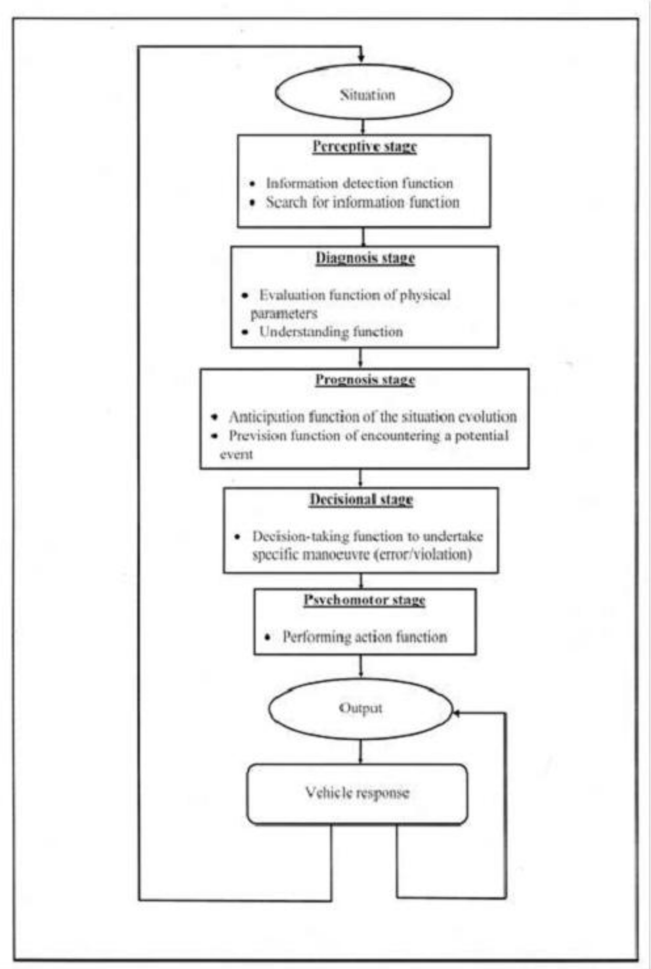


Fig. 3-2: Functional model for analysing human needs as regard to safety functions

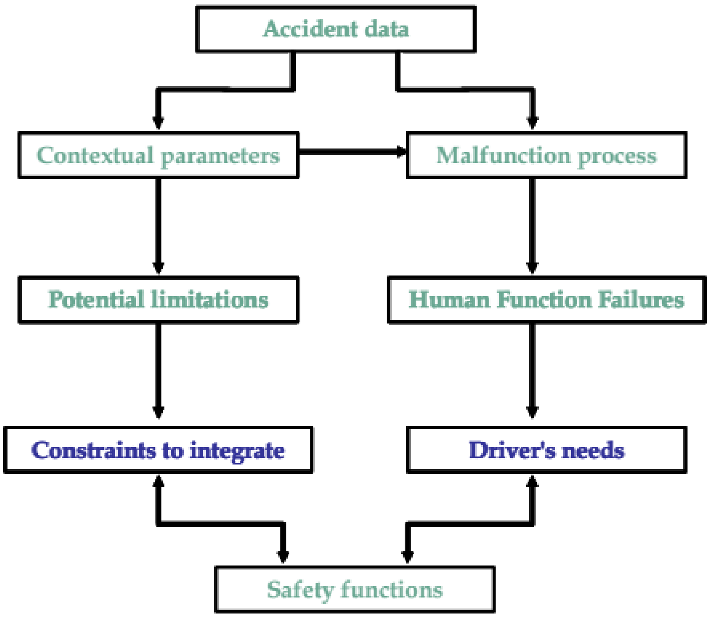


Fig. 3-4: Overall procedure for analysing drivers' needs and contextual constraints

- **TRACE (2008) – Deliverable 5.1**

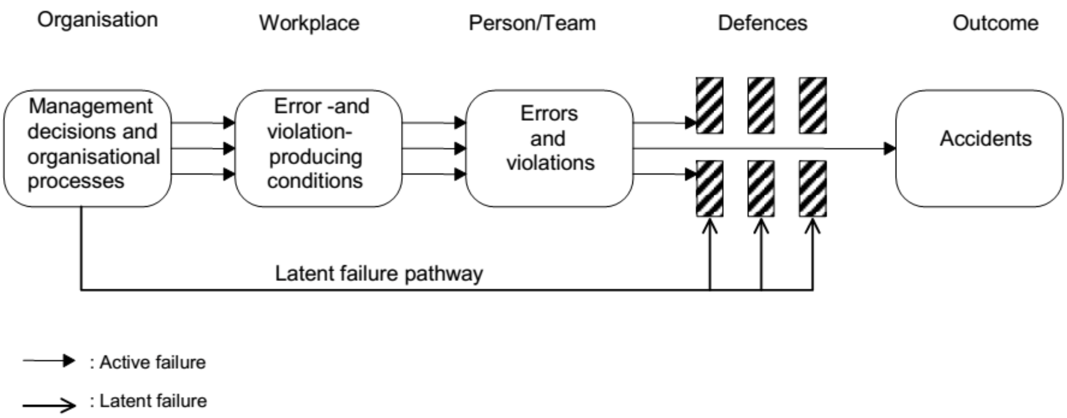


Figure 2: The active and latent paths of unsafe acts in the system process (from Reason, 1995)

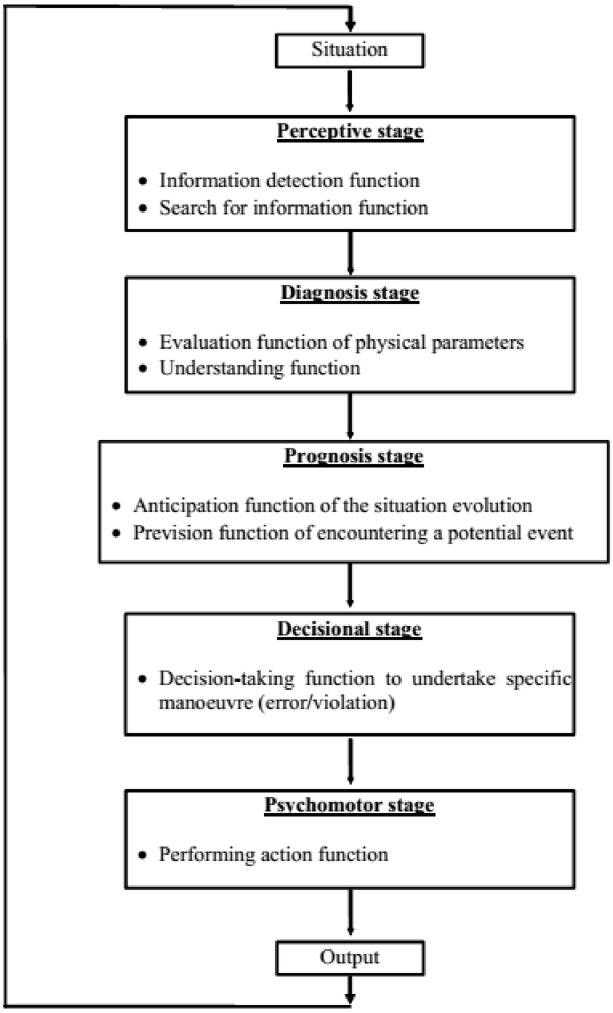


Figure 4: Functional chain involved in driving activity

Driving phase	Rupture phase	Emergency phase	Impact phase
↓	↓	↓	↓
Behaviour on approaching the place	Meeting an unexpected event	Avoidance manoeuvres and dynamic demands	Nature of impact

Figure 5: Major steps to consider in a sequential analysis of accidents

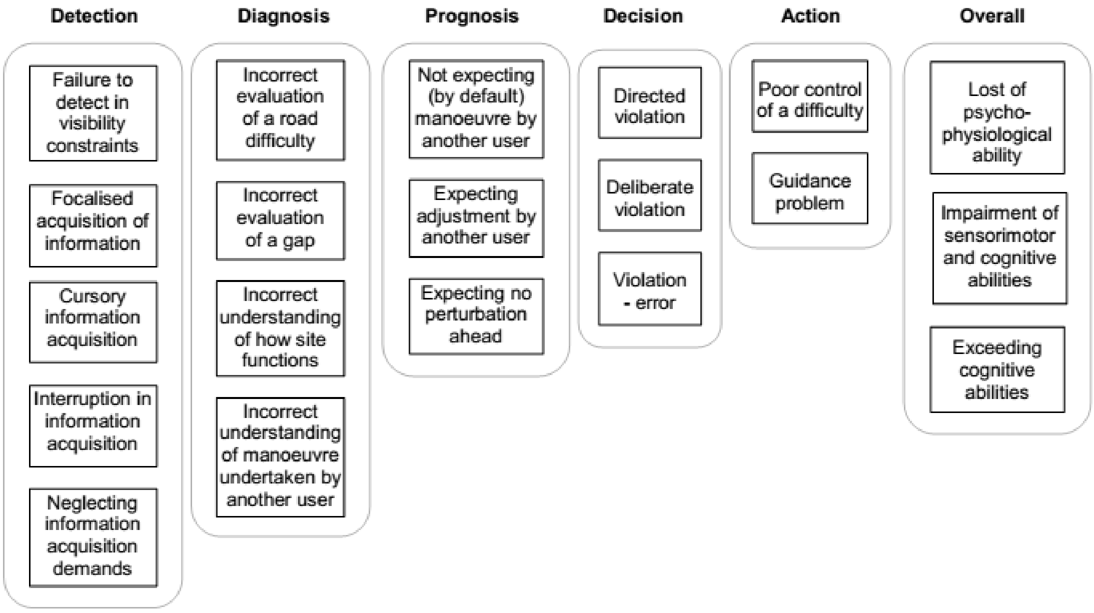


Figure 7: Delineation of functional failures found in In-depth accident data

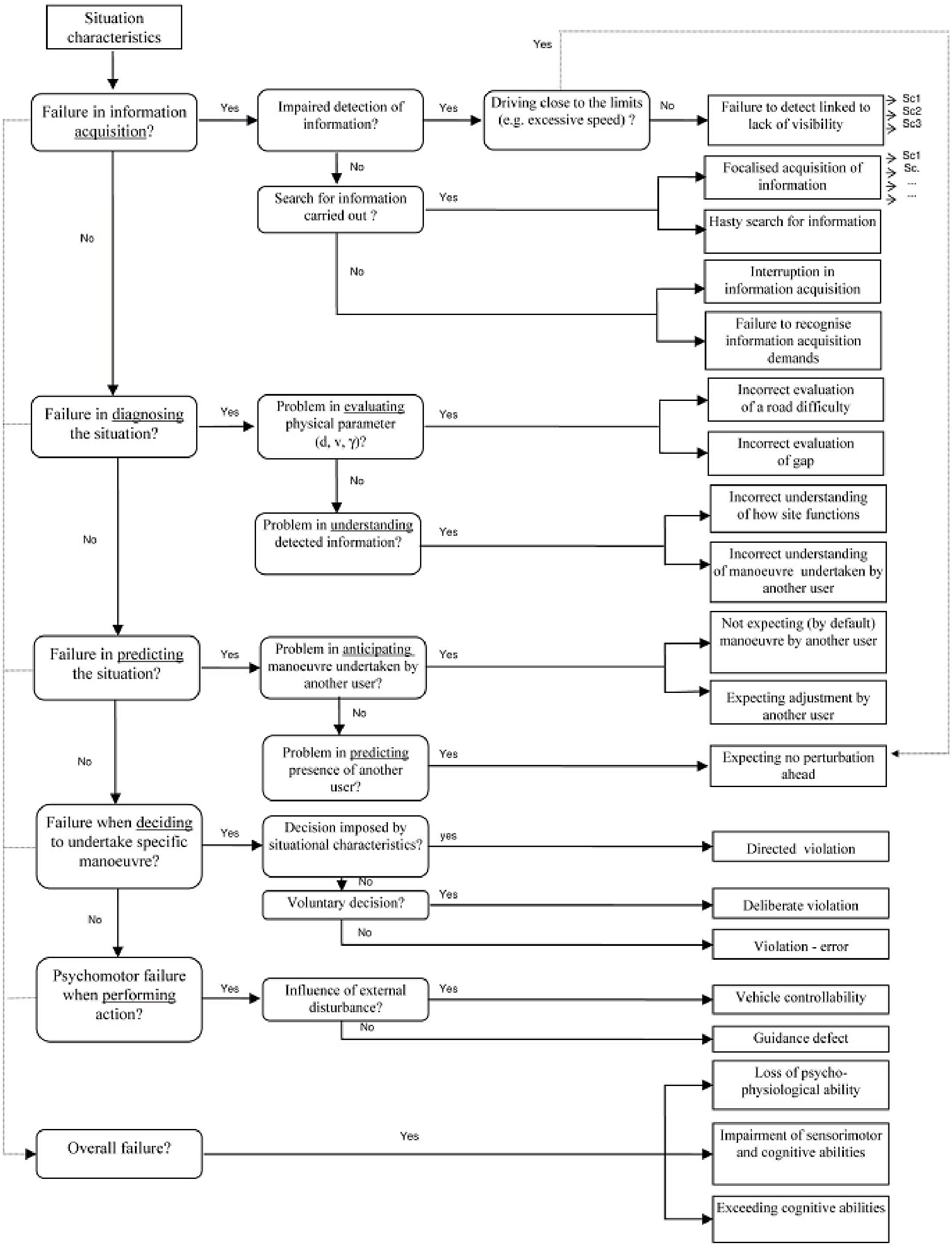
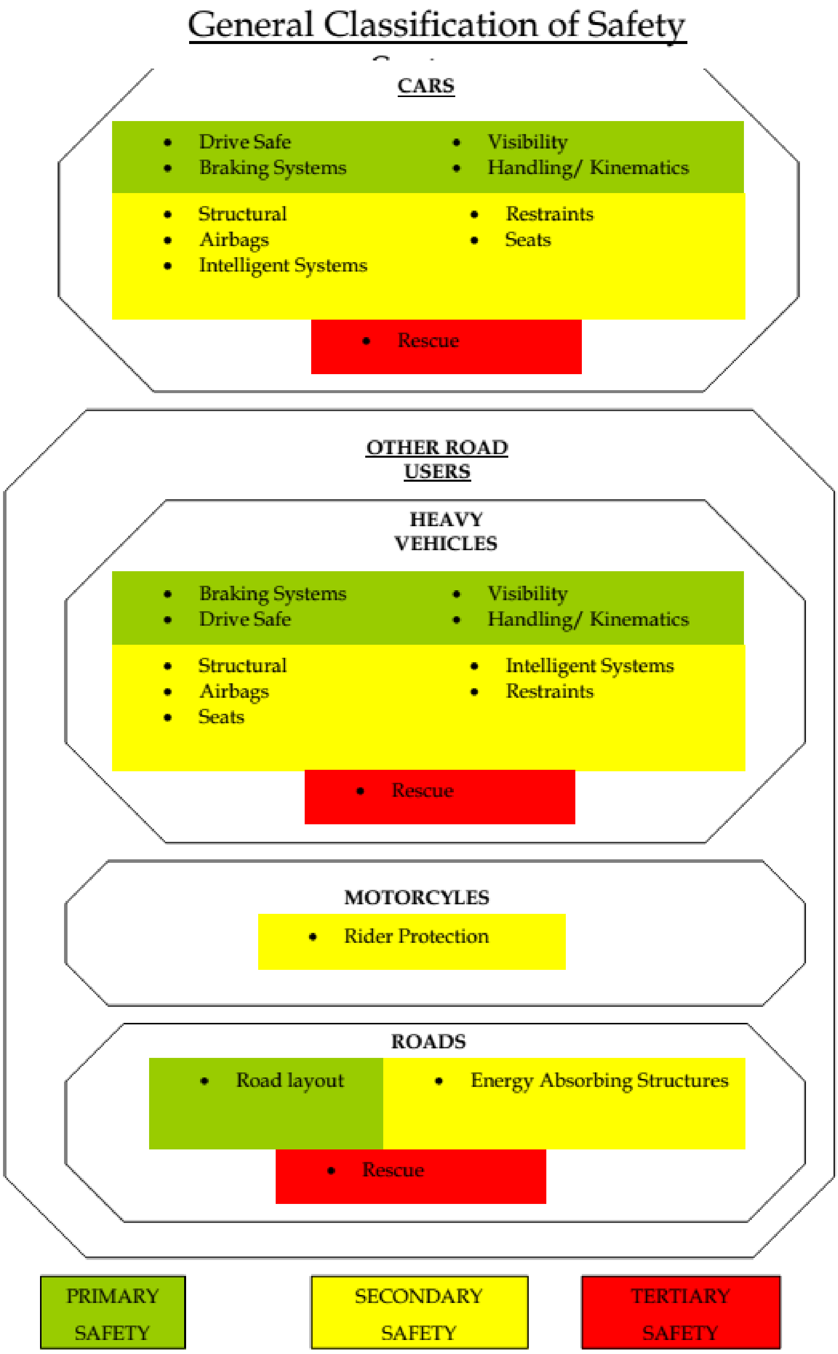


Figure 9: Model for Human Functional Failures classification

- **TRACE (2008) – Deliverable 6.1**



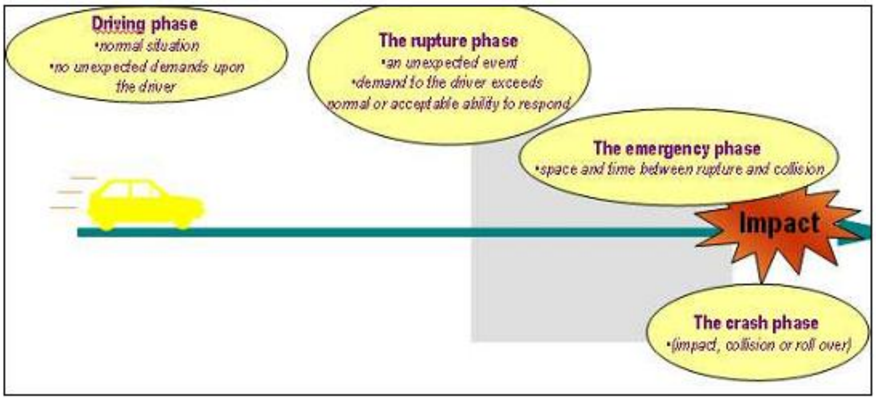


Figure 5-1: Sequential aspect of accidents

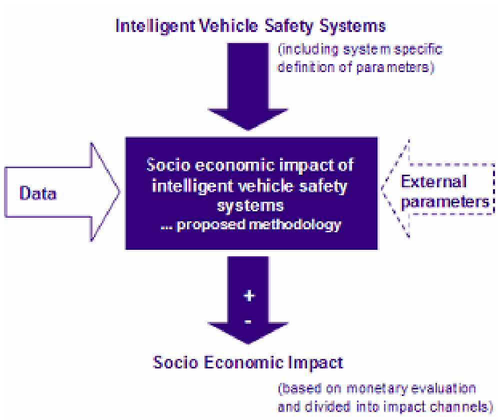
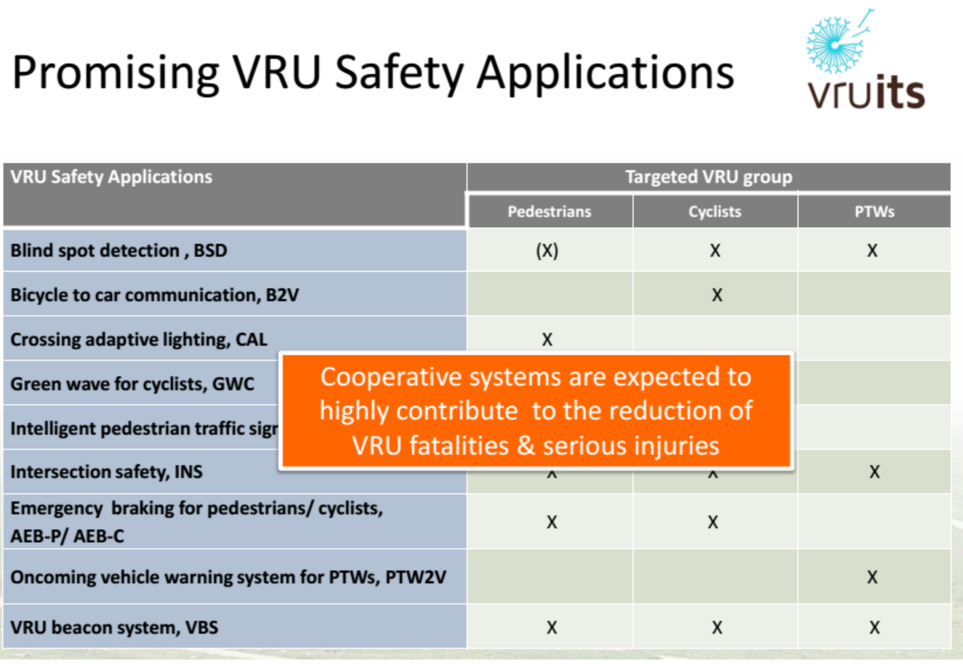


Figure 8-1: SeiSS structure

- **VRUITS (Ongoing) - Deliverable 2.1**
  - The project made an inventory of ITS applications targeting VRU with a total of 86 systems, among which 28 for PTWs and a number of 10 systems which would benefit all kinds of VRUs. The final selection of systems considered the most relevant for the impact assessment are:

1. Blind Spot Detection	12. Urban sensing system
2. Intelligent Pedestrians Traffic Signal	13. Automatic Bicycle Identification
3. Intelligent Speed Adaptation (ISA)	14. Night Vision and Warning
4. Red Light Camera /Average Speed Camera	15. Information on vacancy on bicycle racks
5. Intersection Safety	16. Bicycle to car communication
6. Pedestrian Detection System + Emergency Braking	17. Rider Monitoring System
	18. Crossing Adaptive Lighting
7. Trip Planning and navigation for VRUs	19. Infotainment
8. PTW Oncoming vehicle info system	20. Real-time information systems for public transport
9. VRU Beacon System	
10. Cyclist digital bicycle rear-view mirror	21. Road weather warning for pedestrians
11. Roadside Pedestrian Presence	22. Advisory system for elderly cyclists

Figure 10 VRUITS selected applications



Promising VRU Safety Applications

vruits

VRU Safety Applications	Targeted VRU group		
	Pedestrians	Cyclists	PTWs
Blind spot detection , BSD	(X)	X	X
Bicycle to car communication, B2V		X	
Crossing adaptive lighting, CAL	X		
Green wave for cyclists, GWC			
Intelligent pedestrian traffic sigr			
Intersection safety, INS	X	X	X
Emergency braking for pedestrians/ cyclists, AEB-P/ AEB-C	X	X	
Oncoming vehicle warning system for PTWs, PTW2V			X
VRU beacon system, VBS	X	X	X

Cooperative systems are expected to highly contribute to the reduction of VRU fatalities & serious injuries

- **VRUITS (ongoing) – Deliverable 2.1**
  - Safety issues for VRUs and ITS – Expert inteviews outcomes:
    - *Visibility and conspicuity of VRUs in traffic*: especially in situations where different road user groups are involved and are sharing space.
    - *Infrastructure design*: is mainly related to the space in traffic that is specifically aimed at vu lnerable road users. Especially situations in which pedestrians, cyclists, PTWs and car drivers are using same road lanes, at crossings and at intersections with high density traffic and complex situations
    - *Speeds* are mainly related to car driver behaviour and speeding. High traffic speeds have negative effects on subjective safety. Relevant solutions discussed in this regard focus on systematic enforcement of traffic rules, automated speed enforcement, dynamic speed control and improved driver training
    - *Risky road user behaviour*: individual characteristics such as lack of awareness, lack of skills and a lack of willingness to act properly in traffic lead to erroneous forms of behaviour that moreover often times has no direct consequences
    - *Education – training – awareness*: being trained and educated well (important for all road user groups) in combination with a heightened level of awareness towards the negative implications and effects of inconsiderate and badly adapted traffic behaviour can drastically improve traffic safety.
    - *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 s pecifically adapted solutions on different levels. Knowledge on actually critical situations is needed for sustainable improvement

- General potential of ITS – Expert inteviews outcomes:
  - *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
- ITS hazards & barriers – Expert inteviews outcomes:
  - *Distraction*: due to visual and audio warnings and information provided during the driving/riding tasks. In addition interaction with interfaces of navigation sys tems 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.
- 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 (e lectric 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 a dapted to the needs of different road user groups
- Table 31 shows for the selected application the VRU types for which they apply, the expected impact (either on safety or on mobility and comfort), and the type of ITS (infrastructure, veh

icle and VRU as intelligent component of the system), and the maturity of the system. For the maturity level, M ind icates that the first systems are appearing on the market. Most of the systems selected are mainly available on a limited number of high-end vehicles or still have a very low penetration level, and still have many possibilities for improvement, e.g. regarding the performance or the suitability for specific user groups. P indicates a prototype, produces as part of a research project, but not yet available on the market. R indicates that the systems are still under research.

Table 31 ITS for VRUs selected for impact assessment

	ITS applications	Type of VRU						Impact		Type of ITS			Maturi-ty
		Pedestrians	Cyclists	PTWs	Disabled	Elderly	Child	Safety	Mobility/ Comfort	Infrastructure.	Vehicle	VRU	
1	Blind Spot Detection	X	X	X	X	X	X	X			X		M[1]
2	Intelligent Pedestrians Traffic Signal	X	X		X	X		X	X	X			M
3	ISA (Intelligent Speed Adaptation)	X	X	X	X	X	X	X			X		M
4	Red Light Camera /Average Speed Camera	X	X	X	X	X		X		X			M
5	Intersection Safety	X	X	X	X	X		X		X	X		P
6	Pedestrian Detection System + Emergency Braking	X	X	X	X	X	X	X			X		M
7	Navigation systems for VRUs	X	X	X	X	X			X			X	M
8	PTW Oncoming vehicle info system			X				X			X	X	P
9	VRU Beacon System	X	X	X	X	X	X	X			X	X	P
10	Cyclist digital bicycle rear-view mirror		X					X				X	M
11	Roadside Pedestrian Presence	X	X		X	X	X	X		X		X	P
12	Urban sensing system	X	X	X	X	X		X	X			X	P
13	Automatic Bicycle Identification		X					X	X	X			P
14	Night Vision and Warning	X	X	X	X	X	X	X			X		M
15	Information on vacancy on bicycle racks		X						X	X		X	M
16	Bicycle to car communication		X					X			X	X	R
17	Rider Monitoring System			X				X				X	P
18	Crossing Adaptive Lighting	X	X		X	X		X		X			M
19	Infotainment	X	X	X				neg.	X			X	M
20	Real-time information systems for public transport	X	X		X	X			X			X	M
21	Road weather warning for pedestrians	X	X		X	X		X	X			X	M
22	Advice system for elderly cyclists		X			X		X	X			X	R

[1] M: on market; P: prototype; R: Research

- 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 consi dered to be of major importance in this group with ITS having mainly adverse effects on riding beha viour. 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.

- There are of course potential adverse effects of ITS solutions that can pose a threat, especially to vu lnerable road users. The need of a better understanding of people´s attitudes and opinions about ITS applications has been highlighted as an important area for further research (Regan et al., 2 001), especially given the rapid rate at which ITS applications are becoming available. As Van der Laan et al. (1997) stated, it is counterproductive to invest in developing new technologies if the systems are never purchased or if they are purchased but never used. In other words, these systems can only enhance users´ safety and mobility if they use them. For this reason, acceptance is a decisive aspect to be considered in the development process of such systems.
- 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 cou ld 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 deve lop and adapt ITS, which have the potential to increase VRU safety and improve general mobility and comfort.
- Single VRU accidents, especially pedestrians and cyclists, are underreported in traffic accident databases. There is only little research performed on the scenarios of these accidents, and there are only little ITS applications attempting to avoid these accidents. Two of these applications: road weather warning for pedestrians and an advice system for elderly cyclists are included in the final list of ITS applications

I.3 Short description of ITS systems – PTW´s

ID: #C1
ITS: VRU Beacon System
DESCRIPTION: The VRU carries a simple device (e.g. smart phone, or item in bags, clothes …) that facilitates detection by the roadside infrastructure or in-vehicle systems.

ID: #C2
ITS: Intersection Safety
DESCRIPTION: Intersection Safety assists the driver in avoiding common mistakes which may lead to typical intersection accidents. It covers these functions: Traffic light assistance, right-of-way assistance, as well as right and left-turn assistance.

ID: #C3
ITS: Oncoming vehicle information assistance system
DESCRIPTION: This system exchanges vehicle information between automobiles and motorcycles, such as position, direction and speed, allowing advanced warning of other approaching vehicles. Motorcycle riders can view information about vehicles near them on a display, and can receive information through an in-helmet audio system. Drivers can view information on the status of motorcycles in their vicinity and receive warnings on their navigation system display. Collision Warning, and wireless local danger warning are included in this kind of systems.

ID: #C4
ITS: Lane Keeping Support / Lane Departure Warning
DESCRIPTION: A lane keeping system supports the driver to stay safely within the "borders" of the lane

ID: #C5
ITS: Lane Change Assistant
DESCRIPTION: The system enhances the perception of drivers in lateral and rear areas and assists them in lane change and merging lane manoeuvres

STABILITY AND BRAKING ENHANCING ITS

ID: #C6
ITS: Anti-lock brakes
DESCRIPTION: This system controls and optimizes the braking performance of the vehicle and prevents wheels from locking under forceful braking events. ABS monitors the rotation of the wheels, and regulates braking pressure should they begin to lock

ID: #C7
ITS: Brake assist system
DESCRIPTION: Brake assist systems maximize the braking potential of the vehicle, reducing stopping distances. Brake assist aids the user in achieving maximum braking force in an emergency situation. Anticipatory brake assist systems also exist. These incorporate forward scanning radar or other forward-facing sensors to detect objects or vehicles on the road ahead. If the system deems that a crash is eminent, and that the drivers braking response is inadequate, brake assist will automatically be applied. These systems may also incorporate an in-vehicle warning that informs the driver when the system is active.

ID: #C8
ITS: Linked braking system
DESCRIPTION: This system aims to counteract the potential of non-optimum motorcycle braking behaviour by applying dual braking pressure (i.e. from both brakes) even when only one brake is applied

ID: #C9
ITS: Roll stability system
DESCRIPTION: This system monitors the yaw rate and speed of the vehicle, and the rider is warned if a critical threshold of tilt has been breached.

VISIBILITY-ENHANCING SYSTEMS

ID: #C10

ITS: Adaptive/Active Headlight - AHL

DESCRIPTION: Headlights that orient the lighting in the direction the vehicle is going to better illuminate the road ahead and uncover potential obstacles sooner.

Adaptive headlight systems can use sensors to determine when the brightness should be adjusted. Some systems can determine how far away other vehicles are and adjust the brightness of the headlamps so that light reaches them without creating glare.

ID: #C11

ITS: Visibility improvement helmet

DESCRIPTION: It serves to prevent visual impairment due to fogging of the helmet shield, which may occur in cold and rainy conditions.

ID: #C12

ITS: Night vision and Warning / Vision enhancement systems

DESCRIPTION: These systems provide an augmented view of the road environment. These may employ radar, laser or infrared imaging to detect objects on the road, and overlay this enhanced image on the visor of the rider. These systems enhance the riders´ functional viewing distance and increase the contrast of objects in poor visibility conditions such as night-time or in fog.

ADAS

ID: #C13

ITS: Curve Warning

DESCRIPTION: Provides the rider with a warning signal when the motorcycle speed is too high in relation to a curve ahead

ID: #C14

ITS: Road surface monitoring

DESCRIPTION: This system continuously uses laser, radar, and/or video imaging to screen the road surface for abnormalities, such as debris, ice or potholes. The system may be used to either provide additional information to the rider, or integrate with advanced braking or collision avoidance systems to increase stopping distances and headways to suit the road conditions

ID: #C15

ITS: Helmet-mounted display

DESCRIPTION: Helmet-mounted displays project vehicle information onto the rider onto an area of the helmet visor. These systems serve to eliminate the need for the rider to take their eyes of the road to view vehicle information, such as speed and RPM. The display is projected at a similar focal distance as the roadway, so that the rider does not need to re-focus while viewing the information.

ID: #C16

ITS: Rear-view display / digital bicycle rear-view mirror

DESCRIPTION: This system provides the user a view of the roadway behind the vehicle. Rear-facing cameras continuously capture the road environment, and display this information either on visual interfaces within the vehicle, or on the upper area of the helmet visor.

ID: #C17

ITS: Intelligent Speed Adaptation

DESCRIPTION: System that compares the current speed and the position of the driver with the local posted speed limit and performs an action if the vehicle exceeds this posted limit. The action can be advisory or intervening.

DRIVER MANAGEMENT / MONITORING SYSTEMS

ID:#C18

ITS: Alcohol Ignition Interlock

DESCRIPTION: Automatic control system that is designed to prevent driving with excess alcohol by requiring the driver to blow into an in-car breathalyser before starting the ignition. The alcohol interlock can be set at different levels and limits.

ID: #C19

ITS: Driver Drowsiness Monitoring and Warning

DESCRIPTION: System that monitors the condition of the driver and warns him/her when symptoms of drowsiness are observed

ID: #C20

ITS: Electronic Driver Identification Interlock

DESCRIPTION: An EDI systems locks ignition unless a smartcard is inserted in an in-vehicle card reader, with a valid driver license. A biometric system can be included to verify driver identity

ID:#C21
ITS: Motorcycle airbag
DESCRIPTION: Airbags for motorcyclists are inflated when there is a sudden dangerous movement of the motor-cyclist or when the rider is propelled from the vehicle

ID: #C22
ITS: e-Call
DESCRIPTION: e-Call is a vehicle-based system that automatically establishes a voice connection with, and sends digital location and vehicle information to, emergency services in case of a crash.

ID: #C23
ITS: Emergency lighting system
DESCRIPTION: This system illuminates the vehicle in the event of a crash and serves to enhance the visibility of the vehicle to other road users and emergency services

ID: #C24
ITS: Telediagnostic Module
DESCRIPTION: Provide added value related to safety and security concerns, performance, maintenance and upgrading. It allows the driver to monitor constantly the use and functioning conditions of the vehicle and it offers early warnings about next vehicle services or imminent failure of some vehicle subsystem. i.e.: Tire-Pressure Monitoring warns drivers when a low tire or blowout is detected

ID: #C25
ITS: Helmet reminder system
DESCRIPTION: It reminds motor riders and cyclists to wear a safety helmet.

ID: #C26
ITS: SAT
DESCRIPTION: It is a system of satellites that provide autonomous geo-spatial positioning with global coverage. It allows small electronic receivers to determine their location.

ID: #C27
ITS: Red Light Camera or Speed Camera
DESCRIPTION: Integrated system for the detection, recording, storage and uploading of static digital images and / or sequential processing, archiving and report generation of fine notifications from a Control Center.
The system is based on the detection of license plates of vehicles that are past the stop line after the light that controls the passage in a given direction of flow is in red phase.

ID: #C28
ITS: Urban sensing systems sensing system/ Social networking service
Description: Social network based system allowing citizens to provide information on vandalism, potholes… it can help to inform public service and infrastructure providers and other road users about issues and problems as well as dangerous situations.

- **WATCH OVER (2008) – Deliverable 2.1**

N.	Considered Parameter	Summary of Achievements	Note
1	Accident configuration and first contact point	1. The vehicle moves in a straight line or turns left; PTW is travelling in straight line or performs a passing manoeuvre on the left. 2. PTW into other vehicle impact at intersection. 3. In front of the vehicle or in the left/right side.	
2	Collision opponent	Passenger cars (primary option).	To be considered as a parameter
3	Collision speed	Different options. The vehicle speed mainly considered should be below 50 km/h.	To be considered as a parameter
4	Time of day	Day and night. Attention to dusk conditions.	To be considered as a parameter
5	Road conditions	Dry road (main option).	To be considered as a parameter
6	Accident location	Urban environment (intersections) and rural roads (second option).	To be considered as a parameter
7	First contact point	See point 1.	
8	Age group of user	All ages.	To be considered as a parameter

Table 32: PTW accident survey outcomes

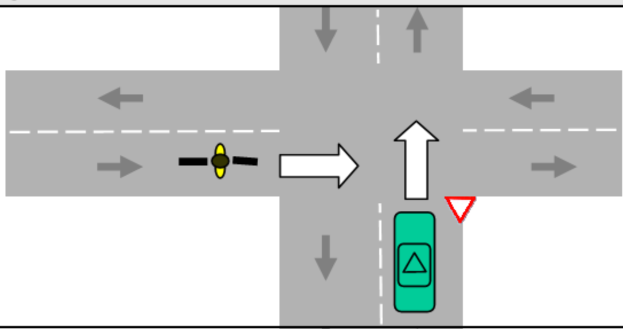
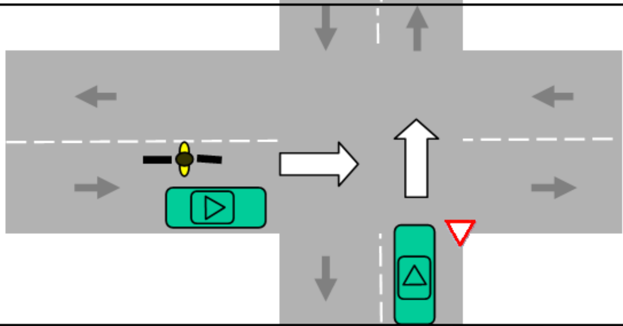
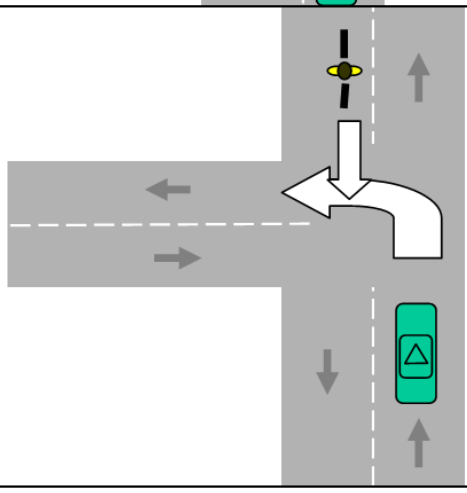
N.	Description	Sketch
12-14	PTW arrives from left side (or from right side) at intersection, paths perpendicular.	
13	PTW arrives from left side at intersection, paths perpendicular, occluded from parked car or other obstacles.	
16	PTW (or pedal cyclist) and vehicle travelling in opposite directions, vehicle turns in front of PTW.	

Table 48: Group of medium relevant scenarios

D7: Awareness Campaigns

Project/website	Ending date	Final report	• Relevant Deliverables
[2-BE-SAFE]()	1/09/2011	[http://www.2besafe.eu/sites/default/files/deliverables/2BES_D35_FinalReport.pdf]()	• [3.1 Social, cognitive and behavioural differences of PTW riders with reference to their attitudes towards risk and safety]() • [5.1 Interaction processes of motorcycle riders with other]()

			road users
CAST	31/01/2009		• Cast Manual
DaCoTA	30/06/2012	http://www.dacota-project.eu/Deliverables/DaCoTA_Final_Report.pdf	• Driver distraction report • Cellphone Use while driving report • Powered Two Wheeler report (ERSO)
eSum	30/11/2010	-	• Potential impacts for improving PTW safety
ROSA	31/03/2011	http://ec.europa.eu/transport/road_safety/pdf/projects/rosa_handbook_en.pdf	• European Handbook on Good Practices in Safety for Motorcyclists - Epigraph: MOTORCYCLISTS EQUIPMENT – • European Handbook on Good Practices in Safety for Motorcyclists - Epigraph: HUMAN FACTOR – • European Handbook on Good Practices in Safety for Motorcyclists - Epigraph: TRAINING -
ROSYPE	30/06/2012	-	• http://rosype.michelin.eu/listeEvenements.php?lang=en
SARTRE 1-4		http://www.attitudes-roadsafety.eu/index.php?eID=tx_nawsecuredl&u=0&file=fileadmin/Results/SARTRE%203%20results/S3_reports/Part%201_Report%20on%20principal%20results.pdf&t=1426947005&hash=37ce58463fddcf23253e64977ec9e93f	• Sartre 4 - European road users' risk perception and mobility
SUPREME	1/06/2007		• Best Practices Handbook

- **2BESAFE project (2011) – Deliverable 3.1**
  - Within the European context we can find many disparities within EU member countries in campaigning and education issues. In some countries, e.g. in the United Kingdom, campaigns based on a high degree of realism are often used, which aim to shock viewers into acknowledging certain facts. This method while effective in one context is not necessarily

applicable in others. This arises from different cultural and societal environments existing across Europe. That said, at a more general level we can find a lot of points, on how to make successful road safety campaign, and a form of campaign can be customised according to local conditions. Moreover, there are more types of communication campaigns, as stand-alone campaigns, campaigns combined with other supportive activities, mid-term and long term action plans and integrated campaigns. As viable mediums TV, cinema, radio, newspapers, billboards, public performance, presentations, discussions, internet or public space can be used. From this a variety of tools can be employed by road safety campaigners in each country.

  - Long-term education is proving to be much more effective than stand-alone campaigns. All EU member countries have their own road safety educational programme, which usually starts in maternal school age (4 – 6 years). Regrettably, this education often ends in elementary school and covers only transport behaviour from the pedestrian or bicyclist point-of view. Then in driving schools a road safety topic is overshadowed by driving lessons, so behavioural aspects often take a back seat of topics related to skill and technique. This situation can be improved by the creation of transport behaviour education in high schools, as well as during driving training.
  - In summary, road safety campaigns are powerful instruments for decreasing road accidents, but they have only limited effectiveness in time. For this reason they are often combined with long-term education, which forms people's thinking and conviction in childhood and adolescence. This approach fosters considerate and cautious drivers, to whom is just sometimes reawakened the danger in roads by campaigns. Unfortunately, behaviour factors are often stronger than consciousness of cautious driving, so that's why vision zero is still so far.

- **2BESAFE project (2011) – Deliverable 5.1**
  - ✓ **Recommendation:** Based on observation data as well as the statements given by the riders of the Focus Group Interviews, the 2BESAFE project made a recommendation on awareness campaigns: Campaigns to improve the mutual understanding of all road users can be helpful in this regard and have been mentioned several times by the motorcycle riders. These campaigns need to make both, motorcycle riders and car drivers, aware of the vulnerability of PTW riders and need to foster interactions between different road users. In addition, media needs to promote a positive attitude towards special protection clothing and protection equipment. This can be achieved by promoting an attractive image of PTW riders.
- **CAST (2009) – Manual**
  - Road safety communication campaigns can be defined as purposeful attempts to inform, persuade, or motivate people in view of changing their beliefs and/or behaviour in order to improve road safety. The European CAST Manual recommends 6 steps to design, implement and evaluate in an effective way road safety campaigns.
  - Communication campaigns about road safety have as many as five main goals: (1) to provide information about new or modified laws; (2) to improve knowledge and/or awareness of new

in-vehicle systems, risks, etc., and the appropriate preventive behaviours; (3) to change underlying factors known to influence road-user behaviour; (4) to modify problem behaviours or maintain safety-conscious behaviours; (5) to decrease the frequency and severity of accidents.

- A communication campaign is not the only intervention that can reduce the number of road crashes. Other supportive activities such as enforcement, education and legislation are often used in combination with communication campaigns.

✓ **Recommendation:** Based on the material presented in the manual, the CAST project would like to make the following general recommendations:

  - Base the campaign on statistics and research
  - Select a specific target audience
  - Translate the overall goal into specific objectives
  - Devise the campaign strategy and plan the campaign
  - Formulate the message
  - Conduct a proper implementation of the campaign
  - Ensure rigorous evaluation
  - Disseminate the results

- **DACOTA (2012) – Driver Distraction**
  - In recent years, the growing use of mobile phones and other technologies in cars has led to increased interest in the problem of driver distraction among policymakers and researchers. Driver distraction is understood as a form of inattention and has been defined as "a diversion of attention away from activities critical for safe driving toward a competing activity".
  - Given the difficulty in removing the causes of distraction, such as the use of mobile phones, and in enforcing laws related to particular sources of distraction, the use of strong campaigns to promote awareness of risk and change behaviour is a necessary part of a program of countermeasures.
  - But, when compared to data from the 1970s, the results show that anti-drunk driving campaigns have changed how younger drivers view drunk driving but that norms have not yet changed for driver distraction in spite of consistent results showing that risks are known. The research data support the idea that driver distraction is not connected to the lack of perceived risk but rather a disconnection between the norms underlying the behaviour and knowledge of risk. These data, suggest that driver distraction campaigns cannot simply focus on risk-awareness strategies, but should instead use an approach that deals with both descriptive and injunctive norms.
- **DACOTA (201)– Cell phone Use**

- While little research has been conducted into public attitudes to car telephone use in Europe, the available surveys indicate an under-estimation amongst drivers of how this behaviour adversely affects driving performance, an erroneous belief that the use of hands-free phones is largely danger-free but general support for hand-held bans for all drivers.
- Information and publicity has been used to draw attention to the consequences of using a telephone while driving and in support of the introduction of legislation. See for example the Think! campaign. Several wireless providers and automobile manufacturers have launched campaigns to increase the awareness of the risks of driver inattention.
- One of the research-based recommendations for action to address the cell phone use issue is to inform, educate and train road users: Drivers need to be made more aware of the dangers of mobile phone use and of other various distracting activities and educated about the possible effects of distraction, their ability to compensate for it, as well as receiving practical advice on how to deal with telephones in vehicles.

- **DACOTA (2012) – PTWs report**
  - ✓ **Recommendation:** Several subjects are eligible for promotional campaigns to prevent PTW crashes and injuries:
    - Wearing helmets (properly locked) and protective clothing
    - Headlights on and wearing fluorescent/ retroflective clothing
    - Avoiding risky behaviour and situations (speeding, alcohol, red light violation)
    - Attention from car drivers to the presence and behaviour of PTW riders (using turning lights, using mirrors as well as head checks to make sure blind spots are clear etc.)
- **eSUM (2010) - Potential impacts for improving PTW safety**
  - ✓ **Recommendation for actions:**
    - Given that in most Mediterranean countries alcohol production and consumption have been interwoven with the economy and culture for a long period of time, authorities should actively try to modify the behavioral culture of drink-driving among PTW users. It is evident that this requires not only intensive police control supported by a severe penal system, but also large-scale awareness raising campaigns aiming to increase perceived susceptibility to drink-driving fatalities.
    - Another obvious recommendation is that the city of Athens should address the limited PTW helmet use compliance through massive publicity and more systematic police enforcement efforts.
- **ROSA (2011) – European Handbook PROTECTIVE EQUIPMENT**
  - Identified problems related to protective equipment:
    - Helmet
      - Lack of information about how to choose a helmet

- Incorrect use of helmet
- Lack of awareness about the use of helmet
- Improvement of the safety behaviour of the helmet

- Clothing
  - Lack of information about the clothing the riders need
  - Improvement of the safety behaviour of clothing
  - Injuries in the trunk part of the riders: Trunk protectors
  - Injuries in the neck part of the riders: Neck protectors
  - Lack of acceptance
- Others
  - How to know the correct homologation of the products
  - Lack of homologation procedures for all the clothing sold related to riders
  - Lack of conspicuity

- Collected good practices include:
  - Campaign on recommendations about how to choose a helmet: http://www.acem.eu/cms/ppe.php
  - Campaign for the increase of the use of helmet
    - Surveillance by Spanish police: http://www.dgt.es/was6/portal/contenidos/documentos/la_dgt/recursos_humanos_empleo/oposiciones/Presentacion_campana_casco_Sur_Espana.pdf
    - Helmets Programmes, Cambodia and Vietnam: www.grsproadsafety.org/themes/default/pdfs/Helmets%20Cambodia.pdf ; www.grsproadsafety.org/themes/default/pdfs/Helmet%20law%20Vietnam.pdf
    - Community Youth Helmet Project, Thailand: http://www.grsproadsafety.org/themes/default/pdfs/Annual_report_2009+country_pages.pdf
    - Spanish´s campaign: http://www.dgt.es/was6/portal/contenidos/visor_multimedia/#app=7f51&c92cselectedIndex=3
  - Campaign on recommendations about how to choose suitable clothing: http://www.acem.eu/cms/ppe.php
  - Good Kit, Bad Kit campaign: http://www.roadsafetygb.org.uk/downloads/STD-LEAFLET.pdf

✓ **Project recommendations include:**

- Manufacturers should make easier the identification of the characteristics that the helmet has.
- National administrations in charge of traffic aspects should carry campaigns on helmets to obtain better percentage related to the helmet use

- **ROSA (2011) – European Handbook HUMAN FACTORS**
  - Identified problems related to human factors:
    - Socio-demographic aspects of riders: age, gender and experience
      - The tendency of the young riders to violate the rules of safe riding and towards negligence of potential risk. The same way as the lack of superior cognitive skills for riding due to the lack of experience
    - Perception of riders/human errors
      - The tendency to ever-rate their own abilities and chances of positive outcomes due to the psychological construction of unrealistic optimism.
      - Low hazard perception skills to detect dangerous traffic situations and a lack of abilities to respond appropriately in the face of the hazard.
    - Riding/ Driving Attitudes and Patterns
      - Risky attitudes carried out by motorcyclists in group riding at weekends and holidays
      - Risky behaviour associated to personality features, sensation seeking, and risk-taking decisions of some riders
      - Attitudes and risky behaviours associated to riders with aggressive personality or anti-social features
    - Psycho-physiological state of the motorcyclist
      - The effects of fatigue on motorcyclists reaction time and decision making ability
      - Alcohol consumption in motorcycling rallies and weekends
    - Perception of drivers/human errors
      - Fail to detect the motorcycle by the other road users, despite its presence in the driver’s field of view, referred to this as the conspicuity hypothesis
    - Attitudes and sociological consideration
      - The motorcyclist’s image among the other road users
  - Collected good practices include:
    - Campaign on safe riding:
      - “eMoto Café” website: http://www.e-motocafe.net/category/11

- “Safe Riding” website: http://www.seguroenmoto.com/
- Hugger campaign: http://www.think.norfolk.gov.uk/Motorcyclists/Campaigns/2009-Campaigns/Hugger-Campaign
- Operation Pitstop: http://www.local-transportprojects.co.uk/files/BP3%20013%20Operation%20Pitstop%20v2.pdf
- Pilota per la vita : www.romanotizie.it/sspip.php?article13070
- Lucky 13. ACEM Rider safety cartoons: http://www.acem.eu/cartoon/
- Restez Motard a Moto. Securite Routiere website: www.restez-motard-a-moto.fr
- MSF Rider Classroom Cards: http://www.msf-usa.org/downloads/ERC_Rider_Classroom_Cards.pdf
- "Think. Ride Smart.": http://www.motorcyclesafety.state.mn.us/latest/MMSCHomeSecondary.asp?cid=4&mid=196&scat=67
- “Down from the gas!” website: www.runter-vom-gas.de/homepage.aspx

- Campaign on alcohol consumption and fatigue
  - “A soft drink, your best fuel”: A campaign to prevent the tiredness of riders: http://www.fatigayconduccion.com/
  - Recommendations to avoid the fatigue: Motorcyclist’s Handbook: http://www.ncdot.org/dmv/driver_services/motorcyclists/motorcyclehandbook/download/MotoHandbook.pdf
  - Preparing your ride: trips to reduce the fatigue: http://www.rcmedic.com/images/MotorcycleFatigue.pdf
  - “Live To Ride” campaign: http://www.motorcyclesafety.state.mn.us/latest/MMSCHomeSecondary.asp?cid=4&mid=18&scat=42
  - “Riders Helping Riders” Programme: http://www.nhtsa.gov/DOT/NHTSA/Traffic%20Injury%20Control/Articles/Associated%20Files/810908.pdf
  - “Free to ride, free to choose”: http://www.gyr-riders.com/GYR-Riders/home.html
  - “If You Ride, Don’t Drink”: http://www.motorcycledialaride.org/BAC%20impair%20handout.pdf
- How close is too close: www.network.mag-uk.org/smidsy/How%20Close%20is%20Too%20Close.pdf
- Campaign on other road users awareness and PTW conspicuity

- "Are motorcycles your blind spot?": http://www.lbhf.gov.uk/Directory/News_Archive/Press_releases/2006/61337_Are_motorcycles_your_blind_spot.asp
- Named Riders campaign: http://www.dft.gov.uk/think/
- Don´t Look campaign: http://www.tfl.gov.uk/tfl/corporate/media/newscentre/motorcyclists.shtml
- The top 10 High-Viz Tips: http://www.motorcyclesafety.state.mn.us/latest/MMSCHomeSecondary.asp?cid=5&mid=280
- "Go High-Viz": www.highviz.org
- Take It Easy: http://www.motorcyclesafety.state.mn.us/latest/MMSCHomeSecondary.asp?cid=4&mid=19&scat=43
- Safe Driving Tips for Motorists: http://www.dps.state.mn.us/mmsc/latest/MMSCHomeSecondary.asp?cid=5&mid=78&scat=19
- Driver Awareness campaign
- See me campaign
- Look Twice, TWICE campaign: http://www.skaties2x.lv
- Calderdale Route Signing: Look, Look Again campaign: www.calderdale.gov.uk
- Advices about how to be seen in urban areas: http://www.scootermania.es/files/2009/09/8conduccion.pdf

✓ **Project recommendations include:**

- National administration in charge of traffic aspects should carry out campaigns on safe training
- National administration in charge of traffic aspects should carry out campaigns on alcohol consumption and driving/riding
- National administration in charge of traffic aspects should carry out campaigns on other road user awareness

- **ROSA (2011) – European Handbook - TRAINING**
  - Identified problems related to training:
    - Lack of training to ride a motorcycle
    - The motorcyclists´ awareness and education
    - First aid for motorcyclists

- The other users´ awareness

- Collected good practices include
  - Rider Skills Day: An initiative: http://www.bikesafe-london.co.uk/
  - Rules for motorcyclists: MUST/MUST NOT: http://www.direct.gov.uk/en/TravelAndTransport/Highwaycode/Motorcyclists/index.htm
  - Great Roads, Great Rides 2: http://www.ridesafebacksafe.co.uk/more_info.asp?current_id=109
  - Motorcycles and Weather Conditions: tips from the Motorcycle Safety: http://www.dmv.org/how-to-guides/motorcycle-weather-conditions.php
  - The complete Motorcyclist: http://www.ifz.de/e-publications-publications.htm
  - Helmet Campaign (2007): Wear and Lock
  - Minnesota Helmet Challenge: http://www.motorcyclesafety.state.mn.us/latest/MMSCHomeSecondary.asp?cid=4&mid=197&scat=68
  - Rider Training: http://www.motorcyclesafety.state.mn.us/latest/MMSCHomeSecondary.asp?cid=4&mid=384&scat=105
  - VAL OP, LET OP: http://www.motorplatform.nl/zichtbaarheid.htm
  - A speaker to talk with your group: a service: http://www.motorcycle.ohio.gov/speakers.stm
  - Weekender Project, Northumbria Police: http://www.local-transportprojects.co.uk/files/BP3%20007%20Weekender%20Scheme%20%28v1%29.pdf
  - Kill Spills BMF/IAM
  - Put yourself in their shoes: https://www.tacsafety.com.au/jsp/content/NavigationController.do?areaID=13&tierID=2&navID=AB5F82F47F00000100E26D2E0AB43666&navLink=null&pageID=1041

- **ROSYPE**
  - Whatever their age, young people pay a high price for dangerous roads. Every year, more than 1,000 children are killed in road accidents. For all categories combined, youngsters under the age of 24 account for 20% of deaths on roads. However, there are solutions and it is possible to improve the situation significantly. Education is one of the keys to achieving this aim.
  - The ROSYPE project organizes actions Europe-wide. Their actions are organized by age ("Discovering mobility": from 6 to 12 years old; "Learning road safety rules": from 13 to 16 years old; "Responsible driving": from 17 to 25 years old).

- **SARTRE 4**
  - ***Speed:*** Contrary to expectation, motorcycle riders, at each age group, experienced fewer speed tickets than car drivers. Again, this may mostly reflect amount and type of 'exposure' and enforcement efficiency, and not necessarily universal slower driving by motorcyclists compared to car drivers.
  - ***Alcohol:*** Riding a motorcycle while impaired is one of the most dangerous situations known in road safety. The impact of alcohol on riding skills is even greater than for driving skills. Motorcyclists seem to be aware of this and often decide, when they know that they are going to drink heavily, to go by car rather than by motorcycle (Syner & Vegega, 2000). Indeed, motorcyclists are also car drivers. Unfortunately, from a road safety point of view, this adaptation attempt is clearly not a good decision: we would have preferred that they decide not to drive or not to drink. This point is important to mention because it shows that motorcyclists are already aware of the risk associated with drink-riding. Communicating on this risk and informing motorcyclists about it appears thus useless and other means of deterrence have to be found;

    However, those results have to be moderated by geographical considerations. Indeed, motorcycle use is very different among SARTRE countries because of both cultural and weather differences, especially between northern and southern countries. The type of motorcycle, the profiles of motorcyclists, the frequency of use and the number of motorcyclists differs widely between those European regions
  - ***Protective equipment***: The results of the survey revealed important differences between various groups of motorcyclists and also various countries in usage of helmets and other safety devices. Besides general safety awareness of individual countries, there are complex factors affecting wearing rates.
  - ***Helmet wearing***: According to respondents, their safety helmet wearing rate is high with less than 2% reporting that they "never" or "rarely" wear a helmet. The type of road that the motorcyclist uses is one factor affecting helmet use with the highest rate on motorways ("always" wear a helmet 91,4%) while it is the lowest in built-up areas ("always" wear a helmet 84,6%). However, the proportion of the riders always wearing a helmet is not satisfactory.
    - *Gender*: The percentage of females "always" wearing a helmet is somewhat higher (consistently greater than 2% higher) than that of males for each of the four road categories
    - *Engine size*: The helmet-wearing rate is higher among drivers riding motorcycles with an engine size greater than 250 cc, consequently with higher performance and faster
    - *Annual mileage*: The percentage "always" wearing a helmet is somewhat lower among those who drive more than 5000 kilometres a year on a motorcycle compared to those who drive less than 5000 kilometres a year. However the helmet wearing rate is signifi cantly lower if the motorcycle vehicle-kilometres are over 10 000 km/year

- *Location*: A signif cant relationship between the countries and helmet wearing has been found for all road categories
- *Passengers' helmet-wearing* rate is somewhat poorer than that of the drivers with 78,5% of the motorcycle drivers "never" carrying a passenger without a helmet; The proportion of motorcycle riders who report "never" carrying passengers without a helmet is the lowest for the youngest age-group (18-24 years of age); as age rises the proportion of those not carrying passengers without helmet increases
- *Other protective clothing:* The percentage of motorcyclists wearing a technical jacket is highest in Austria, Sweden, Estonia, and the lowest in Greece, Italy and Hungary. Back protection equipment is most used in Sweden, Ireland and Austria and the lowest use is found in Italy, Greece and Hungary. The use of technical shoes/boots is most often found in the Netherlands, Sweden and Austria, while less often in Italy, Greece and Serbia. Finally, use of a phone system installed in the helmet is highest in Serbia, Israel and Austria, while the lowest usage is in France, Sweden and Slovenia; Concerning use of other safety equipment, such as technical jacket, back protection, or technical boots, the highest wearing rates we can find in Austria, Sweden, Estonia, Ireland and Netherlands, and the lowest in Italy, Greece, Hungary and Serbia. There is a relation to styles of motorcycling typical for individual countries, but also to weather conditions

o ***Motorcyclists Profiles***: significant differences exists between sub-groups of riders, regarding both their motivations for driving a motorbike, their motorcycling practices, and their respective attitudes towards risk and risk taking while motorcycling. Countermeasures among motorcyclists liable to be implemented for increasing road safety (in terms of awareness campaign, training, riding licences or traffic laws, for example) should probably take into account these sub-groups characteristics and their respective specificities, in order to be specifically adapted according to each motorcyclist's profile. Such type of dedicated "target approach" per profile may be a more efficient way for road safety than general countermeasures among all the riders.

✓ **Recommendations:**

- Development and implementation of risk communication should be based on:
  - Specific knowledge about motorcyclists' expectations, attitudes, motivations and habits concerning drinking and riding, speeding, use of safety equipment and interactions with car drivers.
  - The knowledge about specific motivations for the use of powered two wheelers.
  - Age and gender specific differences.
- Risk communication approaches should include internet-based dialogue oriented strategies. Especially the implementation of safety topics on social network sites seems to be a promising strategy to reach younger people. An improved risk communication should be implemented in the process of obtaining a motorcycle license.

- In this section, we observed a very clear distinction between northern and southern motorcyclists. They are very different regarding their motivations (and thus profiles), use of safety equipments, drink and drive, and proportion in road deaths. We thus recommend a different approach to road safety communication in northern and southern countries.

- **SUPREME (2007) - Best Practices Handbook**
  - Road safety education aims to promote knowledge and understanding of traffic rules and situations, to improve skills through training and experience, and to strengthen or change attitudes towards risk awareness, personal safety and safety of other road users. Whereas road safety campaigns eventually want to result in a behaviour change, they are often directed at either improving knowledge about a road safety problem or at changing attitudes towards particular road behaviour, e.g. drink driving or speeding.
  - Road safety campaigns as a stand-alone measure generally don't have a large effect on road safety. However, campaigns are crucial as a support for other measures such as legislation and enforcement.

D8: National strategies

Project/website	Ending date	Final report	Relevant Deliverables
2-BE-SAFE	1/09/2011		• 5.1 Interaction processes of motorcycle riders with other road users • 6.4 Guidelines, policy recommendations and further research priorities
APROSYS	1/12/2009	http://www.transport-research.info/Upload/Documents/201203/20120313_143223_50861_Final%20APROSYS%20Report.pdf	• Final report for the work on 'Motorcyclist Accidents'
DaCoTA	30/06/2012		• Deliverable 1.2 Road safety management
eSum	30/11/2010		• D5.2 ACTION PACK - ADDRESSING URBAN PTW ACCIDENT • Potential impacts for improving PTW safety
PROMISING	1/01/2001	http://www.transport-research.info/Upload/Documents/200310/promisingrep.pdf	• Deliverable 3

ROSA	31/03/2011	no more website	• European Handbook on Good Practices in Safety for Motorcyclists - Epigraph: ENFORCEMENT POLICIES – • European Handbook on Good Practices in Safety for Motorcyclists - Epigraph: HUMAN FACTOR – • European Handbook on Good Practices in Safety for Motorcyclists - Epigraph: TRAINING -
SARTRE 1-4			• SARTRE 3 Principal results (p.197) • Sartre 4 - European road users' risk perception and mobility
SUPREME	1/06/2007		• Best Practices Handbook

- **2BESAFE project (2011) – Deliverable 5.1**
  - ✓ **Recommendations:** The 2BESAFE project recommends (supported by observation data and statement in the Focus Group) working on 5 areas:
    - Infrastructure: Measures concerning the infrastructure: use of anti-slip materials for road surfaces; Separate lanes for PTW riders; The use of bus or emergency lanes has been considered as safety and comfort enhancement for riders.
    - Vehicle: Requirements for motorcycles: Improvements of the lighting of the motorcycles; the awareness of riders for assistive technologies
    - Interaction between road users and individual characteristics: Training: awareness training (training for PTW riders which enhances riding skills and training for PTW riders which enhances riding skills). Research of traffic conflicts has to take into consideration that addressing certain groups of road users is not an isolated issue. The observation data and the experience obtained in the data analyses repeatedly showed that conflicts and errors by motorcycle riders are to a certain degree the fault of other road users. Therefore, the focus in future traffic research must lie on the interplay of different road user groups.
    - Society (Legal requirements, media): it is crucial to adapt the regulatory framework in order to comply with the specific fears, needs and wishes of the group of the PTW riders. In this regard MC riders often mentioned the imbalance of the traffic system which focuses mainly on car drivers. A large proportion of the mentioned behaviour of PTW riders is not legal but still considered as "typical behaviour" and already socially accepted. This aspect needs to be considered in the process of traffic legislation. Campaigns to

improve the mutual understanding of all road users can be helpful in this regard and have been mentioned several times by the motorcycle riders.

- Individual: the training of motorcyclists needs to focus more on the vulnerability of riders and the fact that fast acceleration, speeding and braking abruptly as a consequence of inappropriate speed are particularly risky. Refreshing training for riders who haven't been riding a motorcycle for a long time need to be advocated. The design of the motorcycle protection clothing should be adapted to different riding tasks. For motorcyclists who use the motorcycle for riding to work or for short trips protection clothing which is also suitable for the office or daily use is needed. The costs for protection clothing in general needs to be adequate so that it is not "exclusive" clothing but for the daily use. In addition, there should be a standard level of security of the safety equipment in order to ensure the quality. Therefore legal requirements should focus on adequate protection clothing for different riding tasks.

- **2BESAFE project (2011) – Deliverable 6.4**

Table 1: Fields covered by the report

Chapter	Fields Covered
Institutional Organisation of Road Safety	Road Safety Visions
	Road Safety Programmes and Targets
	Road Safety Guides and Studies
Road Infrastructure	Self-Explaining/Forgiving Roads
	Measures for Urban Traffic
	Pavement
Vehicles and Safety Devices	Brakes
	Passive Safety Devices
	Advanced Rider Assistance Systems
Conspicuity & Lights	Improvement of Conspicuity
	Installation and Type Approval of Lights
Environmental Issues	Issues concerning Air Pollution
	Issues concerning Noise Pollution
Protective Equipment	Standards
	Various Components of Protective Equipment
Driver Education, Licensing and Testing	Licensing, Basic Training
	Post Licensing Training
	Behaviour
Traffic Law & Enforcement	Enforcement (Strategies)
	Regulations concerning Driving Manoeuvres
Road Safety Education and Campaigns	Ways to Promote Motorcycle Safety
	Improvement of Awareness
Rehabilitation and Diagnostics	Rehabilitation of Severe/Young Violators
	Traffic Psychological Assessment
Post Accident Care	Improvement of Emergency and Post-Injuries Services
	Motorcycle Issues in Emergency and First Aid Trainings
Road Safety Data and Data Collection	Improvement of Data Collection
	Ways to Collect Data
Measures involving other Vehicles	Other Road Users' Responsibilities to Riders
	Use of ITS
Other Measures	Responsible Advertising Policy
	Issues concerning Electric Vehicles

- The report on Powered Two Wheeler related guidelines contains an overall number of 144 measures. The largest number of measures was found within the category “Road Infrastructure” (35 measures), followed by “Vehicle and Safety Devices” (30 measures) and “Driver Education, Licensing and Testing” (20 measures).
- Assuming a limited availability of resources, road safety measures should be efficient. In 2004, Elvik (2004) found that effective countermeasures to accidents in macroeconomic terms are widely not applied due to political constraints. Elvik concluded that decision-making should more focus on sound and measureable approaches proposing cost-efficiency as the most appropriate one.

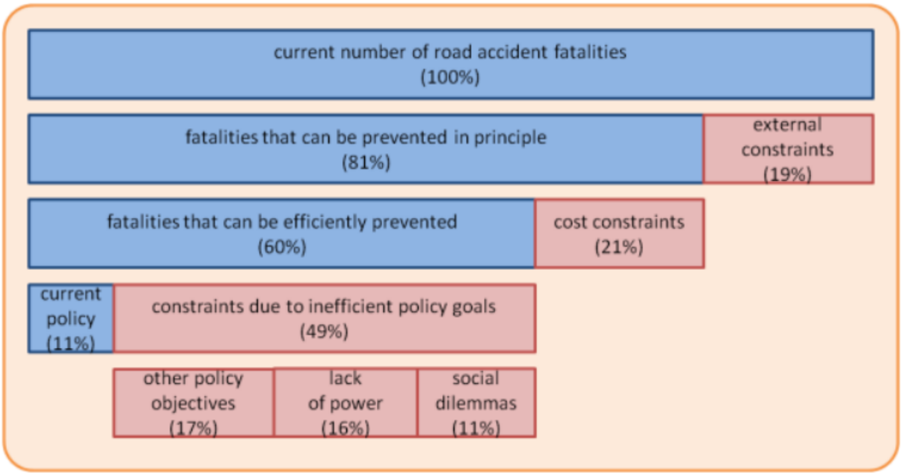


Figure 4: Preventable road safety fatalities

- Acceptance of the measure includes public acceptance, acceptance by road users, policy makers, and other stakeholders (e.g. automotive industry). It is related to attitudes and behavioural consequences of the measure, especially to willingness to apply the measure, or to comply to it. Other relevant issues can be political, legal, financial, technical and administrative aspects. Acceptance is a particular issue in terms of PTW safety measures. Riders are a rather inhomogeneous group of road users. Experience valid for passenger car drivers might not be relevant to PTW riders. Hence, specific attention should be given to an objective assessment of acceptance. PTW riders are a group of road users particularly keen on having their needs and wishes considered. In most of the cases it may be useful to consult rider organisations and implement a constructive process of consulting and discussion.
- The highest number of popular measures depicted from the expert evaluation (both expert and FEMA) include measures that involve road infrastructure. A great number of measures scored highly and those measures were considered to be of high implementation priority in EU. Another type of measures that got high scores involved post accident care. Measures including improving emergency and post -injury services and acquiring particular knowledge on how to deal with certain types of riders’ injuries that need specific care. In addition almost all measures related to road safety data and data collection received great support by experts and FEMA. Such measures include improvement of data collection, road conflict investigation, in-depth analysis of PTW accidents, naturalistic riding studies and identification of accident black spots. The interaction of PTWs with other vehicles which is

considered to be a contributing accident factor was also considered as the measure involving other road users' responsibilities to riders also scored high.

- On the other hand there were several measures that were not considered to benefit PTW riders at all receiving rather poor scores. Specific measures that were classified under the road infrastructure category did not receive high scores from experts (although they did receive high scores from FEMA) mainly due to the high costs involved or the risk compensation that riders were anticipated to demonstrate which could reduce or even the eliminate the anticipated improvement on PTW road safety.
- Measures on driver education, licensing and testing received high, medium and low scores depending on the examined measure. For example defining the legal regulations for obtaining a PTW licence providing initial rider training, organising workshops for young moped riders and providing practical training for novice riders were favoured amongst experts, whereas the graduated license scheme received diverse evaluations. On measures for traffic in urban area, FEMA's score was quite high as such measures improve PTW mobility (such as filtering), whereas the experts gave a low scoring mainly due to safety concerns. A category of measures which was considered promising by experts but not at all by FEMA involves PTW conspicuity; examples being the mandatory use of headlights, having automatic headlamps on (AHO) and recommendations when riding at night including reflective clothing or strips. For the majority of such measures the standpoint of FEMA is that they object to such measures because they infringe on the freedom of road user and that safety-conscious riders already rely on their judgment to decide when their comfort and safety requires actions related to conspicuity. However, the adaptive front lighting system received high scores from both "sides". The category of road safety education and campaigns received medium or low scores from experts in several cases by high scores from FEMA experts, as was expected, except for showing shocking films concerning motorcycle safety which according to expert and FEMA views should not be implemented.
- Still, it should be noted that further research is required in order to be able to suggest potentially successful PTW road safety measures and implement them. What the researchers need to have in mind are the needs of the riders, their characteristics (riding behaviour, cognitive performance, mentality, acceptance, motives etc), their interaction with the elements comprising the road network (other road users, the road environment and the actual PTW) and the way "things work" in each country.

✓ **Recommendations: specific measures on Powered two-wheelers Safety:**

- Road Infrastructure
    - Guidelines on Road Design
    - Road Safety Audit
    - Road Safety Inspection
    - Black Spot Management
    - Signposting of Speed Limits at Dangerous Spots in Curves

- Installation of Rumble Strips
- Clarification / Highlighting of Longitudinal Roadway Arrangement
- Enhanced lane separation by floor markings
- Elimination of Sight Barriers in Curves and Improving Sight
- Predictable Curvature
- Transitional vs. circular bends
- Elimination of Dangerous Obstacles in Bends
- Provision of Full Paved Shoulders
- Technical Standards for Road Restraint Systems
- Wire Rope Barriers
- Under-ride Barriers for Guardrails
- Guide Posts Made of Flexible Material
- Reconstruction of Intersection Points
- Entry Angle at Roundabouts
- Speed Limits for PTWs
- Speed Limits at Hazardous Sites
- Ban on Passing
- Use of Bus Lanes by PTWs
- Separate PTW Lanes
- Moving Mopeds from the Cycle Lane on the Carriage Way
- Advanced Stop Lines for PTWs
- PTW Parking within Intersections
- Shared Space
- Skid Resistance: Magnitude and Consistency
- Road Surface Testing
- Improvement of the Transversal Slope (Crossfall) in Curves
- Improvement of Pavement Friction on New Asphalt Surfaces
- Reduction of Roadway Debris from the Roadway and Roadside
- Maintenance of Roadway Surfaces in Work Zones
- Further Issues concerning Friction

\- Vehicles and Safety Devices

- Type Approval
- Definition of a Moped
- Multi-Wheel Vehicles
- Standard on measurement of maximum speed of PTWs
- Mounting the Rear Registration Plate
- Requirements for Braking
- ABS and other Advanced Braking Systems
- Future Brake Systems
- Automatic Stability Control (ASC)
- Method of Assessment of Secondary Safety Systems
- Safety Belts
- Motorcycle Airbags
- Protective Cages
- Collision Warning and Avoidance Systems
- Curve Speed Warning
- Tyre Pressure Monitoring Systems
- eCall
- Adaptive Cruise Control
- Intelligent Speed Adaption
- Alcohol Interlock Devices for PTWs
- Rear-view Mirrors
- Specifications of Tires and Wheels
- Method of Measuring Tire Rolling Circumference for New Tires under Loaded Conditions
- Trailer Coupling Devices
- Stands for Two Wheel Motor Vehicles
- External Audible Warning Devices
- Internal Audible Warning Devices
- Standardized Speedometers
- Standardized Symbols on Controls, Telltales and Indicators
- Steering Wheel Locks

- Conspicuity and Lights
    - Mandatory Use of Headlights
    - Type Approval of Lighting and Light-Signalling Devices
    - Automatic Headlamps On (AHO)
    - Guidelines for Improvement of Rider Conspicuity during Daylight Riding
    - Guidelines for Improvement of Rider Conspicuity during Night-time Riding
    - Xenon Headlamps
    - Automatic Dipped Beam Inclination
    - Adaptive Front Lighting
    - Alternative Front Light Patterns
- Environmental Issues
    - Requirements concerning Air Pollution
    - Requirements concerning the Permissible Sound Level
- Protective Equipment
    - Standards for Motorcyclist Protective Clothing
    - Standards for Motorcycle Helmets
    - Obligatory Helmet Use for PTW Riders and Passengers
    - Standards for Eye Protection
    - Eye Protection Regulations
    - Protective Gloves (for Professional Motorcycle Riders)
    - Impact Protectors for Motorcyclists
    - Protective Footwear (for Professional Motorcycle Riders)
    - Neck Braces
    - Airbag Jackets
- Driver Education and Licensing
    - Legal Regulations for Obtaining a PTW Riding License
    - Graduated Licensing
    - Initial Rider Training
    - Age Limitations for Pillion Passengers
    - Riding Without Pillion Passengers Requirements to Ride a Moped
    - Probationary License

- Riding Bans for Novice Motorcyclists
- Access to Certain PTW Classes for People with a Driving License
- Multiphase Education
- Rider Trainings provided by the Police
- Workshops for Young Moped Riders
- Practical Training for Novice PTW Riders
- Deceleration Tester
- Ride-Outs for New PTW Buyers
- Group Work and Problem Based Learning in Experienced Rider Training
- Training of Practical Behaviour on a PTW-Simulator
- Establishment of an Advanced Riding Network

- Behaviour
    - Code of Behaviour for PTW Riders
    - Legal Conditions for PTW Pillion Passengers
- Traffic Law and Enforcement
    - Framework for Motorcycle Law: Road Traffic Law
    - Targeted Enforcement Strategies
    - Filtering
    - Lane Splitting
    - Motorcycles Operating Two Abreast in Same Lane
    - Vehicle Identification Number
    - Measuring Power and Speed
    - Safety Cameras
    - Anti-Tampering Measures and Enforcement
    - Periodical Technical Inspections
- Road Safety Education and Campaigns
    - Signposts, Displays, Roadside Boards and Bills Alongside Dangerous Roads
    - Events Promoting Motorcycle Safety
    - Educational Brochures
    - Shocking Films concerning Motorcycle Safety
    - Using Community Collaboration to Promote Motorcycle Safety

- Using Peer Activities to Promote Motorcycle Safety
- Integrated Road Safety Education Programme
- Peer Activities to Prevent Drink Riding
- Programmes to Increase Awareness on Safety Helmet Use
- Promotion of Protective Equipment

- Rehabilitation and Diagnostics
    - Rehabilitation of Severe Violators
    - Rehabilitation of Young Offenders
    - Traffic-Psychological Assessment of Drink Drivers
- Post Accident Care
    - Improve Emergency and Post-Injuries Services
    - Motorcycle Issues in Emergency and First Aid Trainings
    - Helmet Removal System
- Road Safety Data and Data Collection
    - Improvement of Data Collection
    - Road Conflict Investigation
    - Naturalistic Riding
    - Field Operational Tests
    - In-Depth Analysis of Motorcycle Accidents
- Measures involving other Vehicles
    - Other Road Users' Responsibilities to Riders
    - Vulnerable Road User Protection
    - Collision Avoidance System
    - Inter-Vehicle Communication System
- Other Measures
    - Responsible Advertising Policy
    - Measurement of Road Operating Ability of Pure Electric Vehicles
    - Measurement of Road Energy Performance of Thermal Electric Hybrid Vehicles

- **APROSYS (2009) – Final Report**

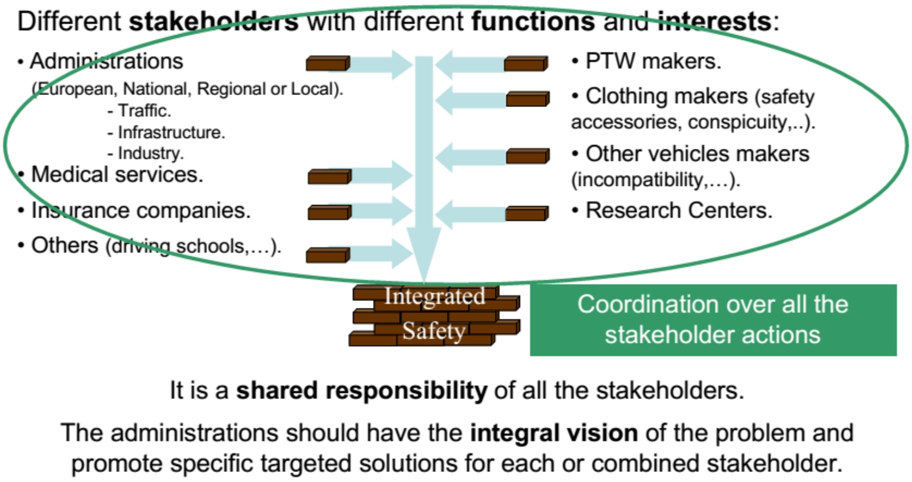


Figure 29.- Working plan about how to proceed for an integrated safety point of view.

- **DACOTA - Road safety management**
  - Road Safety Management can be globally defined as a government area geared at reducing the number of road crashes and victims on the territory and in the population governed. Road Safety Management is thus justified by its outputs in terms of measures or action programmes implemented to prevent or reduce road crashes and injuries and includes activities (policy-making tasks and transversal processes) as well as the organisation necessary for these activities to take place (the Road Safety Management System).
  - As on one hand, road crashes and injuries are a public health problem and on the other hand, any measure taken to alleviate the problem impacts on economics, the environment and citizens' everyday life, stakeholders are multiple (provincial or local authorities, Parliament members, private businesses, NGOs) and have varied interests in road safety, ranging from advocacy through participation in action to downright opposition to specific measures. Involving non-governmental stakeholders in policy-making may include two complementary approaches: (1) bottom-up approach or (2) "top-down" approach.

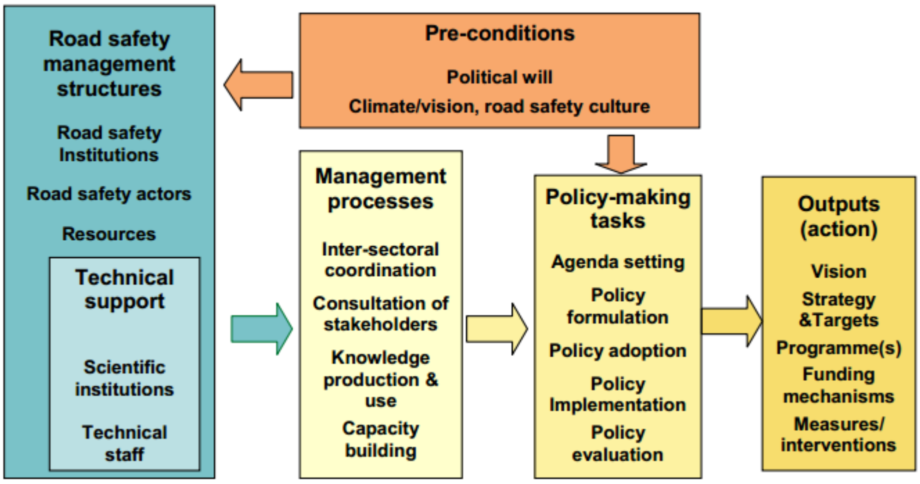


Figure 3.3 Road Safety Management

✓ **Good practice in road safety management:**

- A lead agency responsible for road safety at the highest government level:
- A long-term vision enduring political and government changes
- A compelling quantitative target, challenging but achievable and commitment of the higher levels of government to reach it
- A national road safety programme adopted at the highest level of government after consultation of stakeholders
- A well-defined and realistic funding procedure and fund allocation
- an efficient coordinating structure at all necessary levels, precisely defined
- (key sectors and actors involved, roles and responsibilities)
- A system for monitoring progress in realizing targets and providing feedback to the agencies in charge of implementation
- A strong process of knowledge production and knowledge transfer

- **eSUM Action Pack**
  - The Action Pack sets out a simple methodology for designing and implementing a PTW casualty reduction programme. Essentially there are 6 stages:
    - Gather data required for analysis of PTW casualty problems: at least collision data and contextual data (background to the use of PTWs)
    - Analyse data
    - Identify casualty issues: From the analysis it should be possible to identify common causation factors to assist in selecting appropriate interventions.
    - Develop targets and select interventions: match interventions to the problems defined by the analysis of data.

- Implement interventions and monitor: A robust monitoring framework should be established in order to accurately evaluate the effectiveness of any interventions implemented.
- Evaluate effectiveness: a named individual should be responsible for the project management of implementation; interventions selected should be suitably modified to ensure that they are appropriate to national/city conditions; sufficient resources should be in place.

✓ **Recommendations:** the eSUM Action Pack provide guidance on potentially successful casualty reduction projects based on 6 themes:

- Rider Training and Awareness
- Highway Features and Policy
- Targeted Enforcement
- Specific Highway Remedial Measures
- PTW Design and Protective Equipment
- 'Softening' the Highway Infrastructure

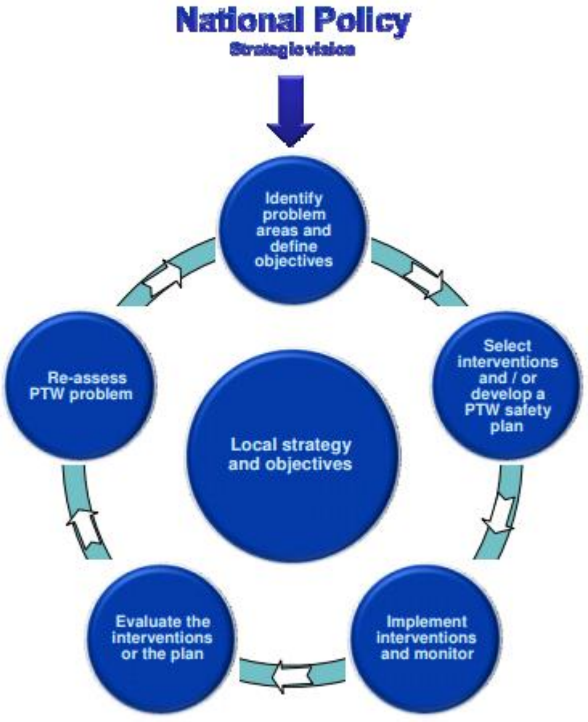


Figure 2: Planning Process

- **eSUM potential impacts for improving urban PTW safety**
  - PTW safety is a complex undertaking, as improvements in the field require an integrated, ‘safe system’ approach and rely on adoption of measures by all participating disciplines and behavioural modifications by the public at large.
  - In urban area, three major modifiable risk factors for PTW injuries can be addressed: helmet non-use, driving under the influence of alcohol and unlicensed riding. On alcohol, 37% PTW fatalities could be avoided each year in Paris if all riders were sober while driving, and 26% in Barcelona. On unlicensed riding, 12% PTW deaths could be avoided in Paris if all riders were driving with a valid driving license. On helmet use, in Athens 42% of human lives could have been saved in 2008 if all PTW drivers had respected existing helmet use legislation.

  ✓ **Recommendation**

    - This report, aiming to elucidate potential impacts for improving urban PTW safety, amplifies an already known need, that is, the need for advancing new initiatives to put an end to the high levels of drink driving. Given that in most Mediterranean countries alcohol production and consumption have been interwoven with the economy and culture for a long period of time, authorities should actively try to modify the behavioral culture of drink-driving among PTW users. It is evident that this requires not only intensive police control supported by a severe penal system, but also large-scale awareness raising campaigns aiming to increase perceived susceptibility to drink-driving fatalities.
    - The city of Athens should address the limited PTW helmet use compliance through massive publicity and more systematic police enforcement efforts.

- **PROMISING (2001) – Deliverable 3**
  - As a result of European regulations, the legislation concerning mopeds and motorcycles has become more uniform in recent years. But there are still many differences in detail.
  - Since the lack of protection can only partly be compensated by protective devices, much depends on the effectiveness of other measures.
  - In general riders of mopeds and motorcycles follow the same traffic rules as car drivers, with the exception of a lower speed for mopeds. It might be argued that problems of congestion by cars can be partly solved by replacing cars by mopeds and motorcycles. This can only be done if the safety of the riders is improved. Under this condition, it can even be considered to give riders of mopeds/motorcycles some privileges compared to car drivers, such as overtaking lines of slow moving cars on the left or right, to take position at the head of waiting lines of cars, to ride on lanes, roads or areas with restricted access (such as bus lanes, inner city areas etc.) and to provide special parking facilities. Some of the suggested traffic rules, insofar as they separate motorcycles/mopeds from cars, can also improve the safety of riders, although care should be taken not to introduce other safety problems (e.g. collisions of motorcycles/mopeds with pedestrians or cyclists, or with cars, at places where the motorcycles/mopeds are not expected). Special traffic rules for motorcycles/mopeds have been tried in several places in Europe, but so far no results are known. More explicit rules are

supposed to result in more uniform behaviour by riders and better knowledge and acceptance of it by other road users.

- In view of their high accident rate, this should not only include technical and non-restrictive measures. Policy makers will therefore have to recognise the role of mopeds and motorcycles as road users and the need for measures to improve their safety.
- Of the technical measures, the design and maintenance of the road in view of the safety of mopeds/motorcycles seems to have been neglected. This in turn may be related to a wrong **image** of riders of mopeds/motorcycles as a minority group of mostly young riders with a high accident rate because of their own behaviour. What is needed in this situation is first of all a correction of this image based on the information in this report. The population of motorcyclists has changed over the years and most riders are now over 25 years of age and their number is still increasing. Apart from Southern European countries, there are more motorcycle fatalities over 25 years than under 25 years. Because of the low minimum age, moped riders are younger than motorcyclists, but even the number of moped fatalities is about the same for both young and old riders. As far as their behaviour is concerned, riders with a dangerous riding style are a minority among all riders.
- Data collection and research are not safety measures by themselves, but serve to study the need for and the effects of such measures. In the case of mopeds and motorcycles there is a strong need for more reliable data and more and better research.
- This report also shows the importance of training of riders of mopeds/motorcycles. Such a measure, or rather package of measures, depends to a large extent on the willingness of riders to accept the measure and to improve their behaviour. Acceptance of a measure is much greater if the target group has been involved in the development and introduction of the measure. Motorcyclists in many countries have some degree of organisation, which makes it easier to discuss measures with representatives of the group of motorcyclists. For moped riders there are no special organisations representing their views and needs, although tourist organisations and the industry may offer to represent them.

- **ROSA (2011) – European Handbook ENFORCEMENT POLICIES**
  - Identified problems related to enforcement policies:
    - General Policies
      - The definition of a Strategic/Action plan for motorcyclist road safety
      - The definition of an Agenda and Guidelines for Motorcycle Safety
    - Targeted Policies
      - The definition of many differing strategies(campaigns, enforcement activities on key motorcycle collision causation factors,…) dealing with motorcyclists
    - Regulations
      - Traffic control during events

- Road Safety Taxation
    - Lack of funding for buying safety equipment or updating it

- Collected good practices include:
  - Strategic motorcycle safety programme, Spain: http://www.dgt.es/was6/portal/contenidos/documentos/la_dgt/recursos_humanos_empleo/oposiciones/plan_sectorial008.pdf
  - Motorcycle and Scooter Action Plan: www.islington.gov.uk/DownloadableDocuments/TransportandStreets/Pdf/final_sustainable_transport_strategy/AppH_MandSActionPlan.pdf
  - A European Agenda for Motorcycle Safety: www.fema.ridersrights.org/docs/EAMS2007.pdf
  - Motorcycling Guidelines, IHIE: http://www.motorcycleguidelines.org.uk/mg_02_1.htm
  - Operation Achilles, Humberside Police: http://www.humberside.police.uk/
  - ACPO UK Motorcycle Enforcement Strategy: http://www.acpo.police.uk/asp/policies/Data/motorcycle_enforcement_strategy_website.doc
  - Security and control during Motorcycling events: http://w3.bcn.es/fitxers/mobilitat/ponencia16forumperenavarro.409.pdf
  - Motorcycle helmets: 0% VAT rate: http://www.hmrc.gov.uk/vat/forms-rates/rates/goods-services.htm
  - Forget the past, update your safety

✓ **Recommendations include:**

- National, Regional and Local administrations in charge of road safety aspects should define strategic plans at different levels, and implement them.
- Implementations of PTW infrastructure guidelines
- National, Regional and Local administrations in charge of police aspects should develop enforcement activities on key motorcycle collision causation factors.
- National, Regional and Local administrations in charge of traffic aspects and civil safety should carry out coordinated actions on motorcycling event among all the forces (police, civil, medical) with the aim of improving road safety for all the attendance.
- National, regional and local administrations in charge of traffic aspects or health should fund or co-fund the safety equipments that can help to mitigate injuries when an accident happen and therefore to reduce costs (medical cost, lost labour output,…) from the injured motorcyclists.

- Manufacturers of motorcycling equipment should carry out campaign with the aim of guaranteeing that motorcyclists are using the best equipment (correct and updated equipment)

- **ROSA (2011) – European Handbook HUMAN FACTORS**
  - Identified problems related to human factors:
    - Socio-demographic aspects of riders: age, gender and experience
      - The tendency of the young riders to violate the rules of safe riding and towards negligence of potential risk. The same way as the lack of superior cognitive skills for riding due to the lack of experience
    - Perception of riders/human errors
      - The tendency to ever-rate their own abilities and chances of positive outcomes due to the psychological construction of unrealistic optimism.
      - Low hazard perception skills to detect dangerous traffic situations and a lack of abilities to respond appropriately in the face of the hazard.
    - Riding/ Driving Attitudes and Patterns
      - Risky attitudes carried out by motorcyclists in group riding at weekends and holidays
      - Risky behaviour associated to personality features, sensation seeking, and risk-taking decisions of some riders
      - Attitudes and risky behaviours associated to riders with aggressive personality or anti-social features
    - Psycho-physiological state of the motorcyclist
      - The effects of fatigue on motorcyclists reaction time and decision making ability
      - Alcohol consumption in motorcycling rallies and weekends
    - Perception of drivers/human errors
      - Fail to detect the motorcycle by the other road users, despite its presence in the driver's field of view, referred to this as the conspicuity hypothesis
    - Attitudes and sociological consideration
      - The motorcyclist's image among the other road users
  - Collected good practices include:
    - Perception of risk in motorcyclists: http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1285350/pdf/archemed00011-0044.pdf
    - Best training methods for teaching hazard perception and responding by motorcyclists: http://www.monash.edu.au/muarc/reports/muarc236.pdf

- Enhancing hazard avoidance in teen-novice riders: Vidotto, G.; Bastianelli, A.; Spoto, A. And Sergeys, F. (2011)Enhancing hazard avoidance in teen-novice riders Accident Analysis and Prevention, 43, Issue, 1, January 2011
- Using a riding trainer as a tool to improve hazard perception and awareness in teenagers: http://host.uniroma3.it/riviste/ats/sixteenth%20issue/Vidotto%2051-60%20A.pdf
- Advanced Rider training / Post Test training
- Effective Interventions for Speeding Motorists: http://www.dft.gov.uk/pgr/roadsafety/research/rsrr/theme2/effectiveinterventionsforspe.pdf
- Red Light Jumper Cameras: http://www.local-transportprojects.co.uk/files/BP3%20010%20Red%20Light%20cameras%20%28v1%29.pdf
- Safety Cameras in London: www.lscp.org.uk/
- Indoor and outdoor motorcycling facilities: http://www.newburghct.org.uk/Index.asp?MainID=7575
- Introduction of zero blood alcohol concentration (0.00 BAC) for novice motorcycle riders: http://www.tmr.qld.gov.au/Safety/Driver-guide/Alcohol-and-drugs/Anti-drinkdriving.aspx
- How close is too close: www.network.mag-uk.org/smidsy/How%20Close%20is%20Too%20Close.pdf
- Calderdale Route Signing: Look, Look Again campaign: www.calderdale.gov.uk

✓ **Project recommendations include:**

- National administration in charge of traffic aspects should carry out campaigns on safe training
- National administrations should promotove alternative punishment measure on risky behaviour on the road: perception risk classes, etc.
- include programme on perception of risk for riders who are punished during the riding (punishments related to risky actions)
- National administration in charge of traffic aspects should improve training methods and training tools of driving/riding schools
- Local administration in charge of urban traffic aspects should consider the installation of cameras in risky intersections regulated through signals
- Local administration in charge of urban traffic aspects should consider the location and arrangement of indoor and outdoor motorcycling facilities to reduce the risks of people using parks, beaches, woodlands, coastal walks or streets for illegal, anti-social motorcycling.

- National administration in charge of traffic aspects should consider running campaign on encouraging drivers to look out for motorcycles supported by PTW sign on the road.

- **ROSA (2011) – European Handbook - TRAINING**
  - Identified problems related to training:
    - Lack of training to ride a motorcycle
    - The motorcyclists´ awareness and education
    - First aid for motorcyclists
    - The other users´ awareness
  - Collected good practices include
    - Shiny Side Up Partnership: http://www.shinysideup.co.uk/shiny_side_up_hotspots/
    - Involvement of Motorcycle Groups in Highway Design
  - ✓ **Project recommendations include:**
    - National administration in charge of infrastructure and traffic aspects should carry out campaign on the awareness of the PTW users supported by low cost temporary poster/signs for positioning at PTW collision blackspots or routes
    - National administration in charge of infrastructure design should take into account this group in the definition of countermeasures related to road safety aspects
- **SARTRE 3**
  - Diagnosing drivers' attitudes to the problems of vulnerable road users (pedestrian, cyclists and motorcyclists) is no easy task. Generally, drivers want their governments to tackle the problem, the relevant support has hardly changed over the last six years; support in European Union countries and non-European Union countries is very similar and finally, just like in the case of other problems, there are big differences from country to country. Since the last SARTRE study support for vulnerable road users has grown in Switzerland, Italy, Austria and the Czech Republic, against a drop in Slovenia, Slovakia, the Netherlands, United Kingdom, Sweden and Spain. As you can see, over the last few years Europe has seen the forming of an unusual group of countries where driver consideration for vulnerable road users is decreasing. The group includes countries considered Europe's safest and those that are lagging behind. With less pressure on the governments to address the problems of vulnerable road users, the result may be less action by countries where risk is high for pedestrians, cyclists and motorcyclists. The change in attitude of Dutch, British or Swedish drivers should also be studied in-depth.
  - The results also suggest that driver opinions about the problems of vulnerable road users are only slightly influenced by the actual risk to these groups. For example there is clearly less support for tackling motorcyclist problems, even despite the fact that the risk to motorcyclists is highest. What is more in many cases there was opposition to government involvement in the matter. This may suggest a negative attitude to the problems of these road users.

- **SARTRE 4**
    - The high accident risk of motorcyclists is well documented in many countries (Lin & Kraus, 2008). Although this is known for many years research on road safety relevant topics concerning motorcyclists have been strongly neglected.
    - ✓ Recommendations:
        - Considering different enforcement strategies depending on the geographical situation of the target country. Southern countries should be regarded as priority targets as they cumulate a high proportion of motorcycle use within local population and a high frequency of drink-driving.
        - Overall regarding the use of motorcycles and riding the behavior and the accident risk of motor cyclists there are many differences between the European countries. Therefore safety measures for motorcyclists should be developed in accordance with the country-specific circumstances.
        - Legal BAC: we recommend a BAC limit of 0.2g/l for motorcyclists.
- **SUPREME**
    - 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 about the long term aims and the role of the various components of the traffic system.
    - SUPREME organised measures in the nine areas: (1) Institutional organisation of road safety; (2) Road infrastructure; (3) Vehicles and safety devices; (4) Road safety education and campaigns; (5) Driver training; (6) Traffic law enforcement; (7) Rehabilitation and diagnostics; (8) Post accident care and (9) Road safety data and data collection.

D9: Motorcycling Community

Project/website	Ending date	Final report	Relevant Deliverables
2-BE-SAFE	1/09/2011	http://www.2besafe.eu/sites/default/files/deliverables/2BES_D35_FinalReport.pdf	• D3.1 Social, cognitive and behavioural differences of PTW riders with reference to their attitudes towards risk and safety
PROMISING	1/01/2001	http://www.transport-research.info/Upload/Documents/200310/promisingrep.pdf	• Deliverable 3

SAFETYNET	1/12/2008	http://erso.swov.nl/knowledge/Fixed/45_PoweredTwoWheelers/powered%20two%20wheelers.pdf	• Use of PTWs
SARTRE 1-4		http://www.attitudes-roadsafety.eu/index.php?eID=tx_nawsecuredl&u=0&file=fileadmin/Results/SARTRE%203%20results/S3_reports/Part%201_Report%20on%20principal%20results.pdf&t=1426947005&hash=37ce58463fddcf23253e64977ec9e93f	• Sartre 4 - European road users' risk perception and mobility
SUNFLOWER +6	1/12/2005	http://www.20splentyforus.co.uk/UsefulReports/SUNflower%2B6_Final_Report.pdf	• Final report

- **2BESAFE project (2011) – Deliverable 3.1**
  - ✓ **Recommendation:** A recent survey in the UK (Jamson & Chorlton, 2009) was centred on the changing nature of motorcycling over the last decades where increases in motorcycling activity but also in accident risk were found. The main results of the survey which gathered a sample of 989 motorcyclists classified in three groups (long-term, returning and new riders) include:
    - *Demographics*: Over half of the male sample was long-term riders, with the remainder split relatively evenly between returning and new riders. The majority of females were new riders and were half as likely as males to be returning riders
    - *Trip activity*: most of riders (56%) claimed to make both leisure and commuting trips, whilst 30% engaged only in leisure trips. Only 13% of the sample was commuter-only riders. Leisure riders were mostly either long-term riders or returning riders and they tended to own higher capacity machines than commuter riders.
    - *Purchasing decision*: the majority (64%) of motorcycles owned at the time of the survey were second-hand at the time of purchase. New riders valued the economics and convenience of owning a motorcycle whereas long-term riders and returning riders based their decisions more on the leisure and status symbol of the motorcycle. In terms of motorcycle ownership long-term and returning riders dominated ownership of the higher CC motorcycles whilst new riders favoured low powered mopeds and scooters.
    - *Patterns of ownership*: using retrospective data, it was found that those motorcyclists who had taken up the activity in recent years, increased the engine size of their machines more quickly, compared to earlier cohorts. As a result, there exists a group of riders who have progressed to large capacity machines relatively quickly, without the steady accumulation of skills and experience that might have previously been the case. The data suggest also

that those riders who took up motorcycling 30 years ago were considerably younger, then, than those who took it up more recently. Motorcycles purchased today are much more likely to be purchased for reasons of styling and image compared to previous cohorts who relied on them more as a form of transport.

- It emerged that riders of higher capacity motorcycles tend to be male, long-term or returning riders, who ride mostly for leisure purposes. In addition they also drive a car, are of higher socio-economic class and earn a higher income. They are also more likely to attend voluntary motorcycling training courses.

- **PROMISING (2001) – Deliverable 3**
  - ✓ Statistical information in this report refers mostly to Western Europe, i.e.: A, B, D, DK, E, F, FIN, GB, GR, I, IRL, N, NL, P, and S. Sufficient information on Eastern European countries was not available. Some of the information was not even available for all western European countries
  - ✓ In Western Europe the absolute number of mopeds is 13-14 million. This number has not changed much over the last ten years, but used to be higher before that. France shows a remarkable decline in number of mopeds from over 5 million in 1980 to less than 2 million in recent years.
  - ✓ The absolute number of motorcycles in Western Europe is lower than the number of mopeds, with almost 10 million. This number is slowly, but constantly increasing. Great Britain is an exception with decreasing numbers of motorcycles and mopeds.
  - ✓ There is a clear regional pattern with many more mopeds/motorcycles in Southern European countries as compared to Northern Europe. The number of vehicles per 1000 inhabitants is ca 50 mopeds for southern countries and 30-40 motorcycles. For northern countries the rates are c.20 for mopeds and 10 for motorcycles. Switzerland has remarkably high rates for both mopeds and motorcycles: c.50/1000 inhabitants.
  - ✓ Absolute numbers of mopeds and motorcycles are also high in Southern Europe, with Italy having the highest numbers: 5 million mopeds and 2.5 million motorcycles. In midwest Europe, Germany has about the same number of motorcycles as Italy (2.5 million), but a much lower absolute number of mopeds (1.7 million). The absolute numbers of mopeds/ motorcycles in northern countries is again low
  - ✓ Because of the low minimum legal age for moped riding, many of the riders are young. During recent years, scooter models became popular. Motorcycle riders used to be young as well, but there is a long-term trend with fewer young riders and many more older. Today about 75% of motorcyclists are older than 25 years.
  - ✓ The population of female riders of both moped and motorcycle is small and seems to vary from country to country. For example, in France less than 5% of motorcyclists are female, whereas in Germany the proportion is slowly increasing and is now almost 15%. For mopeds, the proportions of female riders seem to be slightly higher than for motorcycles.

- ✓ There is a trend towards more powerful engines for motorcycles, but street, touring and custom models seem to be more popular than sports models. Recently the use of 125cc motorcycles has become more popular with older riders in Germany and France, after a change in legislation.
- ✓ Little is know about the actual use of mopeds/motorcycles, i.e. their kilometrage, kind of trips, types of road etc. For some of the Midwest European countries, the average number of kilometres per year are estimated at 2000-3000 per moped and 5000-6000 per motorcycle. Motorcycles are mostly used for recreational trips, but the proportion of riders who use their motorcycle daily is nevertheless close to 50%. Daily use of mopeds is probably higher than for motorcycles.
- ✓ Use factors: Climate is an important factor in the use of mopeds/motorcycles, with not only more vehicles but also more kilometres per vehicle per year in Southern European countries; Other factors that are likely to influence the number and use of mopeds/motorcycles are the direct costs involved (of the vehicle, taxes and insurance) as well as legislation (such as minimum rider age, training and licensing requirements, and special traffic rules) and the range of models on the market.
- ✓ Motivations: Owning and using a moped/motorcycle also has a strong emotional value. Being in control of the vehicle with the whole body, directly sensing the speed, testing the limits of safe riding, competing with other road users, being different from the majority of road users, may all be important motives for certain groups of riders. Others may enjoy being in the open air away from everyday life. With increasing numbers of cars on the road and the congestion problems as a result of this, the use of a moped/motorcycle can also be more practical, saving time and money as compared to using a car
- ✓ The population of motorcyclists has changed over the years and most riders are now over 25 years of age and their number is still increasing. Apart from Southern European countries, there are more motorcycle fatalities over 25 years than under 25 years. Because of the low minimum age, moped riders are younger than motorcyclists, but even the number of moped fatalities is about the same for both young and old riders. As far as their behaviour is concerned, riders with a dangerous riding style are a minority among all riders.

- **SARTRE 4**
    - o More men than women and more younger than older people ride a motorcycle. High proportion of scooter riders is more typical in mediterranean countries, high proportions of conventional street machines in northern countries. In mediterranean countries smaller engine size up to 250cc will be found; in northern countries higher engine size above 750cc is used. Nearly daily use of motorcycle most frequently occurs in southern countries than in northern countries. There are large differences between the countries concerning education of motorcyclists; Male riders rode their motorcycles more frequently than female riders and male riders; Most women riders operate in Southern countries and in builtup environment.
    - o ***Motivation for riding***: The present analysis shows clear differences between (groups of) countries regarding (groups of) motives to drive a motorcycle:

- Constraints like having no other means of transport or no car only concern a limited number of motorcyclists (respectively 22% and 32%). The remaining items are important for about 60% of the motorcyclists (from 48% to 69%). These concern motorcycling advantages for mobility (saving time, avoid traffic jam, limit CO2 emission and saving money) and biking feeling and spirit (acceleration and speed and biker spirit); On average, motorcycling advantages for mobility are important for about 85% of the Meditaranean group, but only for generally less than 50% of the Northern European group. This is very well illustrated by the importance of saving time, which is a key-motivation for more than 90% of Greek, Israeli, Spanish and Cypriot motorcyclists (and for 74% of Italians), but only concerns less than 25% of Finnish, Swedish, German and Slovenian riders; Similar results are obtained for *easiness to park, avoiding traffi c jams,* or *travelling cost* and *CO2 reduction;*
- The same grouping of countries is observed regarding the constraint items, but for this factor Estonia belongs to the Northern European group, whereas Irish and Serbian motorcyclists (and in this not case Italy) belong to the Mediterranean group. Indeed, *lack of car* is a motive for more than 30% of the Israeli, Greek, Irish and Serbian riders, but only concerns less than 12% of motorcyclists in Finland, Germany, Slovenia, Sweden, Belgium and Estonia. Similarly, motorcycling is assessed as the *only possible means of travel* by more than 35% of Greek, Israeli, Cypriot, Spanish, Irish and Serbian riders, but concerns less than 6% of motorcyclists from Slovenia, Sweden, Germany and Finland.
- The opposition between Mediterranean and Northern European countries is less contrasted with regard to biking spirit. The dichotomy is still globally valid for pleasure and freedom, even if these two motives are important for more than 75% of all European riders, except for Serbia (69%). Regarding biking spirit and enjoyment of speed, both groups are partially mixed.

Table 3: Hierarchy of European motorcyclists' motives for using a motorbike.

Level of importance	Motives for Driving a Motorbike: Type of Motive (item number)	Percentage of very and fairly answers
Highest	Pleasure (24b)	92 %
Highest	Freedom (24k)	87 %
Highest	Parking (24c)	82 %
Medium	Biker Spirit (24f)	69 %
Medium	Cheaper (24d)	66 %
Medium	Saving time (24a)	63 %
Medium	Avoid Traffic Jam (24j)	63 %
Medium	Acceleration and Speed (24g)	62 %
Medium	CO2 Pollution Reduction (24e)	48 %
Lowest	No Car (24h)	32 %
Lowest	No Choice (24i)	22 %

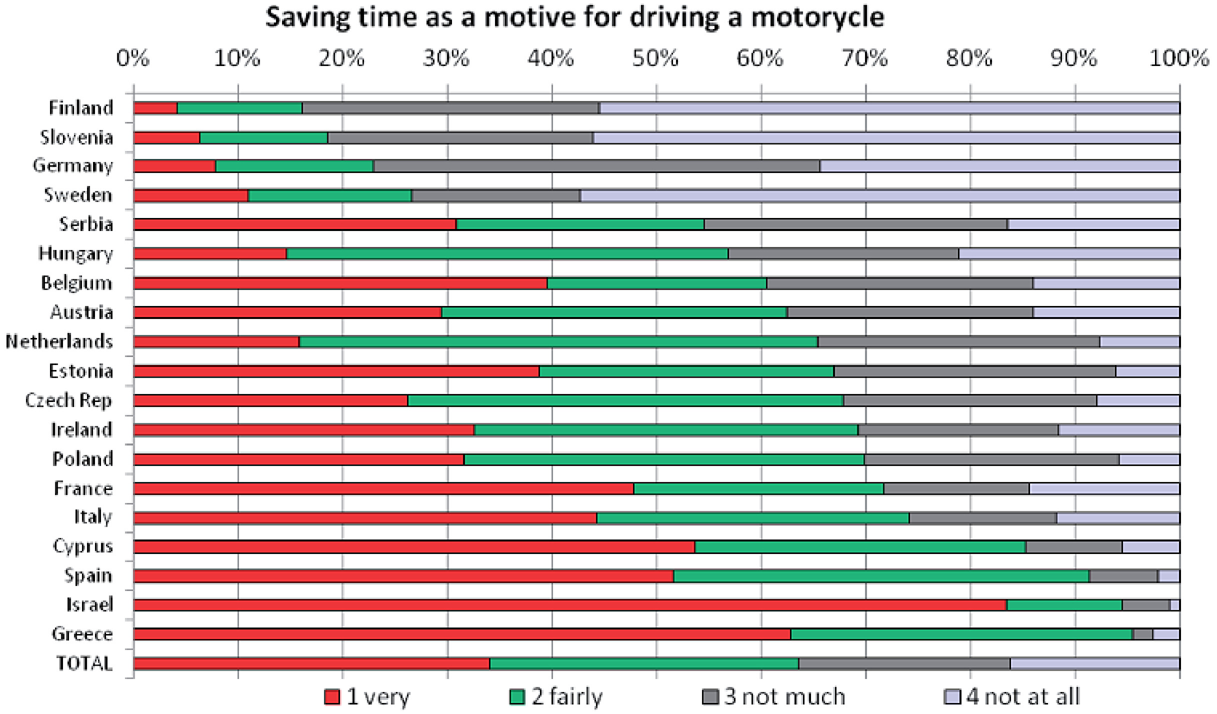


Figure 9: Inter country differences for saving time motive.

- *Accident statistics*

Figure 3: Participating countries separated into northern and southern European countries.

- *Motorcyclists Profiles*:

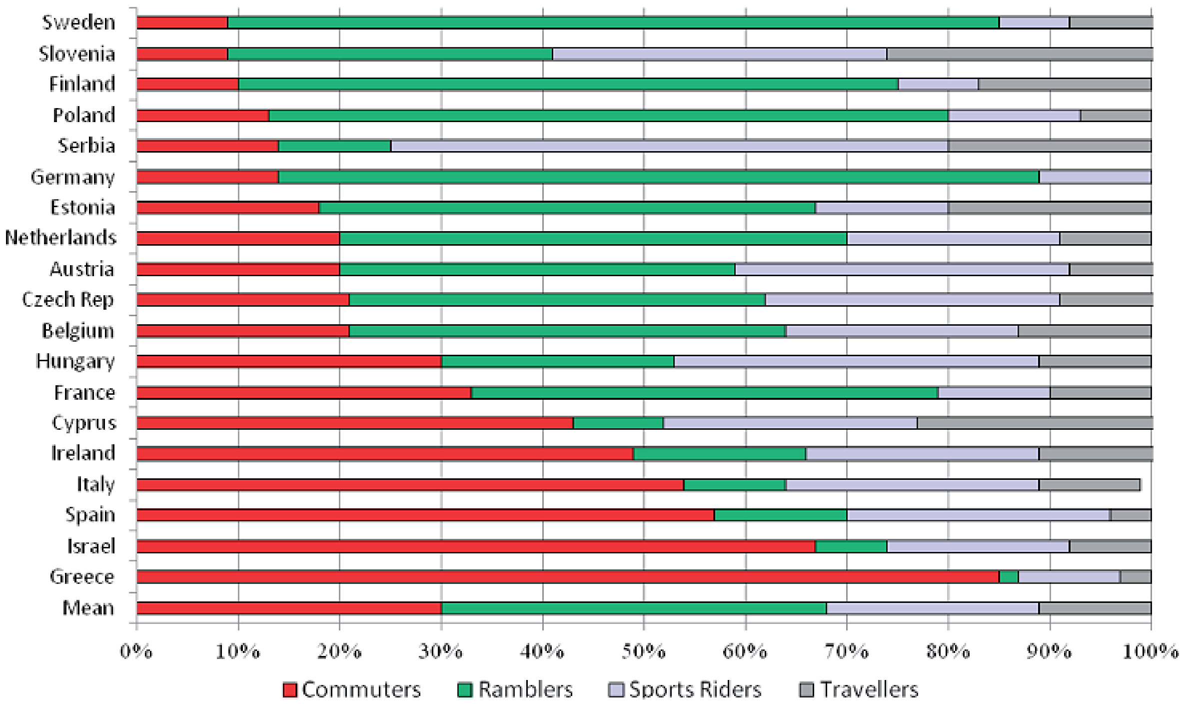
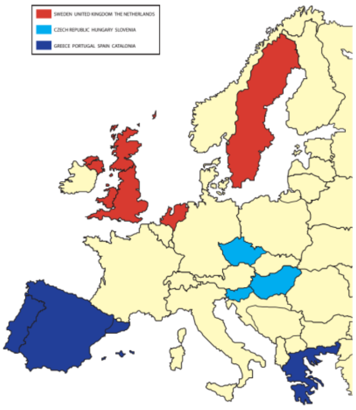


Figure 1: Percentages of each profile per country.

- **SUNFLOWER (2005) – Final report**
  - In the Netherlands, the moped fatality proportion and mortality rate are much higher than in Sweden and the UK. In all three SUN countries fatalities among the 15-19 age group

contribute a disproportionate amount of all moped fatalities. 15-17 year olds contribute a large share of the moped kilometres in both Sweden and the Netherlands. Dutch fatality rates per moped km are 1.6 times higher than the Swedish and 2 times higher than the British. In the 15-17 age group, Dutch fatality rates are 4 times higher than Swedish rates.



- The low general traffic rates in Sweden, compared with Britain and the Netherlands, and the low level of moped use during the winter may partly explain why this relatively easy younger access to mopeds does not produce the higher risk seen in the Netherlands.
- The general improvement in safety trends in the Netherlands over the last decade has not been mirrored by similar improvements in moped risk; the combination of vehicle and user characteristics and the lack of a dedicated infrastructure, as has been provided for cyclists, has hindered progress for this user group.
- Britain has fewer motorcycles per head of the population, or motorcycles as a proportion of traffic flow per year, and has the highest number of kilometres travelled per motorcycle. Britain has a fatality rate per motorcycle kilometre which is 50% higher than that in the Netherlands and doubles that in Sweden. The high fatality rate among younger motorcyclists may be a factor in these differences, as this group potentially comprise a lower proportion of motorcyclists in the Netherlands due to high moped use.
- motorcyclist fatality rate for 25-49 year olds in Britain and the Netherlands is also substantially higher than that in Sweden. These age groups are more likely to be using larger motorbikes. The involvement of older motorcyclists on larger motorbikes is highest in Britain, although there is evidence that this group is also rising in Sweden and the Netherlands. The reason why this group should have such a low fatality rate in Sweden is not clear but it may be associated with the relatively sparser road network and lower traffic volume
  - *RIDERSCAN comment: explanation should be sought into the high membership rate to SMC, the Swedish motorcyclists Association, and SMC's safety activities.*
- The scope of the powered two-wheeler safety problem in Central countries ismarginal in comparison with Southern countries, as their share among all road fatalities is significantly lower in all three Central countries.

- The number of motorcycles in Southern countries is increasing, particularly in Greece and Portugal. Catalonia has a notably high stock of motorcycles (in 2003, almost a third of the Spanish total, almost half the stock of Greece). Motorcycle fatalities per capita show improvements for both Greece and Portugal;
- There are proportionately more young motorcyclists killed in Greece (half are aged 20-29) than in Spain (highest age group being 30-39) and Catalonia (highest age group is 40-49). Portugal appears to have a particular problem with motorcyclist fatalities driving off the road, especially on rural roads
- The number of mopeds is increasing in Spain and Catalonia, and is decreasing in Portugal, but recent data for Greece is not available. The trend in fatality rates per capita for mopeds shows great improvement for all counties but especially for Portugal
- To summarize: powered two-wheelers run a relatively high risk, especially when young riders are involved. In most SUNflower+6 countries motorcyclists are the dominant factor here, in some other countries mopeds are also important. More powered two-wheelers on the road, so more exposure to risk, are the main driving force behind this growing problem. Improving helmet wearing is the simplest contribution to the powered two-wheeled vehicle problem. But also attempts should be made to enable powered two-wheelers to share road space better with other transport modes. Finally, more discipline is needed for those who violate legislation and police enforcement is instrumental in achieving this.
    - *RIDERSCAN comment: This is a perfect example of the lack of understanding some researchers have when addressing PTW safety, and the biased approaches they bring to project conclusions as none of the findings above focuses on law violation and police enforcement; similarly concluding focus on risk exposure is contra productive and useless when identifying solutions is the work objective. Motorcycle safety is complex enough to address for project to conclude with such biased statements.*