



FERSI
Road Safety Research

Towards safer roads in Europe

Nine key challenges for road safety research for the next decade

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The importance of road safety research for European society

Over the last two decades Europe has made great progress in improving road safety. Within the EU the number of fatalities decreased from 54,000 in 2001 to 28,000 in 2012. This is a remarkable success, taking into account the EU enlargement and the increase in private and commercial road transport.

However, this encouraging result falls considerably short of the European targets initially set. Even more worrying is that the reduction in fatalities has become marginal in the last years. For instance, in 2011 the EU countries managed to reduce the number of fatalities by only 700 compared to 2010. The severity of crashes decreased more than the risk of the personal injury crashes. In several European countries even an increase was witnessed in the number of seriously injured, in particular amongst the vulnerable road users.

Thus, the price for road mobility in human and economic terms remains very high. The costs and implications of deaths, injuries and property damage resulting from road crashes are still unacceptably high in the EU. And without appropriate action, this situation will not fundamentally change in the next decade.

In order to redress this situation, it is important to understand the looming challenges and to identify important gaps in road safety knowledge and research methods. The scientific community in Europe has an important responsibility in undertaking adequate research in the relation to these challenges and formulate practical recommendations for policy makers.

FERSI, the Forum of European Road Safety Research Institutes, is a European association of research institutions that are mandated by their governments to conduct road safety research and support road safety policy makers. An ambition of FERSI is to improve European road safety by offering evidence based policy advice derived from empirical research, developing practical recommendations on policy implementation and evaluating implementation results.

Therefore, FERSI has identified 9 key challenges and related research questions that are important to address, if Europe wants to succeed in its ambition to improve road safety and reduce significantly the number of crash victims. These challenges are the following:

- Ageing society
- Vulnerable road users
- Cultural diversity
- Vehicle automation and ITS
- The burden of injuries
- Safe road design
- Educating & training road users
- Behavioural change
- Road safety management

These challenges are briefly outlined in this document. They are based on extensive review and discussion amongst road safety experts at both national and European level. Account was taken of foreseeable evolutions in road safety conditioning factors such as infrastructure, vehicles, behaviour of different road user groups and traffic management and organization. Criteria for identifying research priorities included the extent of the road safety issue at stake, the possible benefits resulting from addressing the challenges and the methodological, technical and financial feasibility of undertaking research in relation to the challenge.

Nine challenges for road safety research for the next decade

(1) Ageing society

Europe's population is ageing at an increasing pace. By 2030, every third driver will be older than 60. Sustainable safe mobility is an extremely important factor for the independence and the quality of life at a higher age. In addition to human and social advantages for the elderly themselves, retaining mobility of the elderly has also economic advantages for the society as a whole.

When people grow older, they may lose some of their cognitive, motoric and other skills that are important for safe driving and for participating in the traffic. This deterioration of skills varies enormously across the elderly. The central challenge is to find ways to keep as many elderly mobile as safely as possible. This requires evidence-based thresholds for deciding whether someone is still capable of driving or not, as well as developing tools, technologies and training approaches that will allow older people to stay mobile longer.

Research questions to be addressed include:

- *What are reliable and effective methods for assessing whether older people are still capable of driving safely (all transport modes)?*
- *How could evidence-based, cost-effective, gradual screening systems be set up for assessing the driving ability and fitness to drive of the ageing population?*
- *How to define thresholds for relevant performance parameters?*
- *How to calculate societal costs and benefits of an age based screening?*
- *How is road safety for the elderly likely to evolve, if current policies and measures would be maintained?*
- *What are effective types of training and support (for different types of older people) in order to improve safety and retain mobility?*
- *How to provide personalized advice for each driver according to age, gender, financial resources, living area, cognitive abilities, self-awareness and social and cultural factors?*
- *What types of vehicle technology and automation will allow older people to maintain safe mobility for a longer time?*
- *How should silver-proof cars be designed and tested (elderly test-subjects, crash test dummies modelled on elderly)?*
- *What are prerequisites for safe and comfortable walking for the elderly (including rolator/ wheelchair/ mobility scooter accessibility)?*
- *What are the most frequent causes and implications of crashes with elderly pedestrians and cyclists?*
- *Does the use of e-bikes lead to higher road crash risks for the elderly than the use of normal bikes?*
- *How will the use of powered two-wheelers evolve with age and what will be the likely implications for road safety?*
- *How to prevent crashes that are specific for elderly (neglect of priority, left turns, etc.) or that particularly harm elderly (as pedestrians)?*
- *How to design elderly friendly interfaces for advanced driver assistance systems (ADAS) (testing with elderly subjects, reduction of distraction, easiness to learn)?*
- *How can dangerous road crossings be identified and their visibility improved for elderly road users?*
- *How to balance safety and accessibility for pedestrian crossings (e.g. bridges and tunnels)?*
- *How to improve the rescuing system taking into account peculiarities of the elderly?*

(2) Vulnerable road users

Every day, very large numbers of vulnerable people use the European roads: pedestrians, cyclists, motorcyclists, children, elderly, disabled... Spurred by requirements for increased mobility as well as health and environmental considerations, the use of certain modes of transport like cycling, is increasingly supported by public policies.

But this comes at a high price. The relative share – and sometimes the absolute number – of vulnerable road users amongst crash victims is increasing. In most European countries, the (large) majority of injured people in hospitals are vulnerable road users. Over the last decades, very little progress has been made in terms of fatality and injury reduction of vulnerable road users, compared to motor vehicles occupants. There are several indications that without appropriate action, the situation will deteriorate further in the future.

Research questions to be addressed include:

- *How to overcome the trade-off between reducing road crash risks and the promotion of sustainable mobility and health benefits through walking and cycling?*
- *How to assure greater focus on vulnerable road users within road safety management systems?*
- *What are appropriate in-depth methods to study crashes with and between vulnerable road users?*
- *What are the specific safety issues of alternatively powered vehicles for vulnerable road users?*
- *What road safety issues are coming with the raise in the use of e-bikes?*
- *What measures can be taken when there is hardly space for sufficient pedestrian and cycle infrastructure?*
- *To what extent could bike-to-car or pedestrian-to-car communication help in improving road safety?*
- *How to provide evidence and implement effective approaches for increasing helmet use by cyclists?*
- *How can the visibility of vulnerable road users be improved?*
- *How can the exposure and mobility patterns of different road user groups be measured adequately to form a basis for determination and comparison of the crash/injury/fatality risks for the different groups?*
- *How to predict changes in the numbers and exposure of vulnerable road users?*
- *What automation technologies and systems are needed to improve the safety of vulnerable road users?*
- *To what extent the demographic shift towards an elderly population in some European countries will influence the road safety of vulnerable road users?*
- *How to quantify the specific risk related to the change from driver role to pedestrian/cyclist role?*
- *How to improve vulnerable road users' competences and knowledge of road traffic rules?*
- *What regulations could be introduced to mitigate pedestrian injury risk and exposure risk?*
- *What are the appropriated tools and model to support pedestrian safety evaluation?*
- *As risk exposure is quite different according to gender, age effects or social inequalities, how to take into account such variability in the whole safety chain (from trauma understanding with human models to final safety system design)?*
- *Which accessibility level would be optimal for people with disabilities?*
- *What are the impacts of ICT measures on safety of vulnerable road users?*

(3) Cultural diversity

The cultural diversity among and within European countries is one of Europe's richnesses. But this diversity presents an enormous challenge as well. At present the probability to become a victim in a road crash is considerably different among countries and different social-cultural groups. This is ethically unacceptable. A more homogeneous performance in terms of road safety is strongly desirable.

This is easier said than done. For instance, best practices in relation to one region or group cannot be easily transferred to another. Without appropriate understanding of differences in values, attitudes and behaviour, policies and measures are likely to be ineffective and possibly even counterproductive. Studies on cultural aspects of road safety should therefore be a priority within the domain of behaviour research.

Research questions to be addressed include:

- *How to improve the quality of the indicators used to compare the performance of countries and regions in the field of road safety?*
- *Which dimensions of road safety management are influenced by cultural factors?*
- *How can adequate data collection be established with relation to culture-specific research?*
- *To what extent are differences in country / regional performance or among particular road user groups attributable to cultural factors (as opposed to technological or economic factors)?*
- *What are differences in attitudes towards mobility and road safety depending on social situation and cultural background?*
- *What are elements of regional or national cultures that lead to different road behaviour and hence to differences in road safety performance?*
- *How can increasing automation reduce the road safety gap between prosperous people and those who are not?*
- *How do road crash risk factors evolve through different life stages and modifications in social environments?*
- *How to accommodate for cultural differences when transferring expertise on road safety to other (incl. emerging) economies?*
- *How to assure an access to safe mobility for most socially disadvantaged people?*

(4) Vehicle automation and Intelligent Transport Systems (ITS)

Over the last decades car manufacturers have made significant progress in developing safer vehicles that protect drivers and passengers when crashes occur. A protection of other collision parties (e.g. pedestrians) has become an important topic, too. More recently, new features like automatic emergency braking have been introduced, aiming at reducing crash risks and taking over the role of the driver for a short moment beyond the drivers' ability to react appropriately. It is expected that continuous automation, permanently carrying out the normal driving tasks for a longer time span, will gradually become common on all cars and that in some cases the car might even take full control over the driving.

These developments will entail both opportunities and threats in relation to road safety.

Research questions to be addressed include:

- *Will human drivers interact appropriately with the increasing degrees of automation in future? How can driver's attention in case of continuous automation be ensured and what is needed for safe transitions from 'automated' to 'driver only' mode and vice versa?*
- *What potential does vehicle automation have for safe driving by particular target groups (the elderly, young drivers, offenders, people with impairments, etc.)?*
- *Will automated safety features in vehicles lead to careless driving behaviour and ultimately reduce road safety (risk homeostasis effect)? What driver monitoring technologies are needed in this respect?*
- *Which types of driver assistance systems have most impact on road safety?*
- *How can new HMI / HVI (Human Machine/Vehicle Interface) designs lead to increased road safety?*
- *What are the effects of automated vehicles and cooperative systems on other road users (including non-equipped vehicles)?*
- *What standards of performance are needed before an automated vehicle system is considered safe? How will this be certified? How will this be ensured over the vehicle life?*
- *Which testing procedures will have to be developed for automated driving?*
- *Which changes are needed with regard to the legal framework and standardisation mechanisms?*
- *How can the massive data from automated road vehicles be accessed and combined to improve transport efficiency and road safety?*
- *What will be the implications of highly automated vehicles on driving education and licensing requirements?*
- *How do cooperative ITS-systems (including road infrastructure) influence the road safety?*
- *How to link ITS with vehicles with different levels of automation?*
- *What is the degree of acceptance of particular technologies (of which there is evidence for improving road safety, e.g. alcolocks) by the general public and how could the acceptability be raised?*
- *How to assess the cost-benefit ratio of further automation for road safety?*
- *How should the liability be identified in case of crashes with semi- or fully automated vehicles?*
- *How will vehicle automation affect insurance mechanisms?*
- *Are there other aspects that concern society? E. g. would society accept possible crash risks due to automation or accept that there are dilemmas with regard to decision processes of automated systems?*

(5) The burden of injuries

About 1.5 million people are injured every year on European roads. One sixth of these injuries are estimated to be serious, often implying long periods of recovery, professional inactivity and lifelong handicaps. The number of people injured on roads between 2001 and 2011 decreased less (all injuries: -26%; serious injuries: -36%) than the number of road fatalities (-43%).

So far little is known at European level about the nature, distribution and implications of injuries. The definition of "seriously injured" varies across countries with the result that country comparisons are barely possible and the magnitude of the problem cannot be fully understood and therefore not adequately addressed. The numbers of crashes and injuries recorded in official statistics are mostly based on police reports. The true number of people injured in road crashes is unknown, but evidence in several countries suggests that it is at least twice as high as the officially recorded one.

In addition, little information is available about the medical, economic, social and psychological implications and costs of injuries. The Commission's request to EU Member States to start reporting from 2015 onwards on injuries based on hospital data and using the MAIS score, presents considerable challenges to most EU Member States. Yet, gathering these indicators is only the first step required to gain insight in the implications of injuries and subsequently to use this information to adapt road safety policies.

Research questions to be addressed include:

- *What factors have caused the slower decrease in accidents with injuries compared to accidents with fatalities?*
- *How can the level of underreporting of slight and serious injuries be assessed?*
- *How can the linking of data on injuries from hospital, police and other databases be improved and which best practices currently exist across the EU?*
- *How can methods for MAIS (re-)coding be harmonised in order to arrive at comparable values for all Member States?*
- *What are – in addition to the MAIS score – the most appropriate classifications and categorisations of injuries and their consequences in view of gaining insights for policy advice?*
- *What relationships exist between road accident types, road user behaviour, vehicle types and injuries types?*
- *How can data on injuries be used for biomechanical injury modelling?*
- *What are suitable methods for calculating different types of costs and human implications of serious injuries?*
- *What are the psychological implications of crashes (on victims, their family, those responsible for the crash, etc.)?*
- *What are profession and income relevant consequences of road crashes for victims?*
- *What are the economic costs for employers of crashes involving their employees?*
- *To what extent will safety technologies (e.g. eCall) actually reduce (or increase) response time of the rescue services and the consequences of crashes?*
- *How can the results of in-depth crash research be linked to long-term tracking of the recovery process?*
- *What is the effectiveness and performance of emergency services following crashes?*
- *How to promote optimized trauma management?*
- *What are the consequences and full costs for hospital and paramedic services?*
- *How to promote costs-benefits evaluation procedures to evaluate the added value of safety devices or technologies with regard to injury impact mitigation?*

(6) Safe road design

Undoubtedly, over the last decades the quality of the European road infrastructure has been steadily improving. Overall, roads have become safer for road users. But in many cases, poor road design or maintenance are still major causal factors in crashes, both in rural areas (car occupants) as in cities (vulnerable road users). Further improvement of the road infrastructure in view of road safety is increasingly constrained by restrictions on funding and by space constraints.

Yet, further improvements in terms of road safety are necessary, because of both the increasing mobility as well as the growing presence of vulnerable road users on European (urban) roads. There is a need to move from a car oriented infrastructure towards an infrastructure that serves all road users.

Research questions to be addressed include:

- *How do conduct efficiently safety assessments of the existing road infrastructure?*
- *What education and training approaches are needed to implement all tools of the Infrastructure Safety Directive (such as RSIA, RSA, RSI)?*
- *What are optimal design approaches for self-explaining and forgiving roads?*
- *How to design roads for safe automated traffic and cooperative driving systems?*
- *To what extent should the road infrastructure be adapted to e-mobiles and vehicles using other novel propulsion technologies?*
- *What is the road safety impact of infrastructural modifications and speed limits, particularly those aimed at increasing safety for vulnerable road users and safety on rural roads?*
- *What are best practices for conducting pre- and post-assessments of infrastructure modifications on road safety?*
- *How to integrate "ideal models" of infrastructure into existing structures with space restrictions?*
- *What measures should be implemented to assure barrier-free mobility?*
- *What are the safety impacts and barriers of the shared space concept – and what are the safety implications of alternative approaches such as encounter zones?*
- *What are optimal parameters for numbers, size, distance, content and place of road signs for particular types of roads, in order to avoid distraction or confusion?*
- *What is the impact of dynamic warning signs on road safety behaviour?*
- *What is the impact of longer and heavier vehicles on road infrastructure and road safety?*
- *How can real time road status monitoring be used for improving road safety?*

(7) Educating & training road users

The majority of crashes can be attributed to inappropriate behaviour and insufficient driving skills. Hence, it is important to prepare, educate and train all road users so that they are able and motivated to act in a responsible way in traffic. This is not just a question of educating young people, but also of training or retraining particular target groups such as offenders, professional drivers, motorcyclists, the elderly etc.

It should be recognised that formal education and training alone is not sufficient. Significant contributions to safe driving arise from (a) extended driving experience acquired through informal practical learning in real traffic, and (b) reducing crash risks in the informal learning phase by introducing appropriate restrictions/protective rules for novice drivers. It is thus also important to implement adequate restrictions to reduce risk.

Research questions to be addressed include:

- *What are the specific education and training needs of different road users and groups?*
- *What are cost-effective means of (re)training large groups of road users (e-learning, simulator, distance learning, etc.)?*
- *How can the impact of education and training on road safety be measured?*
- *How can road safety be given more attention within driving education?*
- *What is the impact of different forms of driving education and (re)training on road safety?*
- *What are the best didactical approaches in driving education and training for particular groups (such as returning motorcycle riders)? How can they be transferred between different contexts (i.e. countries)?*
- *How does road safety education have to be adapted to ensure the maximum effect in view of the changing mobility of children?*
- *What are current best practices in the area of driving education and training?*
- *How can safety education be successfully integrated with related initiatives, such as those on school safety, workplace safety and mobility management?*
- *How to implement progressive acquisition of competences for the whole lifetime of an individual?*
- *What are efficient post-licencing measures – in the first year(s) of solo driving?*
- *What are the most suitable approaches for the rehabilitation of offenders?*
- *Are "serious games" and simulator training valid approaches for educating (young) people for safe road behaviour?*
- *How do road user education, training and campaigns have to be adapted to ensure optimal results for different social-cultural groups?*
- *How can modern technologies be used to strengthen and further improve road safety education of different road users and groups?*

(8) Behavioural change

If all road users would demonstrate appropriate and responsible behaviour on the road, the number of fatal and serious crashes would be reduced significantly. Inappropriate behavioural patterns, e.g. drink driving, speeding, distracted driving or incorrect seatbelt use, are still the main causes of crashes and injuries. Measurements in many European countries have moreover shown that over the last decade, inappropriate behaviour of road users has hardly improved.

Adequate education and training is a necessary but not a sufficient prerequisite to achieve the desired sustainable change in behaviour. Several other mechanisms are also needed, such as risk communication (e.g. campaigns) and an effective and efficient regulation enforcement system, including cross-border enforcement.

The real return on investment in measures aimed at behavioural change is however difficult to grasp. Moreover, it is still unclear which mechanisms are most suited and most cost-effective in order to achieve behavioural change of particular target groups.

Research questions to be addressed include:

- *Do we need an improved theoretical basis to initiate behavioural change ? What driver behaviour (explanation) models should be developed for a better underpinning of policy measures and interventions?*
- *How can key human factors such as attitudes and expectations be shaped towards improved safety in a sustainable way?*
- *What methodological approaches are most suitable for behavioural measurements (both on the road and within simulators), including naturalistic driving studies (ND) and field operational tests (FOTs)?*
- *How could road users be integrated as an active, motivated, consciously interacting and decision making part of the road traffic system?*
- *What is the relative success (return on investment) of different types of measures (enforcement, incentives, training, campaigning, etc.) for influencing road users behaviour? How does this relationship vary across different target groups and different forms of inappropriate road behaviour (speeding, driving under influence, etc.)?*
- *Are existing attitude-scales sensitive enough to assess attitude change?*
- *How to model and analyse the interaction between motor vehicle drivers, pedestrian and cyclists?*
- *How can social media and other instruments based on modern communication technologies be used to influence the behaviour of particular road users groups?*
- *What are useful segmentations (beyond gender, age, region) of drivers and other road users that have different risk challenges? How can such segmentations be used for setting up effective communication strategies?*
- *How can the general public be convinced that even small deviations from regulations (e.g. slightly exceeding a speed limit) will lead to an increase of the number and severity of crashes?*
- *To what extent have «black boxes» for driving monitoring have a preventive effect on road behaviour?*
- *How to use modern ITS to improve enforcement in relation to different types of infractions?*
- *How can both the actual probability and the perceived chance of being caught in the act be increased without raising costs?*
- *Under what conditions is "awarding enforcement" better suited than punishing enforcement?*
- *What types of penalisations or alternative punishments are most effective in particular circumstances and/or for particular target groups?*
- *What are effective enforcement methods for motorcyclists and cyclists?*
- *How can cross-border enforcement be made more effective and efficient?*

- *Can automation of enforcement be applied to other traffic safety regulation and be generalized?*
- *What is the potential of new methods in rehabilitating DUI offenders, such as motivational interviews?*
- *How to sensitize the general population to age-related changes to improve road sharing?*

(9) Road safety management

"Road safety management" refers to the strategic pillars of road safety actions and how these are interrelated. Key components of road safety management are: scientific support & capacity building; institutional organisation and stakeholder involvement; policy formulation and adoption; policy implementation; and monitoring and evaluation. Essential requirements for successful road safety management are a holistic view on road safety and an evidence-based approach.

Effective road safety management systems are required at local, regional, national and (for some issues) on international level. Measures aimed at improving road safety in European countries will bring the intended results only if they are part of an integrated, evidence-based approach. Although key components of such road safety management systems exist in many European countries, fully integrated road safety management systems do rarely exist.

High quality road safety indicators are indispensable in this regard. The reality is that such indicators are often lacking and where they exist they are often not comparable at international level.

Research questions to be addressed include:

- *What are the priority research topics in order to improve road safety management? What should be the components of research programmes at international level in this regard?*
- *How can policy advice become more effective?*
- *How can policy-makers be supported in designing integrated road safety management systems?*
- *To what extent are current road safety management systems evidence-based? Is high quality data available and to what extent is such data actually used by policy- and decision-makers?*
- *How should policy objectives for road safety management be formulated at national and international level?*
- *What should be the potential impact and implications of adopting a "safe systems" approach?*
- *How to ensure appropriate evaluation of road safety measures?*
- *How should road safety management systems be assessed, evaluated and compared among countries? What type of information and indicators should be available?*
- *What are good practices in setting up and maintaining successful road safety management systems?*
- *How road safety management could be assessed at sub-national level? What measures could be set up to ensure coherence between policies at European, national and sub-national level?*

Implications and the next steps

Addressing the road safety challenges identified by FERSI will be a prerequisite for maintaining and improving road safety over the next decade. The research questions identified are complex and will require considerable investment both at national and European level. They will also require more investment in new methodologies, often involving huge amounts of data.

FERSI strongly urges the European Commission and authorities and interest groups at all levels of society to incorporate these challenges in their research agenda and to ensure that sufficient funding is available to address the questions. In turn, the research community is prepared to make sure that the research undertaken in this area will lead to better insight and practical policy recommendations for improving road safety.

Without these joint efforts of authorities, interest groups and researchers, it is unlikely that Europe will be capable of improving road safety and reducing the human and economic costs of crashes.

Annex: About FERSI

The Forum of European Road Safety Research Institutes (FERSI) is a non-for-profit association, governed by the provisions of the Title III of the Belgian Law of 27 June 1921 on non-profit associations, international non-profit associations and foundations. The Association acts as a flexible network of European road safety research institutions.

FERSI unites partners from 21 European countries who have a mandate of their governments to implement a pre-normative road safety research. That means that FERSI participants develop road safety solutions to be translated in legislation and norms, offer consulting to national and European road safety authorities while implementing these solutions and evaluate effects of implementation.

FERSI is open for cooperation with any road safety research institute or organisation, both in exchanging research knowledge and in seeking opportunities for collaborative research. Road safety research entities from outside Europe could join FERSI as associated partners.

FERSI acts on behalf of its partners as their representative vis-à-vis the European Commission, European Parliament, European Council while promoting road safety research agenda and research results and acquiring funding for research projects.

FERSI represents its partners and their reconciled opinion in the dialogue with other international organizations contributing to the road safety improvement, e.g. OECD, UN, professional unions and branch associations.

The association supports its partners in disseminating the knowledge generated by them and is actively involved in knowledge and information exchange.

FERSI mission and objectives

The primary *mission* of the Association is:

To promote or coordinate high quality research on road safety issues, consult on implementation of research results and scientifically evaluate implementation outcomes.

The *objective* of the Association is to contribute to road safety research and enhance the road safety by ensuring that the relevant problems are addressed by best available experts and that solutions recommended by researchers are implemented in the most effective way.

In particular, it may engage in the following (not exclusively) activities:

- enhancing the scientific quality of road safety research ;
- proposing road safety topics for EU and national Research Agendas;
- developing road safety research recommendations and proposing them to competent national and European authorities;
- organizing seminars and meetings on road safety issues;
- participating in road safety research work conducted by EU or other international organizations;
- encouraging the international exchange of researchers;
- awarding prizes or scholarships financed by its resources to road safety researchers .