Priorities for Road Safety Research in Europe

Support Action

Grant Agreement Number 314427

Final Report

Confidentiality level: Public

Status: Final

Summary

About 120 experts from more than 40 stakeholder organisations have contributed to the development of a comprehensive European road safety research roadmap within the two years of running time of the PROS support action. This roadmap is presented in this final report (cf. Fig. 6 and Fig. 7) together with the contents of the eleven prioritised research topics contained therein (cf. annex).

Moreover, this report gives an insight into the background of the project, its specific objectives, its structure and the basic principles followed: covering road safety as a whole, maximising involvement, focusing on priorities, creating transparency and basing important decisions on remote interaction between experts. Following these principles was facilitated by a clearly defined process for setting research priorities, which was developed by the project as a key deliverable and can be applied, with minor adaptations, to other fields of transport research, as well.

According to this process, a comprehensive information base for the development of road safety research priorities was put together by the PROS project, which contains information on relevant societal trends and scenarios, existing road safety research agendas and roadmaps as well as current research activities in this field. About 30 research agendas and roadmaps and more than 100 projects were analysed in the preparation of this information base, which can be made use of by future initiatives in road safety research programming, too. The process for the prioritisation of research topics in a multi-stakeholder group and the related information base are also described in this report.

From the road safety research roadmap developed by PROS, key recommendations for the upcoming Transport Work Programmes in Horizon 2020 can be derived:

For the Transport Work Programme 2016, PROS recommends to include the following topics as important elements of road safety, behavioural and infrastructure-related research:

- Behaviour in traffic – Making us safer road users
- Technological leadership in safe future vehicles – Improving protection in crashes
- Safe roads design – Making them self-explaining and forgiving to the benefit of all road users

For 2017, the following road safety and ITS-related topics are recommended:

- Improving protection in crashes – Counteracting our fragility
- Technological leadership in safe future vehicles – From assisted to automated driving
- Innovation in ITS infrastructure for road safety – Making use of the connected world

These recommendations are based on the assumption, that the main road safety research needs covered by the Transport Work Programme 2014 will finally be addressed by funded projects. Otherwise, the topic “Vehicle technology for two-wheeler safety” and research on “Traffic safety analysis & assessment” should be considered for inclusion in 2016/2017, too.

In order to disseminate the basic project concept, the recommendations above as well as further results, more than 20 presentations on the PROS project and its outcomes have been given at conferences and stakeholder meetings since the project start.

All in all, the PROS project has been the first initiative in which a process for the definition of research priorities with this degree of transparency has been established in a European multi-stakeholder network covering road safety research as a whole. Following the analysis of different options for continuation, PROS activities are now carried on under the umbrella of the ERTRAC Working Group Road Transport Safety & Security with the ambition of integrating the basic principles of PROS in the ERTRAC approach and building on the PROS results.

Document Name

PROS-150109-WP5-REP-V01-FINAL-final_report

Version Chart

Version	Date	Comment
0.1	2015-01-09	Final version

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1 Introduction

Europe has made great advances in road safety over the last decades, but with 28,126 fatalities in 2012 [1], the EU is still far away from the long-term objective of Vision Zero as adopted by the European Commission and by important European stakeholder organisations [2], [3], [4], [5]. In a global perspective, this vision of a road transport system in which nobody is killed or severely injured anymore is even more challenging, as worldwide road safety statistics are alarming: There is no indication of a downward trend in the global number of road fatalities, but estimations suggest that road traffic accidents might become the fifth leading cause of death by 2030 [6]. In absolute figures, the World Health Organisation estimates that about 1.24 million people lose their lives on the world's roads per year. (As a comparison, the ten-years average in the number of fatalities from natural catastrophes worldwide is about 106,000 according to insurance statistics [7].)

This situation is unacceptable both from an economic and from an ethical point of view given the human suffering associated with fatal as well as with severe, life-changing injuries. Due to the importance and long-term nature of the Vision Zero objective, great efforts will be necessary in all phases of the road transport system's innovation cycles to get close to this objective, including road safety research as a key factor. However, in times of economic crisis, public resources for research funding are limited, and the focus of publicly funded road transport research in Europe has moved away from safety topics towards the greening and in particular towards the electrification of road transport. In this situation, it is important to identify priorities, meaning those road safety research topics, which the available financial resources will be invested in most efficiently to bring about maximum benefits in terms of road safety. This applies to Europe, but also beyond: Since Europe is still a forerunner in road safety and the European transport industry is very export-oriented, safety innovations from Europe have the potential to reduce the accident, injury and fatality rates in other parts of the world, as well.

Against this backdrop, the need for a pan-European network capable of setting commonly agreed priorities in road safety research is obvious. This was the starting point of the PROS project.

2 Objectives and Approach

The main objective of the PROS project was the creation of a pan-European network with the ability to set commonly agreed priorities in European road safety research based on a holistic understanding of road safety. This means integrating road user, vehicle and infrastructure aspects, covering all phases from preventive to post-crash safety, addressing all available technologies and taking into account all road transport modes.

More specifically, PROS was to identify untapped or insufficiently explored road safety research areas which should be addressed in order to facilitate meeting future targets in road safety. Based on this analysis, it should develop a comprehensive roadmap for future road safety research in Europe, from which a limited number of concrete topics can be derived for inclusion in future research programmes. It also aimed at implementing the defined research priorities in the roadmaps and research agendas of other stakeholder groups and at improved networking among all groups of European road safety experts. Defining a process for the prioritisation of research topics in a multi-stakeholder group was a necessity to achieve the main objective of the project. At the same time, it was an objective on its own, which should form the basis for the long-term continuation of the networking and priorities setting activities beyond the duration of the project, thus contributing to keeping road safety on the relevant research agendas. The latter is facilitated by promoting the benefits of publicly funded road safety research in Europe as another objective of the PROS project reaching out to a wider audience than the road safety research community only.

The approach followed by the PROS project in order to achieve these objectives was based on the following principles:

Covering the research area as a whole: PROS was not limited to specific research directions in road safety, but covered all phases from normal driving to post-crash safety, all elements of the road transport system (human, vehicle and infrastructure), all road transport modes and all available technologies in an integrated approach.

Maximising involvement: Covering the research area as a whole required the involvement of a large number of experts from various stakeholder groups. 137 road safety research experts were finally included in the process giving them the possibility to make active contributions to the project. Fig. 1 gives an overview of the stakeholders represented by these experts.

Focusing on priorities: PROS did not only put together an exhaustive list of research needs, in which the inputs by a broad range of experts are represented, but, in addition to this, the project aimed at setting priorities. This was done by applying a commonly agreed process, so that the results could be accepted even by stakeholders whose own priorities deviated from the results of this process.

Creating transparency: Full transparency on decision processes was an important means to improve the credibility of results and to further ease their acceptance by experts who shared minority views.

Remote interaction between experts: Important decisions, in particular on research priorities, were based on remote interaction between experts and supported by circulating information and collecting feedback in electronic form keeping records of all inputs received. This was done in order to avoid the phenomenon of “group think” meaning that an eloquent or charismatic leader may make the participants in a physical meeting think in a certain direction and thus may have a big impact on the results of the meeting.

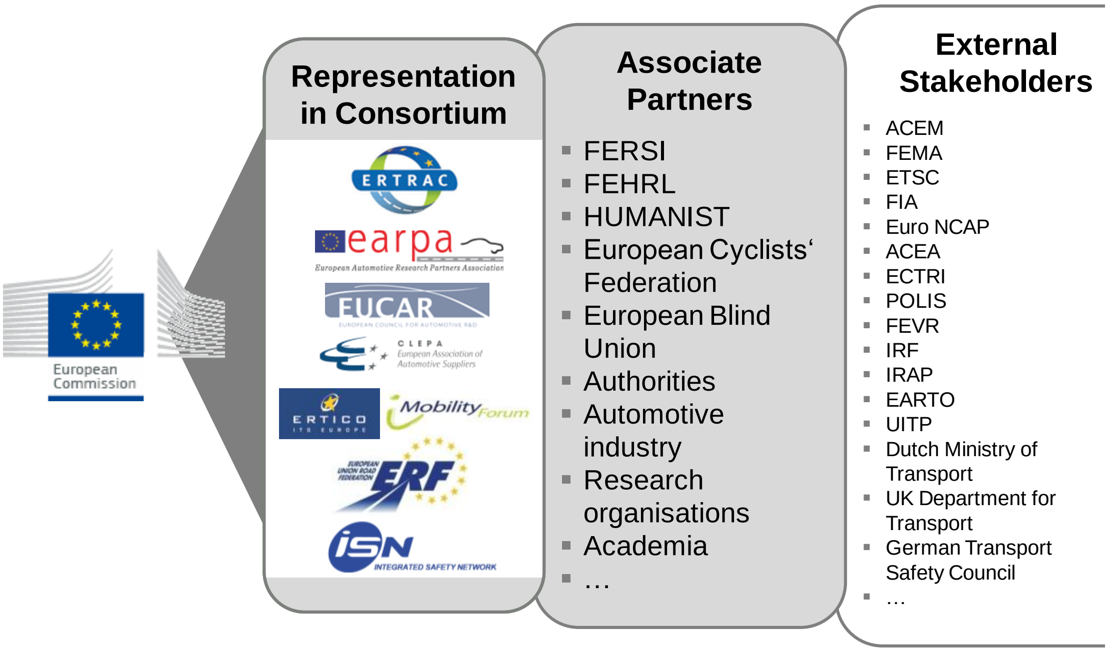

Fig. 1: Stakeholder involvement in the PROS project

These basic principles were implemented in the PROS approach shown in Fig. 2, which also represents the work package (WP) structure of the project.

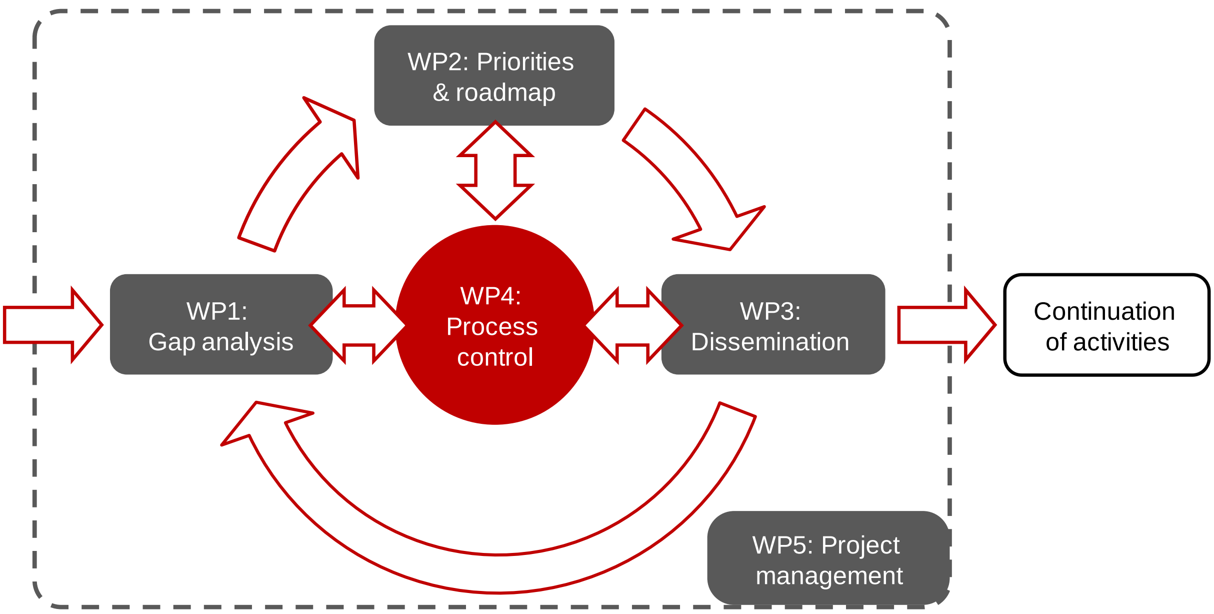

Fig. 2: Work package structure of the PROS project

While the operational work of identifying existing gaps in road safety research, setting priorities, structuring them in a roadmap and disseminating them was done in WP1, WP2 and WP3, WP4 had the pivotal role of defining and monitoring the whole process as well as the methodology applied. The cyclic structure displayed in Fig. 2 is an illustration of the concept of running through this process twice: once in the first year and once in the second year of project duration. This concept facilitated the adoption of a time-efficient method in the first year (September 2012 - August 2013) in order to meet the European Commission's time schedule for the definition of contents for the first calls in Horizon 2020. At the same time, it gave room for further developing the methodology in the second year based on the lessons learnt from the first year.

3 Process for the Development of Road Safety Research Priorities

The basic approach explained above was detailed into a process for the development of road safety research priorities, which can be applied, with minor adaptations, to other fields of transport research, as well. This process is shown in Fig. 3.

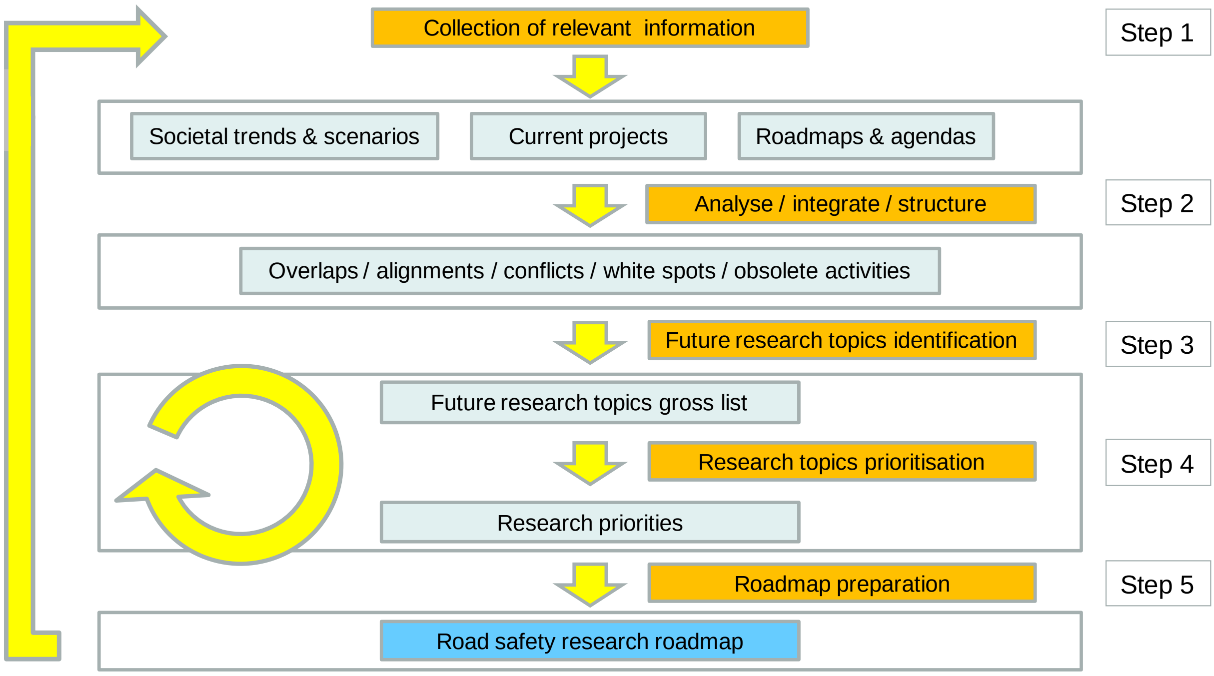

Fig. 3: Basic process followed by the PROS project

The first step in this process is the collection of relevant information, on which the definition of road safety research needs can be based. This includes an overview of relevant societal trends and scenarios, in which the outcomes of future research may be embedded, an inventory of running or recently completed road safety research projects as well as the analysis of existing road safety research roadmaps and agendas. Mapping the contents of these roadmaps and agendas with current research activities, overlaps as well as gaps or “white spots” in road safety research can be identified against the backdrop of future societal trends and scenarios. Inputs on future research needs by the coordinators of ongoing road safety research projects and other stakeholders are an important source of information in this context, too. The result is a comprehensive gross list of future research needs, which are clustered into a limited number of research topics. The contents of each topic are described in a one- to two-page document giving information on:

- Title of the topic
- Specific challenge to address
- Scope of the respective research
- Expected impacts
- Recommended type of action
- Specifics of the topic (if applicable)

According to the key elements of the road transport system, the topics are grouped into the four road safety research areas:

- Human
- Vehicle
- Infrastructure, traffic system & communication services
- Traffic safety analysis & assessment

Prioritisation is then done on the level of research topics within each of the four areas making use of an electronic questionnaire. In this questionnaire, each topic can be rated against three criteria by assigning a value between 1 (very low effect) and 4 (very high effect). The three criteria are listed in the following, each with a weighting factor given in brackets:

- Safety benefit (3)
- Effect on economic growth and job creation (2)
- Level of innovation (1)

A broad community of experts is invited to take part in the prioritisation of research topics by selecting their areas of expertise and filling in the questionnaire for the topics within these research areas. In case a partner cannot rate a specific topic against a particular criterion, this criterion can be disregarded for the specific topic.

For each topic and each criterion, the ratings by the individual experts are averaged. The total score of each topic is then calculated as the weighted sum of the three average ratings and given in percent with 0% being the lowest and 100% being the highest possible score, so that priorities can be defined within the four research areas mentioned above.

This prioritisation is done in two loops in order to enable experts to question their own ratings, take into account comments by other experts and clarify possible misunderstandings. For this purpose, experts are provided with the detailed outcomes of the first loop including, for each topic, a comparison of their own rating with the average rating of all participants. Based on this input, experts can easily identify topics which could be worth to re-consider and check if major deviations in the rating of a particular topic are due to actual differences in experts' views or just to different understanding of the topic.

After two prioritisation loops, the prioritised topics are consolidated in a roadmap, in which they are broken down in different kinds of activity, such as

- Research
- Demonstration & pilot projects
- Regulatory framework & standards
- Market introduction

These activities are put in a logical sequence for each topic, and timelines are assigned to them taking into account:

- The score of the corresponding topic in the prioritisation process (for positioning versus time within the respective road safety research area)
- Ongoing research projects on related topics
- Contents of current work programmes in transport research

Important milestones are added to each topic complementing the information on suggested starting points and on the expected duration of work on individual topics.

Since the whole process explained above was run through twice in the PROS project, it was possible to update the results, to further align their nature with the EC's new concept of defining call topics in Horizon 2020 and also to refine the process in the second cycle. Such refinements are already taken into account in the process description above.

While this process follows all the five basic principles of the PROS approach, which are explained in the preceding chapter, particular attention was paid to maximising stakeholder involvement and creating transparency in the implementation of the process in the PROS project. Important tools in this context were regular e-mail communications to a community of finally 137 road safety research experts as well as a total of seven physical workshops, which were organised by the project in order to:

- Collect feedback and further inputs to societal trends and scenarios, current road safety research projects as well as existing research roadmaps and agendas
- Identify “white spots” and future road safety research needs
- Cluster road safety research topics
- Review topic descriptions
- Come to an agreement on the positioning of topics versus time in the roadmap

Moreover, all important interim results were circulated for review to a wide range of stakeholders and refined iteratively, such as the overview of road safety research projects and relevant research agendas, the initial list of road safety research needs, the topic descriptions and the draft PROS roadmap.

From a methodological point of view, the process described above makes use of key elements of the Delphi method[1], in particular for a well-founded, transparent prioritisation of research topics. Examples of such elements are: structured communication, remote interaction, collecting feedback in at least two rounds and allowing for the revision of earlier answers in the light of the replies from other experts. More details on the applied process can be taken from deliverable 4.3 of the PROS project [8].

[1] The Delphi method is a structured communication technique, originally developed as a systematic, interactive forecasting method which relies on a panel of experts. The experts answer questionnaires in two or more rounds. After each round, a facilitator provides an anonymous summary of the experts' forecasts from the previous round as well as the reasons they provided for their judgments. Thus, experts are encouraged to revise their earlier answers in the light of the replies of other members of their panel. It is believed that during this process the range of the answers will decrease and the group will converge towards an agreed answer. Finally, the process is stopped after a pre-defined stop criterion (e.g. number of rounds, achievement of consensus, stability of results) and the mean or median scores of the final rounds determine the results.

4 Information Base for the Development of Road Safety Research Priorities

In order to provide the PROS project with a good understanding of the potential environment in which the outcomes of future road safety research may have to be embedded, existing reports on societal scenarios and trends were studied. Seven major trends could be identified as the most relevant ones for PROS:

1. Population growth
2. Demographic changes
3. Urbanisation
4. Fast growing cities
5. Rising awareness of CO_2 emissions, climate change and environmental pollution
6. Increasing demand for and price of energy and other resources
7. Connectivity

These trends were further analysed with respect to their potential impact on road safety. As a consequence, the following aspects should be addressed in the research recommendations by PROS:

- Older road users
- Growing cities
- A more diverse traffic mix
- Effects resulting from efforts to meet the CO_2 emission reduction targets
- Increased connectivity (of persons and things)
- Time for penetration of new technologies into the transportation system
- No focus on Europe only – most of the expected growth of transport volume will take place in the other parts of the world

With the latter point in mind, the review of existing road safety research roadmaps and agendas included selected national and international documents in addition to European ones. The following list gives an overview of the relevant roadmaps and agendas which were analysed by PROS:

- China road traffic safety – the achievements, the challenges and the way ahead, World Bank working paper, 2008
- Road safety strategic plan 2008 - 2020, the Dutch Ministry of Transport, Public Works and Water Management, 2008
- Strategic research agenda by the European Technology Platform on Smart Systems Integration (EPoSS), 2009
- Moving forward – 2010 - 2015 strategic roadmap, Euro NCAP, 2009
- Future of transport: ERF strategic road infrastructure priorities – beyond 2010, position paper by the European Union Road Federation (ERF), 2009
- Strategic research agenda – ICT for intelligent mobility, the eSafety Forum, 2010
- White paper on traffic safety in Japan 2010, the Japanese Cabinet Office

- Pedestrian safety strategic plan: recommendations for research and product development,
  submitted to the United States Department of Transportation, Federal Highway Administration, 2010
- European roadmap safe road transport,
  ERTRAC Working Group Road Transport Safety & Security, 2011
- ARTEMIS strategic research agenda, 2011
- New services enabled by the connected car,
  final report for the European Commission, SMART 2010/0065, 2011
- Verkehrssicherheitsprogramm 2011, the German Federal Ministry of Transport, Building and Urban Development
- NHTSA vehicle safety and fuel economy rulemaking and research priority plan 2011 - 2013, 2011
- Road Safety is no accident – synthesis report of four working groups on education, enforcement, engineering and emergency care constituted under the National Road Safety Council, Indian Ministry of Road Transport and Highways, 2011
- National road safety strategy 2011 - 2020, the Australian Transport Council 2011
- Further advances in road safety – importance for European transport research,
  position paper by the European Automotive Research Partners Association (EARPA), 2012
- ETSC comments on Horizon 2020, 2012
- The main research directions in ten years,
  scientific strategy by IFSTTAR, 2012
- Strategic roadmap for traffic safety within FFI (Swedish national funding programme for research, innovation and development), 2012
- Preliminary road safety research agenda, UK Department for Transport, 2013
- ERTRAC multi-annual implementation plan for Horizon 2020, 2013
- The adaptable road: A roadmap for research – an element of the forever open road,
  the Federation of European National Highway Research Laboratories (FEHRL), 2013
- The automated road: A roadmap for research – an element of the forever open road,
  the Federation of European National Highway Research Laboratories (FEHRL), 2013
- CLEPA safety research roadmap – towards Vision Zero, 2013
- Roadmap document by the EUCAR strategic pillar group “Safe and integrated mobility”, expert group: safety, 2013
- Roadmap document by the EUCAR strategic pillar group “Safe and integrated mobility”, expert group: driver-vehicle dialogue, 2013
- Automation in road transport, roadmap by the iMobility Forum, 2013
- Recommendations for 2014 - 2015 research needs, iMobility Forum, 2013

In addition to these documents, current road safety research projects were reviewed in order to identify recent progress and further research needs. All in all, 109 projects primarily from the EC’s Sventh Framework Programme and from national programmes were analysed. This specialist review was complemented by direct contacts to the coordinators of selected ongoing or recently completed road safety research projects, who were asked to provide insights into remaining research needs in the context of their current projects.

The research needs extracted from the existing roadmaps and agendas, if not already covered by current projects, the feedback from the project coordinators and a number of new research ideas gathered from several stakeholders in a dedicated PROS workshop formed the basis of a detailed list of road safety research needs already in the first cycle of the project. This list was circulated in several iteration loops to the consortium members, associate partners as well as external stakeholders involved in PROS and completed with their inputs, until a convergence of contributions was finally observed: Inputs were more and more concerning very detailed aspects, suggesting changes also proposed by other partners, requesting minor modifications, or simply expressing agreement.

The full list of more than 300 specific road safety research needs is available in deliverable 2.1 of the PROS project [9]. Together with the other information from the review of societal trends and scenarios, relevant research agendas and roadmaps as well as current road safety research projects, it forms a comprehensive information base for the development of road safety research priorities. Most of this information is summarised in deliverable 1.3 [10] and its update D1.4 [11], while additional details can be taken from D1.1 [12] and D1.2 [13].

5 Road Safety Research Priorities and Roadmap

Starting from the information base described in the preceding chapter, priorities in road safety research were developed by the PROS project. For this purpose, the entries in the full list of research needs were clustered in 52 road safety research topics in the first cycle of the project. Further condensation into eleven aggregated topics in the second cycle finally resulted in broad research challenges in line with the EC's concept of defining call topics in Horizon 2020.

Fig. 4 gives an overview of the eleven thematic clusters and the individual topics allocated to them within the four road safety research areas already mentioned in the process description (chapter 3). Some topics occur in this overview more than once, as they contain aspects of various thematic clusters. The titles of the eleven aggregated topics in Fig. 4 already aim at the reflection of benefits to society and to competitiveness which the respective research is expected to bring about. Specific links to relevant political objectives, in particular from the EC's policy orientations on road safety [14], were included in the full-text descriptions of these aggregated topics. These descriptions are included in the annex of this report. They provide comparatively high-level information on the specific challenges to address and on the scope of the respective research, thus giving room for various research focuses within each aggregated topic. Additional details on possible directions of research can be taken from the more specific descriptions of the 52 underlying topics, which are included in the deliverable 2.2 of the PROS project [15].

Prioritisation of the aggregated topics was done in two loops according to the process described in chapter 3. A total of 41 organisations including consortium members, associate partners and external stakeholders took part in the prioritisation process, among them several associations which engaged on behalf of a multitude of member organisations. From the names of the consulted experts, which partners were asked to provide, the conclusion can be drawn that about 120 experts delivered their inputs to the prioritisation process. The following list gives an overview of all stakeholders who participated in the prioritisation of the aggregated road safety research topics from the PROS project:

- ACEM − Association des Constructeurs Européens de Motocycles
- AIT − the Austrian Institute of Technology
- Autoliv Development AB
- BASt – the Federal Highway Research Institute
- BRRC – the Belgian Road Research Centre
- CDV – the (Czech) Transport Research Centre
- CIDAUT – the Foundation for Transport and Energy Research and Development
- Continental Teves AG & Co. oHG
- CRF – Centro Ricerche FIAT S.C.p.A.
- CSIR – Council for Scientific and Industrial Research
- Daimler AG
- DNDI – Shulgin State Road Research Institute

- DRD – the Danish Road Directorate
- ECF − the European Cyclists' Federation
- ECTRI – the European Conference of Transport Research Institutes
- EPFL – École Polytechnique Fédérale de Lausanne
- ERF – the European Union Road Federation
- EUCAR – the European Council for Automotive R&D
- FEHRL – the Forum of European National Highway Research Laboratories
- Ford Werke GmbH
- fka – Forschungsgesellschaft Kraftfahrwesen mbH Aachen
- HUMANIST Virtual Centre of Excellence
- IDIADA Automotive Technology SA
- IFSTTAR – the French Institute of Science and Technology for Transport, Development and Networks
- IRF – the International Road Federation
- ISN – the Integrated Safety Network
- KTI – Institute for Transport Sciences Non-profit Ltd.
- LMU – Ludwig-Maximilians-Universität München
- LVCELI – Latvian State Roads
- National Technical University of Athens
- Robert Bosch GmbH
- RRI – the Road Research Institute of Vilnius Gediminas Technical University
- RWS – Rijkswaterstaat
- SAFER – Vehicle and Traffic Safety Centre at Chalmers University of Technology
- SWOV Institute for Road Safety Research
- TECER – Technical Center of Estonian Roads Ltd
- TNO – Nederlandse Organisatie voor toegepast-natuurwetenschappelijk onderzoek
- TRL – the Transport Research Laboratory
- Graz University of Technology
- University of Florence
- Volvo Group Trucks Technology

The analysis of all filled-in questionnaires revealed that many partners actually made use of the possibility to focus on the topics where they saw their main fields of expertise. The main results of this analysis are summarised in Fig. 5. The values in the table indicate the score of each aggregated topic in percent of the best possible score, which would be reached, if all participants assigned a "very high effect" to a particular topic against the respective criterion. The bar diagrams visualise the weighted total scores with the red square showing the mean value and the light section of the respective bar indicating the variation about the mean.

The moderate differences between the scores of the aggregated topics within each research area indicate as an important outcome that none of them is clearly irrelevant. Therefore, the decision was taken to include all the eleven aggregated topics in the final PROS roadmap, but to reflect their relative priorities in the timing of topics in this roadmap.

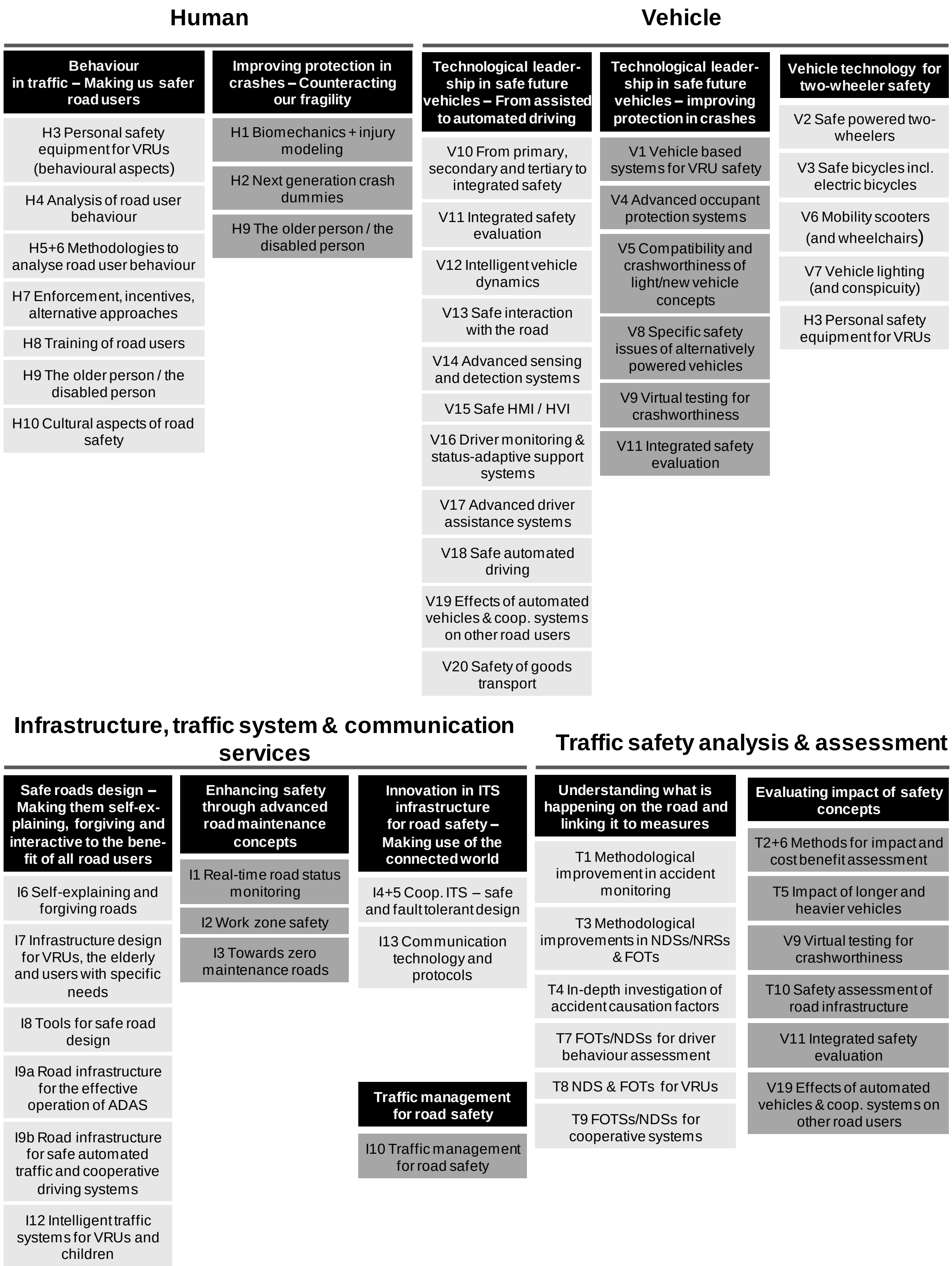

Fig. 4: Clustering of research topics

Following a similar format as applied by ERTRAC in its existing research roadmaps, the final PROS roadmap does not only provide information on suggested starting points and on the expected duration of work on individual road safety research topics. Following the process description in chapter 3, it also provides information on important milestones for each aggregated topic and distinguishes four different kinds of activity under each topic. These activities are indicated by coloured arrows in the final PROS roadmap, which is shown in Fig. 6 and Fig. 7. Complemented by the descriptions of the aggregated research topics in the annex, this roadmap represents a key result of the PROS project.

		Criteria				
	Weighting factor	3	2	1		
	Research areas Aggregated topics	**Safety benefit**	**Effect on economic growth and job creation**	**Level of innovation**	**Total score**	**Visualisation of total score**
	Human					
1	Behaviour in traffic - making us safer road users	83%	39%	55%	64%	
2	Improving protection in crashes - counteracting our fragility	63%	44%	67%	57%	
	Vehicle					
3	Technological leadership in safe future vehicles - from assisted to automated driving	68%	75%	94%	74%	
4	Technological leadership in safe future vehicles - improving protection in crashes	81%	61%	70%	72%	
5	Vehicle technology for two-wheeler safety	81%	51%	74%	70%	
	Infrastructure, traffic system & communication services					
6	Safe roads design - making them self-explaining, for-giving and interactive to the benefit of all road users	85%	64%	69%	75%	
7	Enhancing safety through advanced road maintenance concepts	67%	68%	73%	68%	
8	Innovation in ITS infrastructure for road safety - making use of the connected world	74%	75%	87%	76%	
9	Traffic management for road safety	72%	54%	64%	65%	
	Traffic safety analysis & assessment					
10	Understanding what is happening on the road and linking it to measures	83%	41%	61%	66%	
11	Evaluating impact of safety concepts	79%	43%	63%	64%	

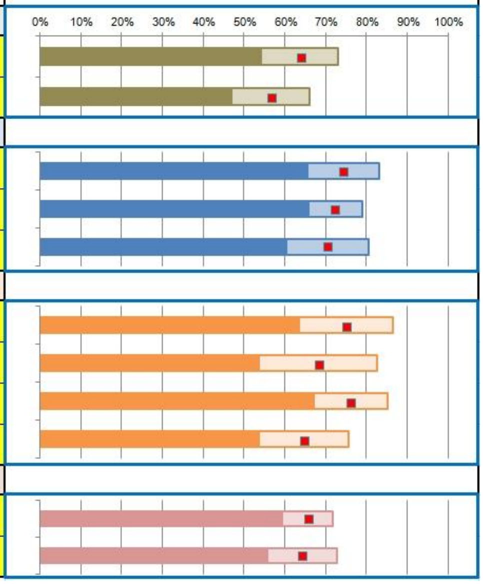

Fig. 5: Results of the prioritisation process

The year in which the respective research is scheduled to start according to Fig. 6 and Fig. 7 refers to the work programme in Horizon 2020 in which PROS recommends including the corresponding research topic. This allocation of topics is based on the assumption, that the main road safety research needs covered by the Transport Work Programme 2014 will finally be addressed by funded projects. Otherwise, the topic “vehicle technology for two-wheeler safety” as well as the two topics from the research area “Traffic safety analysis & assessment” would become candidates for inclusion in the Work Programme 2016/2017, as indicated by the light sections of the corresponding arrows.

Apart from that, an important conclusion from the roadmap is the recommendation to include the following six research topics in the upcoming work programmes:

- Behaviour in traffic – Making us safer road users
- Technological leadership in safe future vehicles – Improving protection in crashes
- Safe roads design – Making them self-explaining and forgiving to the benefit of all road users
- Improving protection in crashes – Counteracting our fragility
- Technological leadership in safe future vehicles – From assisted to automated driving
- Innovation in ITS infrastructure for road safety – Making use of the connected world

The first three topics are recommended as elements of road safety, behavioural and infrastructure-related research for 2016, the last three – two of them ITS-related – for 2017.

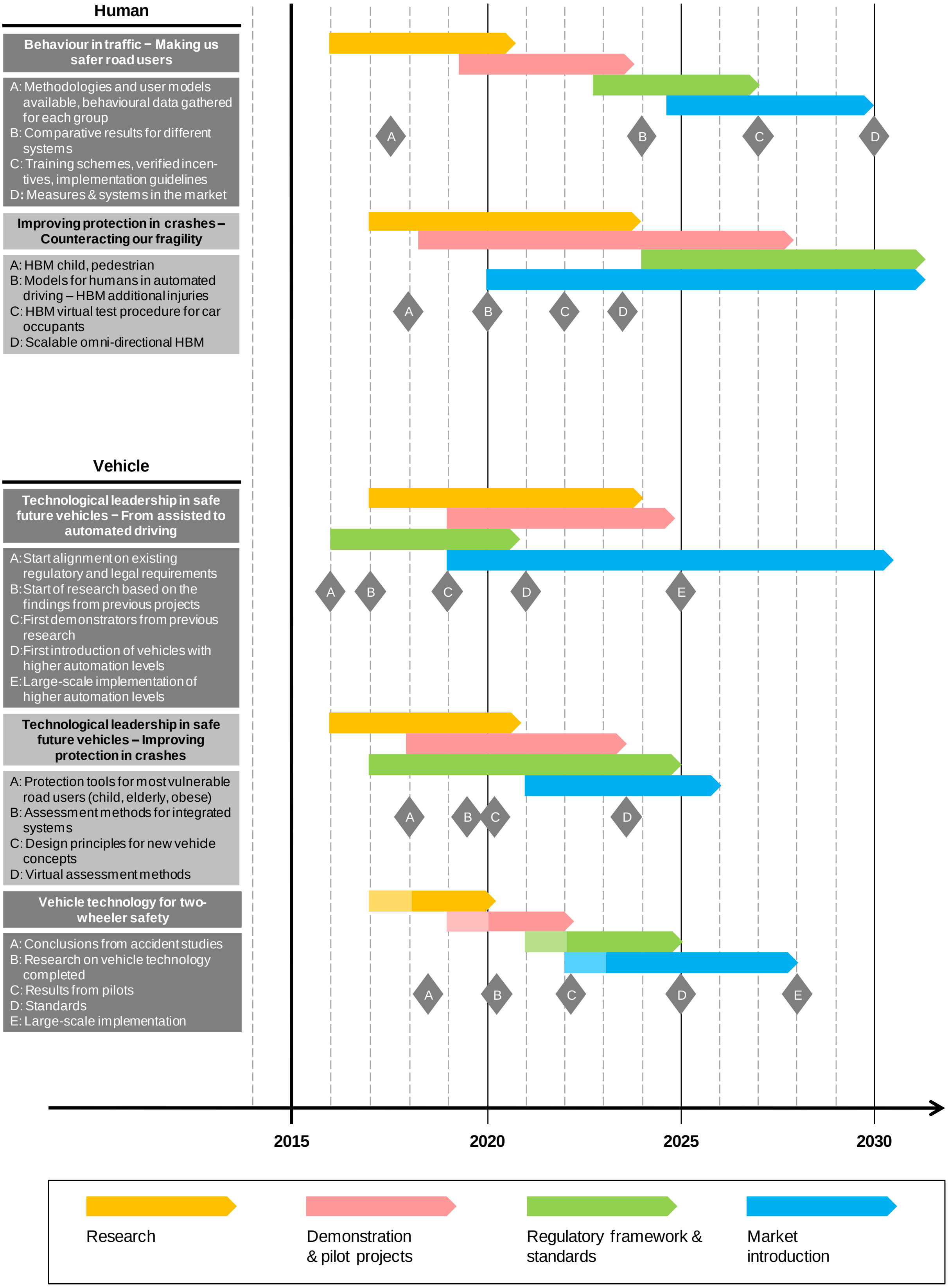

Fig. 6: PROS research roadmap – research areas “Human” and “Vehicle”

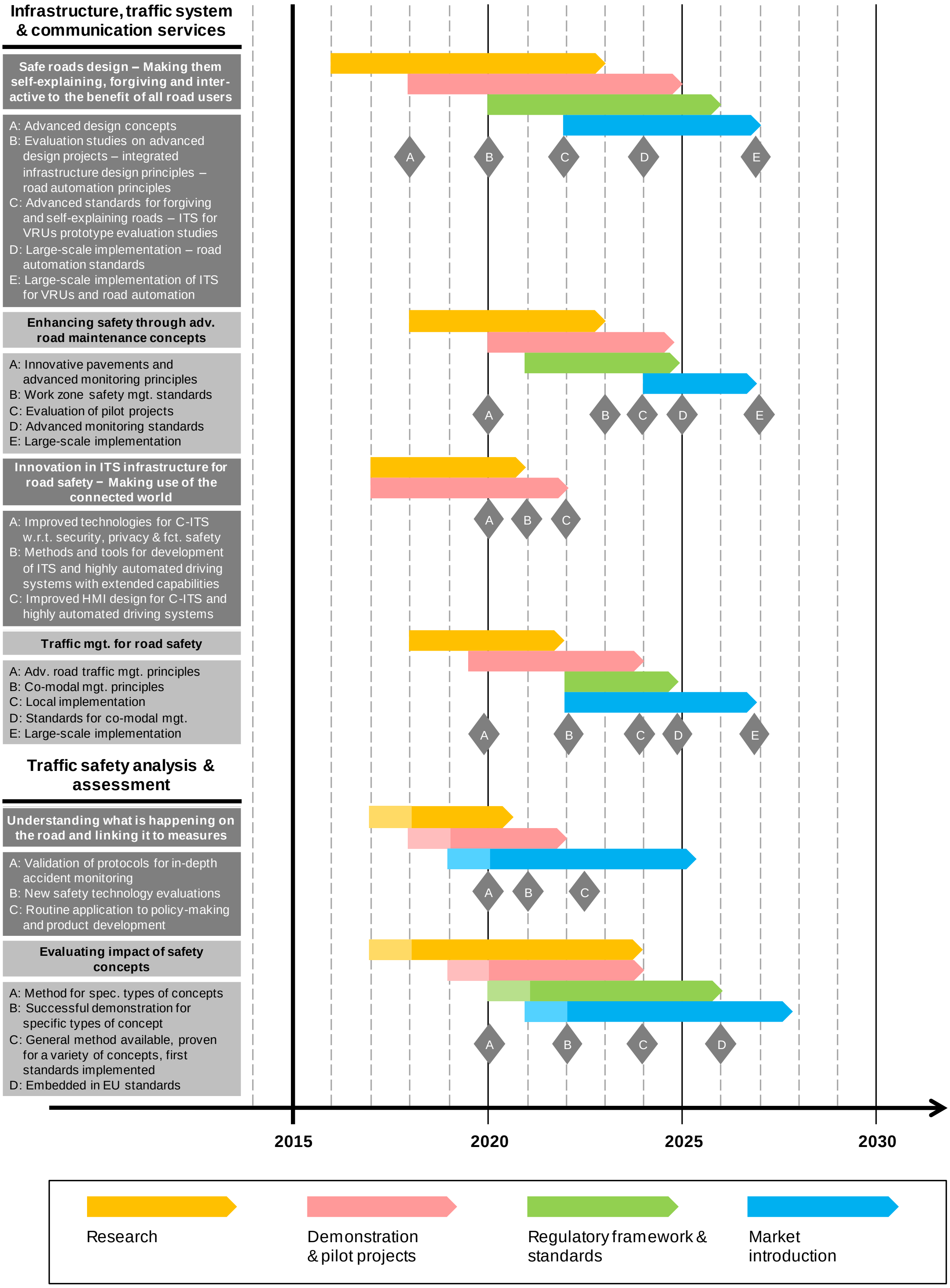

Fig. 7: PROS research roadmap – research areas “Infrastructure, traffic system & communication services” and “Traffic safety analysis & assessment”

6 Continuation of Activities

The PROS project has been the first initiative in which a process for the definition of research priorities with this degree of transparency has been established in a European multi-stakeholder network covering road safety research as a whole. To continue this work beyond the duration of the PROS project, different options were investigated. The continuation mechanism sought for should:

- build on the basic principles of the PROS approach from chapter 2:
  - covering the research area as a whole
  - maximising involvement
  - focusing on priorities
  - creating transparency
  - remote interaction between experts
- handle relations with all relevant stakeholders related to road users, vehicles and infrastructure
- provide an organisational and decision structure
- continue the core activities:
  - keeping the roadmap updated
  - promoting research activities
  - maintaining a continuous link between all interested stakeholders
- provide solutions to raise funding to cover the related expenses

Possible alternatives which were analysed to continue the process at the end of the PROS project are summarised in Table 1.

ALTERNATIVE	COMMENT
Apply for a new project	Not possible – in the short term no applicable calls expected in Horizon 2020.
Carry on without funding	Not realistic to ensure that the momentum within the group is maintained in the long term.
Join an existing initiative or organisation	ERTRAC was identified as the most relevant organisation in this context being a Technology Platform acknowledged by the EC and acting as an important advisory body to the Commission in the implementation of Horizon 2020. In summer 2014, ERTRAC was re-starting its safety working group anyway, which used to involve several PROS partners. Other organisations are typically addressing specific stake-holder groups only and/or focus on certain elements of the road transport system or particular technologies. Further-more, safety priorities should be connected to other develop-ments in the road transport system and its components, which ERTRAC can facilitate.

Table 1: Possible continuation mechanisms

ERTRAC was approached and initial meetings were held from July 2013 onwards with responsible persons within ERTRAC and the FOSTER-Road project which is supporting the ERTRAC activities as a coordination action. An agreement was finally reached in April 2014 between ERTRAC and PROS representatives to work towards the continuation of the PROS activities under the umbrella of a re-established ERTRAC Working Group Road Transport Safety & Security. Accordingly, the ERTRAC working group should build on PROS results and be open to all PROS partners. Several PROS partners have also expressed their willingness to take on significant roles in this working group.

The first two meetings of the re-established ERTRAC safety working group were held in June and November 2014 with the vast majority of participants representing PROS partners. While a good basis for cooperation was established and core elements of PROS priorities implemented in ERTRAC recommendations, a continued dialogue with the ERTRAC management and its safety working group is recommended with the aim to integrate the basic principles of PROS mentioned above optimally within the ERTRAC approach.

7 Acknowledgement

The PROS project partners would like to thank the European Commission for the financial support provided. Only this support has made it possible to generate the previously described results which are considered of great value to the road safety research community as a whole.

The research leading to these results has received funding from the European Union's Seventh Framework Programme (FP7/2007-2013) under Grant Agreement n° 314427. This report reflects only the views of the PROS consortium members, associate partners and external stakeholders. Neither the European Union nor the European Commission is liable for any use that may be made of the information contained therein.

8 Glossary

ADAS	Advanced driver assistance systems
ARTEMIS	European industry association and Joint Undertaking "Advanced Research & Technology for Embedded Intelligence and Systems"
CLEPA	The European Association of Automotive Suppliers
C-ITS	Cooperative intelligent transport systems
D	Deliverable
EARPA	The European Automotive Research Partners Association
EPoSS	The European Technology Platform on Smart Systems Integration
ERF	The European Union Road Federation
ERTRAC	The European Road Transport Research Advisory Council
ETSC	The European Transport Safety Council
EUCAR	The European Council for Automotive R&D
Euro NCAP	The European New Car Assessment Programme
FEHRL	The Federation of European National Highway Research Laboratories
FFI	Fordonsstrategisk Forskning och Innovation
FOT	Field operational test
HBM	Human body model
HMI	Human machine interface
HVI	Human vehicle interface
ICT	Information and communication technology
IFSTTAR	The French Institute of Science and Technology for Transport, Development and Networks
ITS	Intelligent transport systems
NDS	Naturalistic driving study
NHTSA	The National Highway Traffic Safety Administration

NRS	Naturalistic riding study
VRU	Vulnerable road user
WP	Work package

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Annex

Research Area "Human"

Topic: Behaviour in traffic – Making us safer road users

Specific challenge:

A pre-requisite to make road traffic safer is an increased understanding of the behaviour of individual road users (including drivers, riders and all types of vulnerable road users (VRUs)), but also understanding the interaction between them and all types of systems and services (i.e. on-board vehicles, at mobile devices or in the infrastructure), as well as macroscopic effects of road user behaviour (e.g. on traffic flow).
Key influencing factors of road user behaviour should be deeply studied, both on the individual level and across the population. Examples are the influences of fatigue, drowsiness, stress, the use of medicines, trip goal and motivation, and also prevalent behaviour that causes unsafe situations (e.g. refusal to use seatbelt or switching off on-board safety functions). Of particular interest are needs and behaviour of elderly people as well as the impact of socio-cultural aspects.
A big challenge will be to identify and implement countermeasures to the most relevant human aspects and the interaction with the systems that represent the major causes of unsafe road user behaviour. Socio-cultural aspects will also be specifically addressed as well as context based situations.
Knowledge on the (interacting) parameters that define road user behaviour and their combined effects should lead to measures and systems that ensure safe road user performance, to pro-actively anticipate road user responses and to eventually reduce the number of errors and conflicts on the road. Among them, intuitive and forgiving systems, personal safety equipment for VRUs, enforcement measures, incentives and training of all types of road users should be considered.
Transfer of knowledge from other transport modes and an effective deployment of multimodal solutions are recommended, as well as the inclusion of non-traditional transport modes, such as personal mobility devices.

Scope:

Proposals should address one or more of the following aspects:

- Study the parameters that influence road user state, i.e. investigate intra-individual variations in terms of factors such as vigilance, stress, use of medicines, task/trip goal, influence of peers (e.g. passengers) for all traveller types, with emphasis on their response in pre-crash situations.
- Study collective variations in safety behaviour, such as socio-cultural issues, age and disability and how they impact risk assessment and exposure of each individual or group.
- Testing of road users' distraction and impairment as well as design of preventative countermeasures.
- Development and testing of solutions (for all kinds of vehicles) aimed at minimising human workload in the mobility task while guaranteeing access to information, when needed. This can include information and message provision as well as human-machine interaction.
- Development of techniques and tools to measure in real time and in a non-invasive manner, as well as model behaviours for every traffic participant. One example is tools and standards for the assessment of factors influencing older and disabled drivers' fitness-to-drive cars and other mobility devices such as quadricycles.
- Define a reference model for the road user in cooperation with driving or safety assistance for the different levels of automation strategies from highly automated (low and high speed driving) to fully automated driving.
- Development of analysis and assessment methods for factors influencing the level of risk that road users are willing to take and accept in different situations. Factors affecting the road user's abilities to adequately judge and manage boundary conditions like weather, road conditions and traffic should be taken into account.
- Performance of simulator and appropriate driving / riding / travelling studies to extract the necessary data and verify the developed techniques, tools and models.

- Perform studies to analyse the learning of functionalities of new driving and safety assistance as well as adapting to these functions (short- / mid- / long-term view) and “trusting” these functions.
- Development and testing of focused personal safety equipment for various VRU categories, to warn them adequately in high risk situations and/or protect them from the most critical conflicts.
- Development of focused and coordinated training schemes and associated tools for all traffic participants that are based upon reliable interaction and behavioural models and are piloted widely across types of traffic / geographical regions.
- Development and piloting of novel enforcement and incentive schemes for high risk groups and their evaluation across countries / geographical regions.

Expected impact:

Actions will contribute to:

- Insight in the diverse behavioural patterns of road users, methodologies to assess them and systems and measures to handle and/or influence them are expected to have a high road safety impact, reducing not only fatal and serious injury accidents, but even lighter ones and conflicts, thus resulting in a safer and more inclusive traffic environment.
- Change of drivers’ and riders’ behaviours towards a safe use of vehicles in different contexts, resulting in a relevant decrease of road accidents.
- Personal safety equipment, enforcement incentives and training schemes will become much more effective, as they will be based upon reliable behavioural models and they will be coordinated across the different road user groups and their key interactions.
- Safe integration of new types of vehicles (e.g. Segways) or enhancement of penetration of others (e.g. bicycles incl. electric bicycles) with emphasis on the safety needs of the most vulnerable users, such as children, elderly and people with restricted mobility or other disabilities.

Type of action:

Research and Innovation Actions (RIA)

Specifics of this topic:

International cooperation with developed (i.e. US, Japan, Canada, Australia) and emerging economies (primarily China, India, Brazil) is strongly encouraged.

Topic: Improving protection in crashes – Counteracting our fragility

Specific challenge:

The WHO estimates a road injury loss accounting for 2% of gross domestic product in the EU. On average more than 70 people die on European roads each day and many more get severely injured[2]. Consequently the EU aims at reducing both road fatalities and severe injuries by 50% between 2010 and 2020. Several accident types may decrease due to active safety systems. There are also hopes that automated driving will ultimately eliminate accidents. For the foreseeable future, however, a residual of accidents is foreseen to remain and they will require improved and/or modified crash safety. A new generation of green, sub-compact cars poses new safety challenges. The gradually increasing ageing of the population adds to the protection challenge. The development of protection systems will call for more refined ways for assessing the effect on the occupant, and requires new tools – both physical (crash dummies) and virtual (computational human body models).
The protection challenges both from a new generation of green vehicles and from the fragility of an ageing population are also recognised by the EC in its Policy Orientations on Road Safety 2011 - 2020[3].

Scope:

- With the advent of active safety technologies, crash dummies and human body models (HBMs) must become better adapted to lower speed and acceleration loading. Other vital situations are multiple impact crashes (MICs), rollover accidents and pre-crash restraint system activation in conjunction with autonomous braking and steering. Human volunteer testing is a particularly important method here.
- The biofidelity of crash dummies needs improvement in injury prediction, kinematics as well as local mass distribution and properties of the soft tissues. Internal organ injury assessment is urgent and will require new biomechanics research. Road user categories such as children, elderly, obese and females deserve particular attention in this context.
- HBMs require refinement with focus on model robustness and injury risk assessment to boost acceptance by stakeholders and ultimately enable a reduced need for crash dummies.
- Better basic biomechanical data are needed, including for pedestrians, cyclists and powered two-wheeler riders, to achieve the full potential of computational HBMs and for advanced crash dummy development.
- Biological experimental work is required to establish injury mechanisms and refine the assessment methods in two urgent and challenging areas:
    1) Soft tissue neck injuries (whiplash) is the most costly traffic injury in Europe. The injury mechanism is not yet fully understood and needs to include all collision types.
    2) Brain injuries are important at all injury severities.
- Thorax, abdomen and spine loading needs new tissue level injury criteria. Anatomical variability, including children, elderly, obese and females will require basic experimental work fed into HBMs.
- For unprotected road users, a link from global body loading to tissue injury must be strengthened. Dummy development should target vulnerable road users, their postures and accident kinematics.
- Accident reconstruction is needed as a complement to post mortem human subjects to target the impact response of children and other occupant categories.
- Neglected accident conditions other than pure front, side or rear require omni-directional models and dummies. The range of available dummies should be expanded to address a wider and more representative cross-section of the road user driving community including females of various sizes, pregnant women, elderly and children.
- Uncovered characteristics in accident conditions like submarining, misuse of restraint systems and occupant-to-occupant interaction should be implemented in new crash dummies and models.

Expected impacts:

This research is imperative for significant reductions of the societal cost of road traffic accidents. A new generation of human body models and crash test dummies is a must for the development of

[2] European Commission - IP/14/341
[3] COM(2010) 389 final

future safety assessment methods. These methods are in turn an absolute prerequisite to reach the goal of the Transport White Paper, “by 2050, move close to zero fatalities in road transport”[4], as a new generation of green, sub-compact cars is introduced. Moreover, these methods will help improving the competiveness of the European car industry.

Type of action:

Suggested activities are large-medium and small Research and Innovation Actions (RIA) and/or Coordination and Support Actions (CSA).

Specifics of this topic:

Cooperation with research activities in other regions, in particular the US and Japan, is required to result in a set of harmonised assessment tools. Activities should also directly support needs from the UNECE GRSP group developing regulations on passive safety.

[4] COM(2011) 144 final

Research Area "Vehicle"

Topic: Technological leadership in safe future vehicles – From assisted to automated driving

Specific challenge:

Automated driving has become one of the megatrends in the automotive industry. Different circumstances leading to drivers' inappropriate situation assessment, inattention or distraction are among the main reasons for road accidents. Increased levels of vehicle automation could contribute in this context by eliminating or easing conflict situations a human driver hardly can handle without assistance. However, there are still many challenges to overcome in various areas ranging from adaptations to regulations and new aspects of product liability, capability of sensor systems, vehicle dynamics, human machine interaction, monitoring strategies up to communication between the vehicles and the infrastructure. Automated driving might also have a positive influence on emissions by reducing congestions around major metropolitan areas.
With the increase in the level of vehicle automation[5], the number of automated or semi-automated manoeuvres will constantly grow. This requires an effective collaboration between the driver and the automated vehicle. Partially and highly automated vehicle systems shall be engineered to act in harmony with driver expectations and be resilient to system and driver failures. Timely transitions and reactivation of human attention and action shall be handled to guarantee sufficient reliability and robustness in each and every situation in real world traffic. Consequently such vehicles would be in line with - and even go beyond - what is described in the strategic objective "Safer vehicles" in the European Commission's Policy Orientations on Road Safety 2011 - 2020[6].

Scope:

To manage the transition from driver assistance to safe automated driving with an integrated approach, the research activities should be cross-functional and cover the

- Improvement of driver assistance and sensing systems in terms of
  - sensing capabilities and sensor fusion, robustness and performance to enable highly and fully automated driving levels
  - optimisation of controllability and driver adaptation
  - functional safety, realising cost-efficient solutions with high safety integrity

- Enhancement of safe human machine / vehicle interface and driver monitoring strategies to
  - maximise the intuitiveness and situation awareness
  - enable appropriate driver take over strategies
  - monitor drivers' behaviours, predict drivers' actions and increase drivers' acceptance

- Evaluation of driver assistance systems and automated driving functions by
  - developing integrated safety assessment methods considering all types of road usage
  - shaping regulatory and legal environments

- Interaction of the vehicle with the environment and other road users by
  - improving strategies for vehicle-to-vehicle and -infrastructure communication
  - improving strategies for interaction between automated vehicles and other road users including non-automated vehicles
  - enhancing road surface interaction and improve vehicle dynamics
  - considering safety needs of specific vehicle classes such as goods vehicles

Expected impacts:

Increasing the level of automation in driver assistance and driving functions means reducing situations in which misperception, excessive demands, inattention, reduced vigilance and distraction of the driver can occur and result in serious consequences. As these situations account for a prominent subset of all accident causations, vehicle automation must be seen as a major contributor towards Vision Zero.

[5] See SAE J3016 for a widely accepted classification of vehicle automation levels
[6] COM(2010) 389 final

The European automotive industry has demonstrated a good capacity for safety innovations. Both the vehicle manufacturers and their suppliers have developed integrated safety functions in the present tough global competitive environment. Extensive research in the field of vehicle automation will help to maintain this leadership position.
Tax payers' money will be well spent on the design of solutions and on the analysis of effects of a progressive introduction of automated vehicles. Most importantly, this will facilitate to minimise societal concerns thus promoting a more trustful dealing with these new technologies. Promotion and demonstration efforts will help to increase awareness and achieve higher penetration of ADAS and automated driving functions resulting in both increased safety on the roads and lower emissions.

Type of action:

Due to the great complexity of the topic it is suggested to not carry out the research in one single project but to structure it in various, closely linked large-medium and small Research and Innovation Actions (RIA).

Specifics of this topic:

- The automotive industry becomes increasingly global which drives the need for a strong international harmonisation of research. Discussions on the way forward to automated driving are ongoing in various areas and organisations world-wide. Starting with harmonised automation level definitions, especially the regulatory and legislation aspects would profit from international cooperation. It is also expected that a harmonised and predictable behaviour of automated vehicles is required for other road users to feel safe and trust the systems.
- Close links to research on human behaviour are needed to optimise both the human machine / vehicle interface design and the controllability.

Topic: Technological leadership in safe future vehicles – Improving protection in crashes

Specific challenge:

Passive and active safety systems like side restraints or Electronic Stability Control have substantially reduced accidents and injuries. However, for example critical situations at crossings involving all types of road users are still one remaining root cause for nearly every third accident with injuries and fatalities[7]. These scenarios represent complex accident situations, which were evaluated in previous research. Major outcome of those assessments was the remaining high demand for passive safety systems due to the fact that in the nearby future no 100% accident avoidance will be possible through active safety systems. Further advances in passive safety systems would also support the technological leadership of Europe in this area.
World-wide, the largest group of road user fatalities is represented by pedestrians hit by motorised vehicles as shown in previous research. With the growing urbanisation it is expected that also the number of powered and non-powered two-wheelers will continue to increase. Furthermore, according to European data[8], motorcyclists are 20 times more likely to experience a fatal accident than the occupants of passenger cars. The need to substantially improve the safety of these vulnerable road users is also fully recognised as a strategic objective in the EC's Policy Orientations on Road Safety 2011 - 2020[9].
Another critical accident scenario is so-called Multiple Impact Crashes (MICs) in which a vehicle experiences at least two impacts after each other and in which the occupant may be less protected in the 2nd one (3rd etc...). Different accident studies show that about 25% of all passenger vehicle accidents are MICs and have a relative high injury risk[10],[11].
To take full advantage of the active and passive safety systems in an integrated way, systems must be developed to better protect all road users (old, young, obese etc.) and also consider new vehicle types like light and ultra-light vehicle categories, for which hardly any safety regulations exist today.

Scope:

The major scope of this challenge is to improve the protection in crashes for all road users covering the following aspects in order to keep the technology leadership of European industry:

- Tools to enhance the protection of the most vulnerable occupants; such as children, elderly and obese, groups for which the current protection systems are not optimised. Adaptive restraint systems for all kinds of users as part of personalised passive safety. Protection in complex accident scenarios, e.g. far-side or multiple collisions.
- Integrated assessment methods (physical, numerical and combinations) for overall safety of both car occupants and vulnerable road users, reflecting the benefits of both active and passive safety. Evaluation methods demonstrating the true safety benefit in real traffic.
- Optimisation of restraint systems by including pre-crash information (integrated safety) without compromising passive safety.
- Solutions for improved crash compatibility, including collisions with other cars and vulnerable road users, of very light or completely new vehicle concepts incl. crashworthy structures and adapted restraint systems.
- Safe alternative designs for electric vehicles and for their crash structures, in particular including improved design guidelines accounting for additional structural performance benefits from introducing new lightweight materials (e.g. composites); enabling technology for highly crashworthy rechargeable energy storage systems incl. corresponding modelling techniques and dynamically adaptive structures; post-crash issues (eCall for electric vehicles, disposal of damaged battery systems).

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- Computationally efficient and robust crash simulation tools for new lightweight materials, especially addressing axial crushing of composite structures, and new joining techniques required in lightweight design including standardised methods for the characterisation of lightweight materials and joining techniques.
- Standardised and world-wide harmonised methods for virtual assessment of crash compatibility and requirements for crash simulation tools including validation procedures and tools to promote the implementation of virtual testing in regulation and rating, e.g. human body modelling.

Expected impacts:

The European automotive industry has demonstrated a good capacity for safety innovations. Both the vehicle manufacturers and their suppliers have developed integrated safety functions combining active and passive safety. This innovative capacity will be essential to develop European automotive industry in the present tough global competition. By combining the advantages of passive safety with active safety in an integrated way in new safety systems, they can complement each other to increase safety and reduce road fatalities in Europe.
Since only very rudimentary safety requirements do exist for extremely low-mass vehicles today, substantial improvements – if they are introduced in an early stage – may be expected at reasonable costs and applicable in relatively short time. Considering the increased complexity in terms of crash compatibility with heavier vehicles, new safety solutions and enabling technologies as well as customised numerical tools promoting increased virtual development and assessment will be a necessity for the development of future lightweight vehicles with maintained (or increased) crash-worthiness.
It is estimated that electric vehicles will be involved in about 6% of all road accidents by 2025. The implementation of results from the research proposed here shall make sure that in spite of their specific challenges, electric vehicles and alternatively powered vehicles in general will not have a negative impact on the number of fatalities and severe injuries on European roads.
Virtual testing offers the opportunity to significantly reduce the amount of physical testing, thereby saving both time and money in the development process. Virtual testing also introduces a large flexibility in what can be assessed, such as the risks associated with a wider range of traffic accidents and spread in vehicle sizes, as well as the performance of novel types of materials and (active) structures without the need of manufacturing expensive prototypes. In addition, virtual testing offers very time- and cost-efficient methods to optimise systems such as structures and protection systems and analyse phenomena that cannot be analysed by mechanical tests, e.g. active human modelling for the pre-crash phase.

Type of action:

Research and Innovation Actions (RIA)

Specifics of this topic:

International cooperation needed e.g. on future mobility solution

Topic: Vehicle technology for two-wheeler safety

Specific challenge:

The main challenge of this topic is to make powered two-wheelers (PTWs) and bicycles more and more attractive transport means for many European citizens by significantly enhancing their safety levels. Sociological and political pressure in terms of reducing energy consumption and improving environmental friendliness have fostered the spreading of the use of PTWs and bicycles due to congestion and limited parking space in urban areas as well as the rising costs of car ownership. However, PTW and bicycle riders represent the most-at-risk category involved and injured in road accidents. In the last decade, the annual number of fatally injured motorcyclists has decreased proportionally less than the European trend of road mortality. A 2008 study of the European Road Safety Observatory (ERSO) reported that 18% of EU road fatalities are motorcyclists although they represent only 4% of EU road users. Accident analysis data in several EU countries (e.g. Germany, the Netherlands and Sweden) show an increase of the number of seriously injured people due to bicycle accidents over the last years, while the number of cyclist fatalities tends to further decrease. Consequently, the strategic objectives no. 7 “Protect vulnerable road users” and no. 4 “Safer vehicles” from the EC’s Policy Orientations on Road Safety 2011 - 2020 call for the reduction of both fatalities and serious injuries in particular among powered two-wheelers and cyclists[12].
The improvement of mobility scooters’ safety has to be considered as a relevant challenge for vulnerable road user safety, too. Based on an extrapolation of Dutch accident data it is estimated that about 30,000 people in Europe are yearly treated in emergency centres and/or hospitals due to accidents involving mobility scooters (like electric wheelchairs), and this number is expected to increase.
Advanced safety features applied to PTWs, bicycles (including electric bicycles and pedelecs), mobility scooters and personal safety equipment should be considered as a major way to reduce crash fatalities and impairments. Due to the peculiarities of these means of transport, design and testing of such devices need to be supported by in-depth analysis up to new regulation with ad-hoc studies and methodologies.

Scope:

The current range of available safety functions for two-wheelers is clearly inferior to the multitude of current commercial devices for cars. At the same time, passive safety functions are almost exclusively limited to the personal equipment / garment of the rider. While not every safety system developed for cars can easily be transferred to two-wheelers, safety systems should follow a similar basic strategy of rider warning, accident avoidance and accident mitigation. Further, as new cooperative applications enter the market, complex scenarios including two-wheelers and cars can only be addressed by integration of the communication among different road users.

Main topics for research concern the design and development of innovative:

- Active safety systems for PTWs and bicycles (including electric bicycles and pedelecs) in order to avoid or mitigate collisions and injuries in critical, close to crash situations. The systems can be cooperative (e.g. ITS systems) or non-cooperative systems.
- Passive safety systems to make a crash as forgiving as possible. The topic addresses standalone and combined in-vehicle systems and personal equipment (e.g. garment and helmet).
- Visual (e.g. lighting) and/or digital (e.g. cooperative systems) conspicuity enhancement should improve visibility and detectability of vehicles and anticipate potential critical or hazardous situations.
- Adaptive human-machine interaction and decision support systems to properly communicate prioritised information from all ARAS (Advanced Riding Assistance Systems) and OBIS (On-Bike Information Systems) and other ITS systems to the users (PTWs, bicycles, mobility scooters (like electric wheelchairs))
- Safety solutions dedicated to particular user categories such as elderly riders, impaired persons (e.g. mobility scooters), novice and returning riders.

[12] COM(2010) 389 final

Considering that two-wheelers are often found in a mixed traffic environment, (e.g. spaces where bicyclists mix with pedestrians, or motorcyclists and cars) the impact of new safety technologies on infrastructure, traffic system and the design of traffic flow could be envisaged.
For all topics market acceptance studies as well as the identification of potential needs for regulatory action should be considered.

Expected impacts:

Due to the risk exposure of powered two-wheeler riders and the limited range of safety technologies currently available, successful safety research for these particular vehicle categories is expected to result in high safety benefits with a substantial reduction of accident numbers and severity despite the increasing number of powered two-wheeler riders in traffic. The systems developed for all types of powered two-wheelers will enhance stability/manoeuvrability and visibility/detectability in general and improve interaction among road users thus contributing to an increased comfort and safety. Significant improvements in safety might also make two-wheelers incl. powered two-wheelers a sustainable solution for many issues in urban mobility, such as congestion and limited parking spaces.
Furthermore, the emergence of new vehicle design technologies is expected, increasing the competitiveness of the European industry.

Type of action:

Research and Innovation Actions (RIA)

Specifics of this topic:

None.

Research Area “Infrastructure, Traffic System & Communication Services”

Topic: Safe roads design – Making them self-explaining, forgiving and interactive for the benefit of all road users

Specific challenge:

Safe roads are infrastructures designed according to two essential principles: being self-explaining (active safety by leading the users to adopt a behaviour compatible with the infrastructure reducing therefore the probability of having a crash) and being forgiving (passive safety by limiting the consequences of a crash). Current design criteria are very far from these essential principles and based on a mobility structure that is now obsolete due to the dramatic changes that road transport and related technology have undergone in the last decades. There is a strong societal need for improving road safety by defining a new way of designing and, most importantly, re-designing existing roads as part of a new system that has new users, new mobility issues, new vehicles, new technologies and new safety needs. Furthermore the new road design concepts have to move towards performance based design concepts based on the evaluation of cost-efficiency of different solutions to enable the implementation of innovative solutions for achieving safer roads for all users.

Scope:

Proposals should address one or more of the following aspects:

- *Improving the infrastructure safety by means of defining advanced design and re-design concepts towards forgiving and self-explaining roads*: development of an integrated design approach accounting for the road safety effects of various elements of the infrastructure providing, as much as possible, quantitative estimates of expected safety performance. Given that Europe already has a consolidated road network, specific attention should be paid to the concept of re-designing existing roads including pedestrian and cycling infrastructures and on interventions that can generate a large safety benefit in a cost-efficient manner for road authorities. The outcomes of the projects shall include software tools allowing to evaluate the cost-efficiency of different design solutions, that could be readily implemented by designers and decision makers.
- *Integrated infrastructure and ITS design for improving the safety of vulnerable road users (VRUs) including children, the elderly and users with specific needs*: identify the necessary adaptations that need to be undertaken in urban design in the short to medium term to improve the compatibility between the infrastructure and the VRUs. The proposals shall address also the issue of how infrastructure design should be adapted to account for the implementation of ITS technologies.
- *Improving road safety by integrating infrastructures and advanced driver assistance systems (ADAS) for safe automated traffic and cooperative driving systems*: understanding how roads could introduce automation and cooperative systems that would enable fully integrated information and control systems. The proposals should include the evaluation of the infrastructure elements that need to be adapted (e.g. road markings and traffic signs) in order to ensure that ADAS can work with a very high degree of reliability under different weather, daylight and road surface conditions. This includes a study on which information might have to be communicated and the corresponding technologies.

Research will fill knowledge gaps at both European and national levels, and take into account regional differences. International cooperation is strongly encouraged.

Expected impacts:

Research in this area will contribute to delivering essential knowledge to make European roads safer contributing to the achievement of the European policy objective of halving road deaths by 2020, and, in the longer term, to the Transport White Paper's "Vision Zero" objective.
The following specific impacts could be envisaged, depending on the proposed project:

- Development of integrated design tools that could enable to define cost-efficient solutions and to implement innovative solutions to maximise the reduction of road fatalities and severe injuries with increasing budget constraints.

- Reduction of the number of fatalities and severe injuries among VRUs and increased attractiveness of alternative transport modes to car driving in urban areas contributing to public health and to the greening of urban mobility.
- Update of the existing road network to allow for the introduction of automation on Europe's roads and optimisation of cooperative services to maximise the impact on driver behaviour and reduction of crashes.

Type of action:

Research and Innovation Actions (RIA)

Specifics of this topic:

None.

Topic: Enhancing safety through advanced road maintenance concepts

Specific challenge:

Road safety can be compromised by poor maintenance management. Europe strongly needs advanced asset management approaches and up to date road safety management methods for maintaining smooth and safe traffic operation. Road maintenance and road safety inspections are essential elements of the road safety management, as they allow operators to spot potential hazards in advance and to prevent accidents on the network. While several technologies have been developed during the last years, there is great room for further methods development to help road authorities improve safety levels through better monitoring of conditions on different types of roads. As stated by the 3rd objective of the EU Policy Orientations on Road Safety 2011 - 2020[13], application of the relevant principles of infrastructure safety management to secondary roads needs to be promoted across the entire road networks.
In parallel, it is essential to increase durability, optimise maintenance interventions and costs and mitigate the adverse effects on safety and traffic (e.g. caused by frequent road works or long-term interventions). Developing new technologies and new approaches will both reduce the need for maintenance intervention and, at the same time, make work zones safer. The challenge is to increase levels of safety on Europe’s roads in alignment with expectations in lifecycle cost reduction, while increasing availability, quality and reliability of the road infrastructure network.

Scope:

Proposals should address one or more of the following aspects:

- Development and deployment of more durable, high performance and easy to maintain roads that can guarantee a high level of safety for users. This will include further research into innovative materials (e.g. high grip pavements in all weather conditions), and new construction methods for roads, bridges, tunnels and other structures. Research into the prevention of deterioration of materials from weather and research into methods of rejuvenation and regeneration of material properties to sustain the quality and durability of pavements, structures and equipment should deliver new materials specifications and design methodologies.
- Development of a holistic solution for asset management that will enable road authorities to maintain high levels of safety on the road network: This could be achieved by a further development of existing asset management to integrate optimised road safety inspection procedures and systems able to deliver continuous information on all the components of the road infrastructure. The various technologies / systems developed should be validated on relevant stretches of Europe’s road network and with a specific focus on secondary roads where high numbers of fatalities occur.
- Consolidation of knowledge on work zone safety: A more harmonised approach for work zones across Europe is crucial to mitigate risks both for road users and for road workers. In-depth analysis of existing regulations and good practices as well as the investigation of national data collection practices for statistic purposes are necessary steps to fully understand the relationship between congestion on work zones and safety. How work zones affect user behaviour should also be investigated.

Expected impacts:

Research in this area is expected to greatly increase levels of safety on our roads as a result of:

- an increase in the life-span of the road, emanating from the development of new, more durable technologies;
- an enhanced capacity of road authorities to identify maintenance needs in advance and perform cost-efficient maintenance;
- a reduced safety risk associated with work zones for both users and road workers.

[13] COM(2010) 389 final

Type of action:

Research and Innovation Actions (RIA) and/or Coordination and Support Actions (CSA)

Specifics of this topic:

International cooperation (with the US, Japan etc.) seems suitable for this area.

Topic: Innovation in ITS infrastructure for road safety – Making use of the connected world

Specific challenge:

Cooperative Intelligent Transport Systems (C-ITS) have the potential to improve traffic safety, increase traffic management efficiency and reduce the environmental impact of road transport by means of wireless vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communication (V2X) and interactions with other road users. Innovation is also important on access technologies playing a crucial role in cooperative systems since they establish the elementary communication link that vehicles and roadside infrastructure use to exchange information with each other.
Nowadays, for cooperative ITS systems and services to enter the market, they will need to overcome large uncertainties surrounding the impacts of these systems on the interaction of the driver with other road users, other vehicles (both manual and automated), his/her own vehicle and the traffic environment. Human machine interface (HMI) design guidelines need to be developed for general HMI integration as well as for information, warning, intervention, and automation strategies for specific safety functions of C-ITS. Meanwhile, for these design guidelines to be effective, guidelines for describing behaviour of automated vehicles will be crucial to enable harmonised deployment of automation within C-ITS. The development of such guidelines should be guided by an enhanced understanding of the basic mechanisms whereby distraction causes crashes. These interactions are crucial for road safety and also for the function of the whole road transport system.
Moreover, liability, privacy, reliability and security should be addressed for safety applications. With potentially billions of interconnected embedded devices, security is of great concern in safety certification processes. A big data and predictive analytics approach is key for organisations in the transportation sector where maintaining both connectivity and mission critical or safety critical services are the norm. Many security failures are not the result of lack of best practices, guidance, tools and security controls and protection measures available, but often they result from a lack of organisational policy establishing those measures, or where policy does exist, lack of effective implementation. For safety critical traffic management systems, security must be ensured as these systems are becoming ever more adaptive and interconnected, typically remotely managed by traffic management centres. Besides maintaining a high security level, data mining methods should be employed within the C-ITS in order to learn and selectively send information to relieve network load and support future applications. Research into traffic management and transit system security is also a priority. Advanced traffic management systems and V2I applications will require a new approach to supporting operations and maintenance of security as an ongoing service to the driving public.

Scope:

Improve technologies for C-ITS for field testing and demonstration projects through enhanced security, privacy and functional safety:

- Set up a framework which can encourage the implementation of privacy-friendly and secure ITS technologies in particular big data and predictive analytics approach
- Ensure trust by setting up an appropriate European authentication and authorisation framework
- Ensure security, reliability, privacy by design and risk management for C-ITS applications especially the safety critical ones
- Promote interoperability throughout all European Member States and beyond
- Ensure compatibility between services in the application layer contributing to safety, sustainability and efficiency for different modes of transports
- Address specifically the need for C-ITS cyber-security both on and off vehicles

Address the heterogeneous issues related to the deployment of C-ITS technologies:

- Understand how safety critical C-ITS applications can rely on heterogeneous communication means
- Understand how C-ITS can better support cross-border, cross-fleet or cross-mode monitoring of goods, e.g. transport of hazardous material
- Ensure reliable end-to-end networks to support multi-vendor, multi-provider and multi-service solutions.

- Study the impact of C-ITS spectrum sharing with other consumer electronics communication devices

Deploy large scale C-ITS fleets:

- Investigate benefits and acceptance of C-ITS technologies through long-term observations
- Study safe interaction principles when deploying multiple C-ITS services along with large number of onboard, nomadic and infrastructure based applications
- Demonstrate in large scale C-ITS applications for connected PTWs, bicycles and pedestrians
- Identify relevant business models offering basic safety applications without decreasing level of business opportunities
- Investigate the potential of next generation traffic management using C-ITS technologies taking into account the mix of cooperative and standard vehicles
- Support the integration of highly accurate maps sourced from probe vehicle data and other infrastructure sensors in order to enable the operation of highly automated vehicles
- Development of systems allowing safe and smooth automated coordination of C-ITS vehicles in different environment (urban, highway, etc.)

Tools for ITS development, assessment and evaluation: extend current tool capabilities to allow assessment of C-ITS applications

Expected impacts:

Creating an environment for cooperative ITS with globally relevant solutions that are trusted by citizens and that incorporate reliability, privacy friendliness, safety and security requirements. Advanced traffic management systems and V2I applications will require a new approach to supporting operations and maintenance of security as an ongoing service to the driving public. The role of institutions and governance is critical to cyber-security.

Type of action:

Innovation Actions (IA) or Research and Innovation Actions (RIA) and/or Coordination and Support Actions (CSA)

Specifics of this topic:

None.

Topic: Traffic management for road safety

Specific challenge:

Traffic management describes the management of the existing road network and its users to maximise safety, efficiency and reliability with minimum environmental impact. The aim is mainly to optimise road space allocation and safe traffic movement for best performance for all road users at all times. Safety needs to be treated as a boundary condition in all efforts to improve traffic management. Effective solutions are still needed considering several traffic management problems like the control of traffic signals, managing incidents and integration of vulnerable road users (VRUs) or other traffic demands like railway or sea travel for a better co-modality. The contribution which efficient traffic management systems may make towards reaching Europe’s road safety objectives is recognised amongst others in the preparation of a European Strategic Transport Technology Plan STTP[14]. Research should take a holistic view on road safety management and strategies (e.g. safe system approach) and support policy making.

Scope:

Proposals should address one or more of the following aspects of traffic management for safety:

- Integration of existing and innovative traffic data / information for real time traffic management and user information (also by means of Safety Performance Functions)
- Anticipate incidents based on valid and good quality data incl. concepts as extended floating car data. Investigate and define the required data quality when using innovative sources of data and for data fusion.
- Advanced incident management including all stakeholders in a comprehensive management system
- Acceleration of post-accident rescue and lifesaving incl. interaction / data sharing of vehicles with rescue systems
- Assessment of ITS and the influence on traffic management: What is the influence of ITS on traffic management processes? How can (cooperative) ITS be deployed in greenfield and brownfield situations safely?
- Improving the scientific background of methods for designing road infrastructure and for classifying roads as an enabler for a network approach: Reserving the motorways for long distance travel and using the other main roads for regional purposes (network safety)
- Safety aspects of making urban spatial structure more multifunctional and land-use more intensive - for shortening distances and supporting modal shift from car use to public transport and walking/cycling aiming at an optimum modal split for overall efficiency and safety of the transport system
- Cost-efficient ways of how the infrastructure can support non-equipped vehicles in the transition phase to vehicle-based safety technologies like eCall
- Identifying good practices in road safety and traffic management processes and exchanging them with emerging European and non-European economies
- Provide scientific evidence for policy making with regard to road safety and traffic management and for ranking road safety with other policy objectives

Expected impacts:

Especially for rural and urban areas several impacts are expected in terms of accident avoidance. For rural areas the impacts of ITS will give some additional benefit while in urban areas mainly improvements for VRU safety are expected. Post-accident and first aid improvements will be also measurable after implementation and observation. Substantial benefits will result in particular for road safety in emerging economies (within and outside Europe) thus contributing to the goals of the UN’s Decade of Action for Road Safety. Moreover, road safety policy making will supported at Community, national and regional level.

[14] COM(2012) 501 final

Type of action:

Research and Innovation Actions (RIA)

Specifics of this topic:

International cooperation with emerging economies is a must for maximising impact.

Research Area “Traffic Safety Analysis & Assessment”

Topic: Understanding what is happening on the road and linking it to measures

Specific challenge:

This research topic closely addresses the EC Policy Orientations on Road Safety[15] by proposing common tools to monitor safety and the effectiveness of measures.
A detailed understanding of the causes of accidents and injuries is a fundamental aspect of a casualty reduction strategy. Despite the importance of this understanding, there is little information available at EU level, and at national level it is concentrated to a minority of the EU 28. This represents a major gap in data and knowledge, needed to provide the necessary information to policymakers, industry and other road safety stakeholders. Without this information it is impossible to accurately identify EU safety priorities or to provide feedback on the operation of safety measures. Policymaking requires information on accidents that can be generalised to EU level, and on top of the missing EU coverage of commonly collected data, there are key road user groups where information is specifically scarce. These include vulnerable road users, vehicles with advanced safety technologies, electric vehicles (cars and two-wheelers) and commuter accidents. Further information is needed about specific risk factors such as alcohol, distraction, fatigue and nomadic devices use. The introduction of the European Commission’s serious injuries strategy[16] poses new demands on accident and injury analysis, particularly concerning vulnerable road users but also vehicle occupants.
The accident causation information is broadly of two types: 1) in-depth accident studies providing possibilities for detailed reconstructions about the pre-crash phase to elucidate accident causation factors and 2) naturalistic data providing risk factors both for normal driving and critical situations such as near crashes. Field operational tests use naturalistic methods to evaluate the performance of specific safety systems in normal use. While there is experience of both methods within a research context, the application to European safety policies has been constrained by methodological limitations and the challenge to relate the data to EU 28. This research topic addresses these constraints.

Scope:

- Development and implementation of a large scale pilot of a systematic framework, integrating causation methods based on both in-depth accident studies and naturalistic data, to provide continual reference for accident causation in Europe. This will also include methods to ensure results are applicable to the wider EU. All types of crashes will be examined and special attention to crashes involving vulnerable road users will enable new safety policies and measures to be developed by government and industry.
- Methods to evaluate the accident avoidance and mitigation effectiveness of intelligent safety systems in the field, especially focusing the new research on automated driving taking into account different levels of automation and different driving environments. Outcomes will include measures of casualty reduction and feedback to industry over the real-world functionality of safety technologies. Methods to capture information on the operation of crash avoidance systems in collision events are also included.
- Methods to analyse naturalistic driving data including automatic identification of near-collisions and aspects of road user behaviour. Establish the relationship between naturalistic driving data and accident studies on the basis of vehicle trajectories and dynamics, infrastructure characteristics and road user behaviours. Develop quantified surrogate measures to enable casualty reductions to be predicted on the basis of naturalistic driving studies and field operational tests.
- Large scale naturalistic studies of all road users, especially focusing vulnerable road users, vehicles with advanced safety technologies, electric vehicles (cars and two-wheelers) and commuter accidents, to identify infrastructure, behaviour and vehicle-based risk factors and evaluate impacts on high-risk scenarios and near-collisions. Examination of interactions between road users, their vehicles and the network.

[15] COM(2010) 389 final; section 5.2 “Common tools for monitoring and evaluating the efficiency of road safety policies”
[16] SWD(2013) 94 final; On the implementation of objective 6 of the European Commission’s Policy Orientations on Road Safety 2011 - 2020 – First milestone towards an injury strategy; 19 March 2013

- Systematic field trials of new safety technologies, especially focusing the new safety research connected to automated driving, ahead of widespread introduction to quantify expected casualty reduction and confirm applicability to all EU traffic conditions.
- In addition leveraging existing data, such as what has been collected in previous naturalistic studies and field operational tests.

Expected impacts:

Systematic accidents and injuries causation information about pan-European accident scenarios is fundamental for the development of safety technologies, policies and other measures. Yet this data is virtually absent for many European Member States, and the availability of basic data needs to be secured for e.g. accidents, traffic, vehicle types, road and infrastructure. Special focus will be on exposure data. These projects together will provide an effective framework to develop, monitor and feedback the performance of safety systems to industry, policymakers and other road safety stakeholders.

Type of action:

Research and Innovation Actions (RIA)

Specifics of this topic:

The US and Australia have conducted in-depth accident investigations and naturalistic driving studies for many years together with a minority of the European Member States. Korea, China and India are focusing their activities on in-depth accident investigations and have recently set up naturalistic driving studies. International collaboration provides strong benefits in terms of harmonisation and development of common methodologies.

Topic: Evaluating impact of safety concepts

Specific challenge:

Road safety management involves a continuous process of assessment, development and implementation of concepts that influence road safety, addressing road user behaviour, vehicle safety system design, infrastructure design and operation of the traffic system. For the selection of safety measures to be implemented, it is important to be able to take an integrated safety approach, looking at the combined effects of different safety concepts. Furthermore, stakeholders wish to balance the expected savings in casualties (and costs) and the required investments for development, implementation and maintenance.
In addition to safety related measures, impact assessment is of major importance to drive legislation and standards before introducing and allowing new mobility concepts on the road. New mobility concepts are for instance Longer and Heavier Vehicles (LHV), advanced automated vehicles or cooperative safety systems that make strong use of communication between traffic participants and infrastructure.
Often insufficient a-priori information is available and it is specifically difficult to predict the expected impact for newly developed concepts. Some estimates of the effectiveness of countermeasures or the impact of new concepts may be available in scientific literature but this might not directly accommodate stakeholders (authorities, industry and consumer organisations) for decision making.
The rapid development of new concepts such as cooperative safety systems places safety benefits alongside other benefits of transport efficiency. The estimation of the combined benefits is not straightforward and new traffic level simulation methods are needed to integrate vehicle, infrastructure, traffic and driver behaviour on a system level to predict impact. Available data sources from previous research should be used to validate models.
Evaluation studies should provide information for different road safety stakeholders including EU and national policymakers, the automotive industry, road designers and operators. Studies aim primarily at showing the actual safety impact of measures. Providing information and demonstration events aim at increasing public awareness.

Scope:

The topic addresses the obstacles for effective safety evaluations by developing new methodologies that enable a comprehensive and systematic assessment of safety measures and by developing dissemination methods to ensure the safety community can be fully informed. A new road safety evaluation framework is required that will conduct systematic evaluations of newly introduced mobility concepts and possible safety countermeasures.

Research needs:

- Development and implementation of a systematic evaluation framework to predict the safety impact of new systems or concepts, including metrics for system effectiveness, reliability and robustness. The framework should be evidence-based utilising real-world data (e.g. through naturalistic data analysis) and use an integrated safety approach.
- Development of a methodology to scale up safety effects of new systems or concepts from the scenario level to regional, national and international levels. Investigation and provision of data to support the scaling up.
- Harmonisation of methods to perform a cost-benefit analysis (incl. social costs with regard to road safety measures as well as long-term impacts of accidents). Creation of an assessment framework for the translation of safety effectiveness results into impact on direct and indirect costs for the EU (e.g. evaluation of long-term injury consequences).
- Valorisation and demonstration of the combined tool chain for the determination of effectiveness and impact of existing safety solutions and new mobility concepts.
- Harmonising data on the EU level to allow efficient combinations of data and/or access to comparable national data (compare US national data).
- Development of a standardised database of road safety evaluations, e.g. incorporated in the European Road Safety Observatory.

Expected impacts:

- Availability to road safety stakeholders of evidence-based methods to predict the impact of new mobility concepts and safety systems.
- Improved capabilities to conduct impact assessment using harmonised methods for all types of systems and road user types. New predictive methods to estimate the impact of technical measures before systems have been introduced.
- Decision making tool to enhance the implementation of effective (safety) systems or concepts in real life, reduction of the time-to-market, reduction of cost, increased market penetration and increased road safety at the shorter term. This will enhance the competitiveness of the industry and support its global leadership.
- Improved methods for allocation of road safety resources. Support to policymakers and other road safety stakeholders to identify the most effective policies, new regulations and legislation. These methods should establish a clear pathway to conduct evaluations of road safety policies.
- Enhancement of the European Road Safety Observatory with an open access library of effectiveness and impact studies. Coordination framework for future road safety evaluations.
- By contributing to the reduction of accident rates, fatalities and casualties, these methods and tools support the Horizon 2020 objective for a better mobility, less congestion and increased road safety, leading to improved mobility for all.

Type of action:

Research and Innovation Actions (RIA) to develop the tools and perform basic research to supply the tools with the required fundamental data and models.

Specifics of this topic:

Harmonisation of future assessment programmes, rules, standards, procedures and requirements for road safety measures and policies in different regions is essential. Cooperation with Japan, the US and other international partners for development and dissemination of test methods will make evaluations comparable on an international level.