Research and Innovation in Transport Safety in Europe

HIGHLIGHTS

→ Safety is essential for transport and mobility, and a key priority for EU transport policy and research and innovation.

→ 143 EU-funded FP7 and H2020 projects addressing transport safety in all transport modes have been selected for analysis. Their total budget is EUR 929 million.

→ Cross-cutting research themes include digitalisation, with vehicle and operations automation, big data and virtual testing as safety enablers, human factors and safeguarding performance.

INTRODUCTION

Overall context

Safety is essential for mobility, and Europe can be proud of being the safest regions in the world. However, avoidable accidents still occur, especially in road transport, resulting in devastating consequences for victims, families, and communities, as well as financial costs for society.

Improving road safety and maintaining excellent safety records in aviation, rail, and waterborne transport is therefore a priority in the European Union's transport policy, as outlined in the Sustainable and Smart Mobility Strategy [1]. In the wider context of sustainability, improving road safety is a key lever for encouraging modal shift to active and micro-mobility in urban areas. This shift is crucial for improving quality of life and achieving climate neutrality in cities. Additionally, increasing rail traffic and replacing fossil fuels in the aviation and waterborne sectors also necessitate further safety improvements.

Research and innovation (R&I) play a crucial role in improving safety across all transport modes, developing vehicle and infrastructure technologies, safety management procedures, and complementing safety policy and legislation. The digital transition creates new opportunities for safer transport.

Policy overview

Transport safety and security is one of the ten key action areas of the Sustainable and Smart Mobility Strategy's action plan. Furthermore, the New EU Urban Mobility Framework [2], emphasises the importance of the safety of micro-, active, shared mobility, and public transport as means of achieving a shift towards greener transport.

The objective of **Vision Zero** is to have near-zero fatalities or serious injuries in EU roads by 2050. The EU Road Safety Policy Framework 2021-2030 [3] outlines the action areas: **infrastructure** with a focus on safe roads and roadsides, **safe vehicle** technologies, **driving behaviour**, and **response and rescue**. It also sets up the monitoring of 8 Key Performance Indicators (KPI) to track progress towards Vision Zero.

Continuous effort is necessary to maintain excellent safety results in air, sea, and rail travel. The European safety agencies such as the European Union Aviation Safety Agency (EASA), the European Maritime Safety Agency (EMSA), and the European

Union Agency for Railways (ERA), set certification and operational standards in line with international organisations, and oversee and monitor their implementation in the EU.

For aviation, Fly the Green Deal [4] outlines policy perspectives and R&I needs, including safety challenges related to sector competitiveness, automation, drones, airspace management, cybersecurity, and extreme weather. Further initiatives include the European Aviation High-Level Group on AI, for safe automation in air traffic management (ATM) operations, and Data4Safety, for secured identification of anomalies and potential incidents.

For rail, the policy focus [5] is on the promotion of safety culture, the rollout of new versions of the European railway signalling and train protection system (ERTMS), harmonising automatic train protection and communication systems and safety rules across the EU.

In the maritime sector, the European Commission (EC) will review existing legislation on flag state responsibilities, port state control, and accident investigation to enable safe, secure, and efficient maritime transport. EMSA guidelines address the human element in navigation accidents, which affects the safety of vessels and people on board.

Research policy includes safety-relevant calls in the European Framework Programmes. Furthermore, the European Public-Private Partnerships in the domain of transport establish roadmaps and R&I programmes, with safety always as a core requirement. These include the Connected, Cooperative, and Automated Mobility (CCAM) partnership, the SESAR3 Joint Undertaking, Europe's Rail Joint Undertaking, and Zero Emission Waterborne Transport.

Method

This policy brief presents an overview of R&I in transport safety in Europe and recommendations for future orientations. It is based on the full report [6] by TRIMIS, the **Transport Research and Innovation Monitoring and Information System** [7]. The current analysis covers projects mostly funded under the Horizon 2020 (H2020) Framework Programme since 2014, with safety as a primary focus or core requirement for the project. The dataset of selected projects is available in [8].

FINDINGS

Research efforts and trends

143 EU-funded projects were selected for the analysis of R&I in Transport Safety. For each mode, projects were grouped in thematic clusters which showcase the overall R&I trends. The majority come from the H2020 programme (130), yet FP7 projects were also considered for aviation safety.

For road safety, the 47 H2020 projects that were reviewed (Figure 1), accounted for EUR 283 million of EU funding for a budget of ca. EUR 330 million. Projects primarily address the safe vehicle technologies and driving behaviour action areas of [3]. Driver assistance systems, vulnerable road user detection and avoidance, driver fitness and distraction monitoring and alert, receive most attention. Virtual testing will lead to safer design and certification of vehicles and infrastructure. CCAM

projects aim at future proofing road transport towards increased automation.

Figure 1 – H2020 road transport safety R&I effort [6]
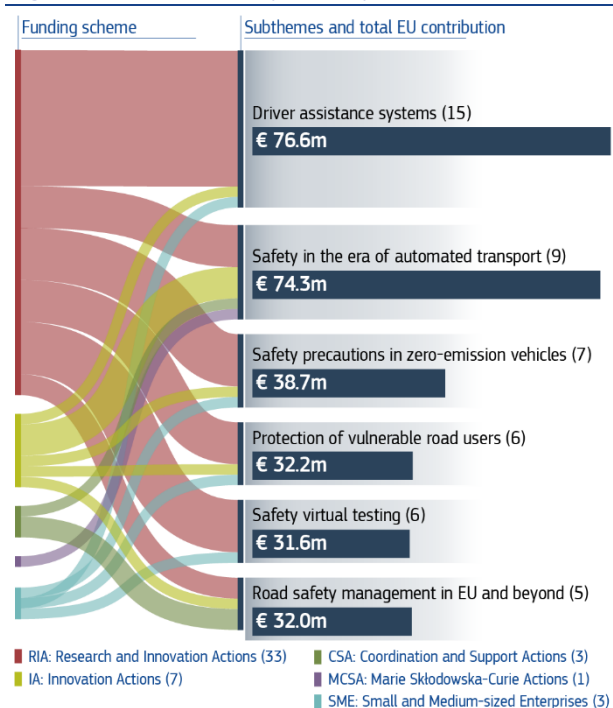
In waterborne safety R&I, the 9 H2020 projects (Figure 2) account for EUR 74 million of EU funding for EUR 81 million of budget. Focus is put on detection and communication for safe navigation, human factors for safe navigation and safe evacuation during emergencies, and smart safety equipment.

Figure 2 – H2020 waterborne safety R&I effort [6]
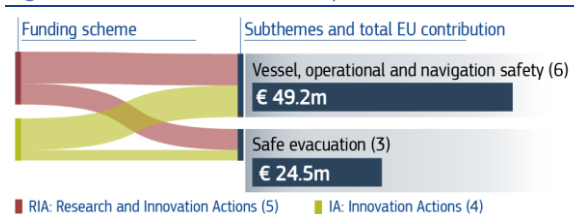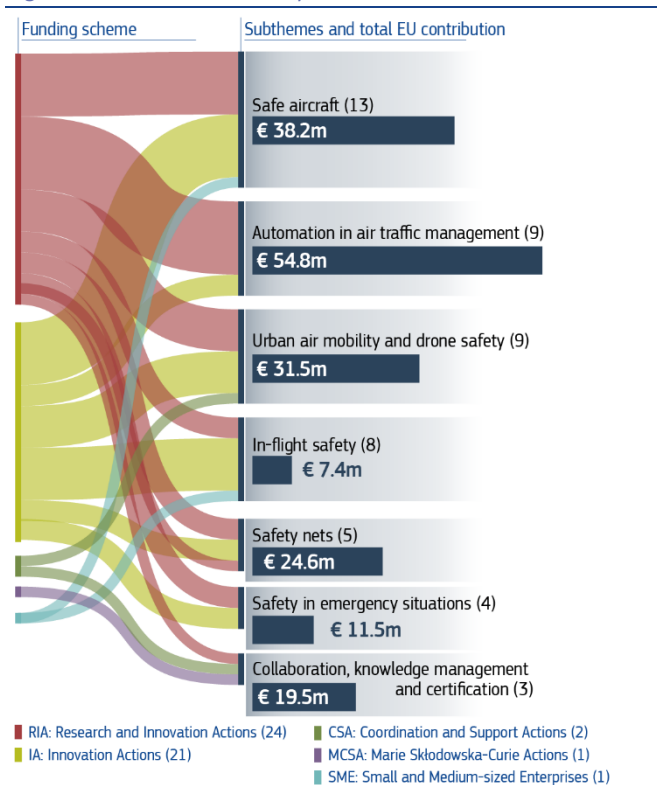

In rail safety R&I, the 22 H2020 projects (Figure 3) received EUR 94 million of EU funding for EUR 129 million of budget. Focus is put on infrastructure safety and security as most accidents occur due to unauthorized track crossings. EU Rail's projects advance towards high rail capacity and traffic concepts while maintaining safety.

Figure 3 – H2020 rail safety R&I effort [6]
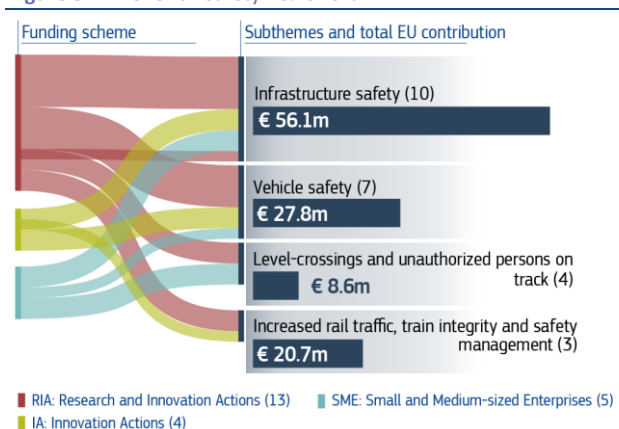
In aviation safety (Figure 4), 49 H2020 projects received EUR 180 million of EU funding for EUR 275 million of budget. Focus areas include improving aircraft safety, considering extreme weather but also preparing for alternative fuels and fuel cells. Increasing automation and the use of AI in Air Traffic Management is both an opportunity and a challenge. Finally Urban Air Mobility and Drones create new safety requirements that require R&I, regulatory and industrial effort.

Figure 4 – H2020 aviation safety R&I effort [6]

Funding scheme | Subthemes and total EU contribution

Safe aircraft (13)
€ 38.2m

Automation in air traffic management (9)
€ 54.8m

Urban air mobility and drone safety (9)
€ 31.5m

In-flight safety (8)
€ 7.4m

Safety nets (5)
€ 24.6m

Safety in emergency situations (4)
€ 11.5m

Collaboration, knowledge management and certification (3)
€ 19.5m

■ RIA: Research and Innovation Actions (24)　■ CSA: Coordination and Support Actions (2)
■ IA: Innovation Actions (21)　■ MCSA: Marie Skłodowska-Curie Actions (1)
　　　　　　　　　　　　　　　■ SME: Small and Medium-sized Enterprises (1)

Box 1 - R&I funding sources

Marie Skłodowska-Curie Actions (MSCA) invest in the careers of excellent researchers and often focus on the development of methodologies.

Research and Innovation Actions (RIA) address new R&I opportunities and aim their technical maturation. Most projects in transport safety were funded by RIAs.

Projects funded under Innovation Actions (IA) indicate solutions that are demonstrated in pilot deployments during the project.

Projects funded under the SME-2 instruments aim market readiness and deployment for promising innovations.

Coordination and Support Actions (CSA) promote sector-wide collaboration and knowledge management.

R&I common patterns across modes

Several patterns emerge from the R&I activities across modes. These patterns are related to the opportunities that digitalisation provides, the challenges of increasing traffic for certain modes, adverse weather and navigation hazards, and the study of human factors for the preservation of capacity, alertness and preparedness for every actor and in any situation.

Simulation and virtual testing allow to generate plausible traffic use cases and outcomes, with a great potential for safe design and certification of vehicles and infrastructure. **Safety data** collection and processing improve the understanding of causalities in incidents and accidents, and pinpoint the conditions that policy, R&I and industry need to focus on. **Performance indicators** extracted from safety data allow to benchmark progress. **Artificial Intelligence** (AI) trained on safety data allows to identify risk areas, predict the evolution of weather hazards, propose optimal navigation paths, and assist human operators both in the cockpit and control tower.

Concerning **human factors**, vehicle operator fitness monitoring and alert apply on all transport modes. The study of human behaviour under stress or distraction, has applications in innovative training for safe conduct under stressful conditions, to achieve positive outcomes in emergencies such as evacuation. Work on human machine interfaces, e.g., dashboards and mobile applications, contributes towards seamless and transparent interaction between human operators and automation.

CONCLUSIONS

R&I brings essential contributions to transport safety and is crucial to achieve the overarching objectives of the Sustainable and Smart Mobility Strategy. The analysed projects investigate automation, digitalisation and telecommunications as levers for improving operational safety for all modes. Human factors, for the preservation of operator fitness and alertness, and for the adequate response to emergencies, are appropriately investigated. Safe vehicle design is a consistent R&I theme, considering the challenges introduced by increasing levels of automation and the use of alternative fuels and energy sources in all transport modes. The reader is referred to the full report [6] for an overview of technological solutions and achievements and detailed analysis of projects.

Way forward

On the way forward, transport safety R&I will continue to leverage the potential of digitalisation while contributing to overall objective of Sustainable and Smart Mobility. The current research and innovation themes outlined in the brief will be further developed for practical implementation.

Sustainability objectives, such as increasing rail traffic will require continuous effort in safe high-capacity concepts that use precise geolocation and telecommunications. Similarly, decarbonisation of the aviation and waterborne sectors will need further developments to ensure the safe use of alternative fuels.

The benefits of automation and digitalisation as safety enablers have already been demonstrated, but their large-scale implementation requires considerable effort from all stakeholders. R&I can explore opportunities for synergies in cross-cutting topics, such as safety data management, human performance monitoring, and the use of AI for accident investigation and prediction of navigation, traffic and weather risks.

It is critical for R&I to investigate the cost effectiveness of safety measures, especially for modes that are prioritized for modal shift and transport decarbonisation, including rail, waterborne transport, and active, micro- and shared mobility in road transport. This presents a challenge for R&I at low and medium technology maturity levels, and efforts are needed to establish a harmonised methodology for estimating and reporting cost effectiveness in EU-funded projects.

Road transport safety can benefit from further showcasing the benefits of the **safe system** approach, which is a key policy priority. R&I can evaluate and demonstrate the combined benefits of technological innovation with non-technological measures such as speed reduction, infrastructure design, signage, and behavioural adaptations. R&I projects should also engage with the **road safety KPIs** as a policy initiative to measure progress towards Vision Zero, making the link between the solutions they develop and the indicators that they can improve. Safety data from on-board and infrastructure sensors, crowd-sensing and communication solutions can also be used for KPI monitoring. Further effort should be directed in **improving infrastructure** design, materials and signage, especially in rural areas.

R&I can help reduce regional differences in safety performance regarding rail and road transport by analysing the underlying causes and investigating relevant policy and technical solutions, including knowledge management and collaboration between member states.

Ensuring the safety of general aviation is particularly crucial as urban air mobility begins to become a reality. This can be achieved through enhanced cockpit and pilot aid solutions, remote piloting in emergencies, improved aircraft survivability, and effective distress tracking and localization systems.

> ### Box 2 Related and future JRC work
> Since 2017 TRIMIS reports have covered a wide range of transport topics and presented analyses of relevant research and innovation initiatives in Europe, providing recommendations to policy makers on future initiatives.
>
> The JRC engages in research and policy feedback for road vehicle safety, including testing the safety of connected and automated vehicles, electro-mobility and battery safety, and in-service conformity of vehicle safety systems and advanced driving assistance systems.

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[8] List of projects dataset *https://data.jrc.ec.europa.eu/dataset/fd8c2211-ef60-4843-9ff9-62971f94e109*

DISCLAIMER OR OTHER FINAL DETAILS

This document is based on the JRC Science for Policy Report: Cheimariotis, I. et al. 2023 [6].

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