A Review of Real-Time Safety Intervention Technologies

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The i-DREAMS project

- **13 Project partners:**
  National Technical University of Athens, Universiteit Hasselt, Loughborough University, Technische Universität München, Kuratorium für Verkehrssicherheit, Delft University of Technology, University of Maribor, OSeven Telematics, DriveSimSolutions, CardioID Technologies, European Transport Safety Council, POLIS Network, Barraqueiro Transportes S.A.

- **Duration of the project:**
  48 months (May 2019 – May 2023)

- **Framework Program:**
  Horizon 2020 - The EU Union Framework Programme for Research and Innovation - Mobility for Growth

Background

- The potential influencing factors that affect the **likelihood of road crash occurrence** and the ways to reduce them have been of major interest for researchers
- The use of in-vehicle real-time intervention technologies prove to be an **efficient solution**
- Providing drivers with relevant and concise, as well as **comprehensive and timely information** is of paramount importance, allowing them to understand and react to a risky situation in a sufficient time
- Usual factors targeted through real-time interventions, include **mental state** such as fatigue, drowsiness, distraction, stress and emotions as well as **driving behaviour** in terms of speed, harsh events, safety distance and lane position

Objectives

- **Review and assess** the variety of real-time safety intervention strategies and technologies for each transport mode, with the explicit purpose of ranking them based on how effective they are towards road safety outcomes:
  - Cars
  - Trucks
  - Buses
  - Rail (i.e. trams and trains)

- Technologies are distinguished on their modality and are assessed based on their **acceptance by the users**

Methodology

- A **standardised coding template** was utilized to record key data from individual studies and concrete guidelines for summarising the findings per real-time safety intervention technology

- Literature was searched within **scientific databases** such as Scopus, PubMed, ScienceDirect and Google Scholar

Mode	Key words	Screened papers	Included papers
Car	"real-time interventions" OR "in-vehicle interventions" OR "real-time feedback" OR "real-time technology" OR "feedback" AND "car drivers" AND "cars"	71	6
Truck	"real-time interventions" OR "in-vehicle interventions" OR "in-vehicle feedback" OR "feedback technology" OR "feedback" AND "truck drivers" AND "trucks"	48	5
Bus	"real-time interventions" OR "in-vehicle interventions" OR "in-vehicle feedback" OR "feedback technology" OR "feedback" AND "bus drivers" AND "buses"	23	5
Rail	"real-time interventions" OR "in-vehicle interventions" OR "real-time feedback" OR "real-time technology" OR "feedback" AND "trains" AND "trams"	10	1

Results

- Findings from the literature demonstrated that real-time feedback was usually delivered via **embedded devices or smartphones**
- **Visual, auditory and haptic warnings** or combinations of both were found to enhance driving safety and were the most popular among the studies investigated
- **Dashboard displays, head-up displays, steering wheels and seatbelts** were versatile and effective solutions for providing real-time feedback to drivers

Modality	Technology	Assessment	Assessment
V	Dashboard Display	●	versatile, can display detailed information, available in all cars
V	Head-Up Display	●	versatile, within line of sight
V	Augmented Reality	●	risk of distraction, not commercially available
V	Centre Console Display	●	far from normal line of sight
A	In-Vehicle Auditory System	●	overrides music, provides navigation, can be positioned in multiple locations (left/right)
H	Steering Wheel	●	intuitive to steering actions (lane keeping)
H	Driver Seat	●	limited information, no available solutions
H	Pedals	●	intuitive with regards to feet actions, contact is required, limited information and applications
H	Seatbelt	●	maintains contact with driver
V & A & H	Nomadic Devices	●	many different devices are available, many options for interventions, commercially available in all vehicles
Modality: V: Visual, A: Auditory, H: Haptic **Assessment in terms of Acceptance/Effectiveness: ● : High, ● : Medium, ● : Low**			

Cars

- In-vehicle signal systems with an on-board display such as the multi-modal detection system, **SASPENCE**, as well as in-vehicle auditory platforms such as **CarChip Fleet Pro** were the most efficient real-time driver distraction detectors
- Multisensory **wearable modules and optalert glasses** had a robust effect on both drowsiness and driving performance
- Safe and eco-driving applications, such as **DriveGain and Drivewise** were a cost-effective solution to modify drivers' behaviour
- **Dutch navigation system and Zephyr BioModule Device** were less effective and acceptable by the drivers due to possible distractions from driving

Trucks

- Technologies that were utilized to detect and monitor truck driving behaviour in real-time were non-intrusive, mainly through a **web-based safety platform**
- Driver monitoring systems, such as **FleetCam, SmartDrive SR4 platform, Bendix Wingman Fusion system and Nauto Prevent** improved driver reliability and safety and provided satisfaction to truck operators
- These real-time intervention technologies were found to be an **important proactive solution** with fewer distractions and collisions for professional drivers
- **Driveri vision-based platform** was not utilized by non-professional operators and personal car users, due to the device's expensive cost

Buses

- New technologies **utilizing only cameras** have emerged but they depend heavily on hardware
- **ZF Openmatics, WebFleet, and MixFleet** were indicated as the best options for ensuring safety, operational efficiency and compliance
- Only a few applications took **eco-driving into account** (e.g. Green Road Bus Telematics and Trimble)
- **Trimble** was the most comprehensive intervention approach as it combined real-time and historic information to inform and consult drivers
- Applications developed by fleet manufacturers, such as **Daimler, Volvo or MAN** were less transferable to other fleets

Rail

- **Automatic Warning System and Train Protection and Warning System** were the two safety systems fitted in the majority of trains

- Similar warning systems such as Automatic Train Protection and Train Protection System were the **best on-train monitoring recorders** which were designed to alert drivers on excessive speeds, providing auditory and visual warnings or signals in order to apply emergency braking if needed

Conclusions

- **Visual and auditory sensors or eye-tracking** might have lower initial hurdles regarding acceptance in cars and trucks, while visual information is essential in real-time for rails

- With the exception of trains/trams, in-vehicle devices with small size, sound alerts and smartphones could be easily **modified and transferred**

- Interventions targeting driver capacity aspects that combine **driving behaviour and operator's mental state** are currently not available

Impact

- Real-time interventions would be triggered based on **specific indication of the safety level** of the environment
- The selected interventions should be versatile and quick in providing feedback, but simultaneously should aim at being as **less obtrusive and distractive as possible**
- Attention should be given on the exploitation of the sensors inside each vehicle so as to **capture all the necessary aspects** required for operator state enhancement and coaching

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