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D8.3
Policy Recommendations

Safe tolerance zone calculation and interventions for driver-vehicle-environment interactions under challenging conditions

iDREAMS

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1 Introduction

1.1 About the project

i-DREAMS was set up to help mitigate the influence of key human factors on road crashes and injuries. It has been established scientifically that distraction, fatigue and drowsiness, health issues, as well as strong emotions impact safe driving. Against this backdrop, the i-DREAMS project has developed, tested, and successfully validated a system that provides feedback and interventions to keep drivers and operators of different transport modes within the boundaries of safe operation.

Considering car, bus; and truck drivers as well as operators in the rail, aviation and maritime sectors, the concept of a 'Safety Tolerance Zone' has been explored in a series of field trials in five European countries. The i-DREAMS system combines dynamical real-time feedback for the driver with customized post-trip interventions for long-term change towards safe driving (Figure 1).

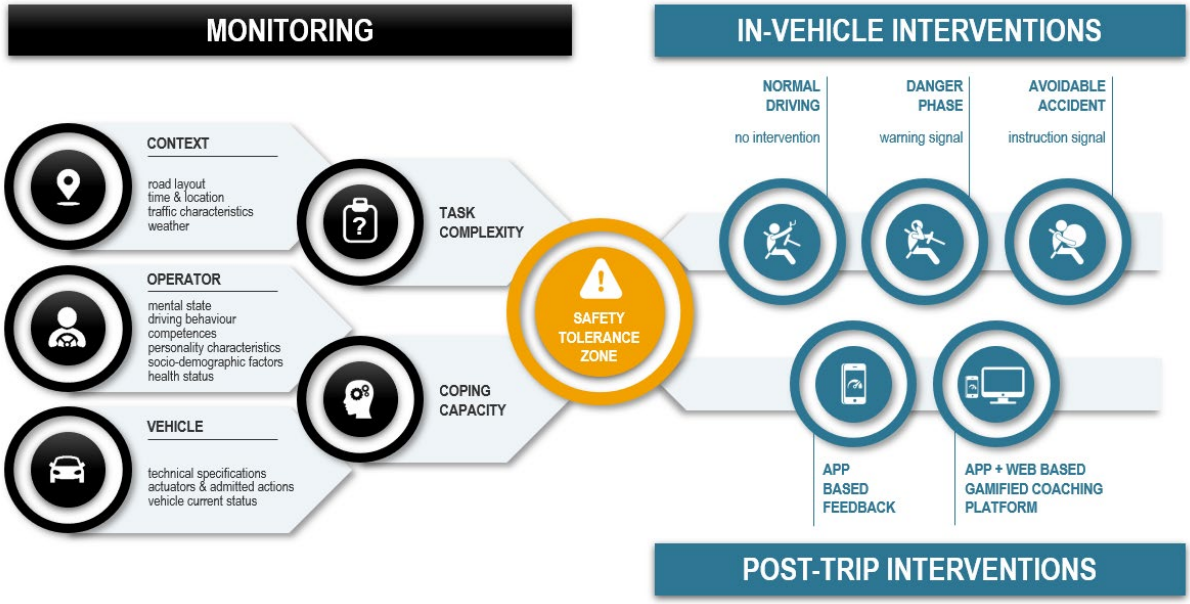


Figure 1: Conceptual framework of the i-DREAMS platform

1.2 About this report

The main aim of the document is the societal valorisation of i-DREAMS, i.e., to provide policy recommendations to society stakeholders across Europe on how transport safety can be improved by the implementation of the concepts and tools developed in i-DREAMS. This advice is tailored to individual stakeholder's requirements, spheres of activity and areas of influence. It covers all relevant areas, from EU level to national and local authorities, and targets also industrial stakeholders. In total, this document provides key recommendations for more than ten groups of target audiences. In chapter 2, per stakeholder group the following information is collated:

- a sketch of i-DREAMS' added value for the specific audience
- the most relevant recommendations
- consultations which were already made, topical case studies carried out during the project lifetime, and – where available – practical results which were obtained.

Chapter 3 provides links and descriptions to further i-DREAMS information media relevant for individual stakeholders. Chapter 4 presents general conclusions of this report and draws together the most important recommendations.

As this document addresses a wide range of stakeholders across Europe, the *policy* recommendations given partly go far beyond the political realm.

2 Policy recommendations

The wide-scale application of the various products developed by the i-DREAMS consortium has shown potential to bring about substantial safety improvements in Europe[1]. The following subchapters therefore address a variety of authorities, organisations & associations, and enterprises with tailored recommendations, from EU-level to local authorities & their public transport providers as well as corporate fleets within private and car sharing companies.

An important general recommendation applies to all the stakeholder groups hereunder, namely that at all times the necessary actions to safeguard privacy of the users of Information and Communications Technology systems (ICT) like the one devised by i-DREAMS need to be taken.[2]

2.1 Recommendations to European Commission

i-DREAMS has unveiled that substantial potential lies with the concept of a safety tolerance zone for drivers and operators across Europe. Although focusing on road transport, the project showed that safety improvements can be achieved also in other transport modes, such as in the rail, maritime and aviation sector. Therefore, it is recommended to the European Commission to

- include further exploration of the concept of a safety tolerance zone in forthcoming **research calls** of the European Commission, e.g., in the framework of Horizon Europe, and seek to launch larger field trials, also involving, amongst others, OEMs and sectoral authorities, and to involve at least the road and rail sectors. For example, more research is required to link the impacts on the lower-level objectives obtained in the i-DREAMS project (i.e., change objectives, performance objectives, safety promoting goals) to the highest-level objectives targeted by the i-DREAMS project (i.e., the safety outcomes). Besides the main safety outcome, (i.e., a reduction in the number of various crash types) other outcomes more related to eco-efficiency such as fuel consumption and related cost savings, emission of greenhouse gases, et cetera could also be explored since the i-DREAMS technology incorporates driving parameters relevant in the context of eco-driving. Accordingly, the proposed pathways to impact can be empirically validated and quantified. For further research needs, it is recommended to consult with the European Road Transport Research Advisory Council (ERTRAC), see also chapter 2.2 hereunder.
- **pay equal attention to post-trip feedback** as an instrument to boost the effectiveness of in-vehicle driver assistance systems (ADAS). The i-DREAMS project has demonstrated that drivers who improved their safe driving performance the most were those drivers who also engaged actively with the gamification features in the i-DREAMS app. Hence, in addition to implementing EU regulations on ADAS in vehicles (real-time in-vehicle interventions), **regulation could also pay attention to systems or apps** that provide drivers more insight and support in improving their safe driving behaviour after the trip (post-trip feedback).
- consider the principles devised by i-DREAMS in future amendments of legislation relevant for **Certificates of Professional Competence** (CPC) in the realm of qualification and (re)training of professional drivers.

[1] i-DREAMS Deliverable 7.2: Effectiveness evaluation of interventions

[2] As a general rule, drivers, without exception, need to be asked for their permission to have their data logged when they drive and other road users (e.g., filmed with a dashcam) need to be anonymised, by blurring licence plate numbers and faces.

- share i-DREAMS results with members of the **European Expert Group on Urban Mobility** (EGUM) and its respective subgroups, with a view to contributing to urban transport safety across the Union.
- consult with the **Conference of European Directors of Roads** (CEDR) on ways how (real-time) infrastructure, traffic and incident data can be made available & exploited in future versions of i-DREAMS technology.
- especially for the **rail** sector (trams and trains) we recommend that the principles of the safety tolerance zone are used to further **adapt the i-DREAMS platform** for adoption in the rail sector through the identification and trialling of appropriate monitoring technologies (currently adapted and new).
- include further **exploration of nudging** for achieving sustainable safety behaviour in the **maritime transport** sector in forthcoming research calls of the European Commission, e.g., in the framework of Horizon Europe.
- initiate a more systematic **scientific exchange** between the **road and aviation** sectors, in order to explore synergies with 'safe envelopes' used in aviation and the decades of experience of automation and cockpit warnings in aviation.
- **monitor the safety culture** and tolerance zones in aviation, especially within the post-covid increase in operator workload and pressure.
- consider, in the process of shaping the future EU's transport system, the fact that i-DREAMS technology has been successfully tested with drivers & operators in countries with different socio-cultural and socio-economic settings – and therefore constitutes an **indispensable safety tool to be utilised across the Union**.

2.2 Recommendations to the European Road Transport Research Advisory Council

The European Road Transport Research Advisory Council (ERTRAC) regularly issues a Safe Road Transport Research Roadmap[3], outlining key needs to future safety research in the EU. One of the prime audiences of this document is the European Commission (DG RTD), with a view to implement the identified research needs in forthcoming calls in research programmes (currently: Horizon Europe).

The following topics & research questions have shown to require additional focus in future research endeavours at European level, therefore we recommend including them as research needs into the forthcoming version of the ERTRAC Safe Road Transport Research Roadmap

- State-of-the-art research on Connected, Cooperative and Automated Vehicles (CCAV) shows that the safety impact potential of these higher-level technologies is dependent upon Market Penetration Rates (MPR), and that these in turn rely heavily upon user acceptance with the following two factors being crucial precursors of technology acceptance: (1) perceived usefulness, i.e., the level up to which technology is believed to improve drivers' safety, and (2) perceived compatibility, i.e., the level up to which users experience a match between technology operation and personal driving behaviour. **More research is needed on how assistive vehicle technologies can be made situationally adaptive and tailored to an individual's driving style without ever compromising safety**. This requires adequate detection and mimicking of individual decision-making and behaviour in real-time with

[3] https://www.ertrac.org/wp-content/uploads/2022/07/ERTRAC-Safety-Roadmap-2021.pdf

simultaneous insurance of vehicle operation continuously remaining within the objectively available safety margins.

- Research in the field of Behavioural Sciences has consistently shown that sustained behavioural change not only requires the opportunity to demonstrate the desired behaviour and the necessary (physical and mental) capacities to do so, but to a large extent also depends on personal motivation. In the context of user acceptance towards ADAS and higher levels of automation (SAE-levels 4 & 5), current attention mostly went to examining how assistive in-vehicle technology (1) can identify and signal situations where changes in vehicle operation are required (i.e., opportunity-oriented functionalities), and (2) effectively reduce error margins and increase margins for correction (i.e., capacity-oriented functionalities). **Much less however is known about ways to increase people's willingness to make appropriate and sustained use of such technology (i.e., motivation-oriented functionalities).** This actually requires a *persuasive* approach in terms of system design where the focus is more on how assistive in-vehicle technology can effectively influence the socio-cognitive and affective aspects involved in safety-related decision-making.
- Engagement and retention in the context of the uptake of (pre/post-trip) behavioural interventions supported by mobile technologies requires more than a user-friendly design, learnable user protocols, or an attractive front-end. **More research is needed on how the concept of Just-In-Time-Adaptive Interventions (JITAI) can be implemented** in order to tailor intervention content, dosing, frequency, and timing to momentary personal needs and available opportunities for intervention uptake, with special attention to the **possibilities for Artificial Intelligence (AI)** to realize this.
- Available research on occupational health and safety indicates that corporate safety culture is important to consider in the context of adoption of (real-time and post-trip) interventions aimed at monitoring and influencing vehicle operation of professional drivers. **More research is needed on how to successfully anchor and embed such interventions in the safety-oriented policies and programmes of transport companies.**
- Technology-supported (pre/post-trip) interventions for the promotion of safety and eco-efficiency are usually a combination of different behavioural change techniques simultaneously applied and targeting a variety of psychological determinants of behaviour. **Effectiveness studies are usually unable to uncover which constituent intervention components generate the desired effect on behaviour (or not), and which underlying psychological determinants mediate or moderate such an effect.** Also, it often remains unclear to what extent users actually were exposed to and interacted with intervention tools used, and **whether (and to what extent), intervention effectiveness is dependent upon such exposure (i.e., dose-response relationships).**
- Vehicle telematics data can be a useful source to learn more about an individual's driving style, for example through the inference of (different severity levels of) events for different driving parameters monitored by sensors. **Such data however can be further enriched with video footage, providing deeper insight into the situational context where events detected were occurring.** Via more advanced Deep Learning techniques, it could for instance be explored to what extent vehicle operators themselves were responsible for events detected or not, or which circumstances or road conditions can be qualified as more risk prone.

2.3 Recommendations to Member States' federal and regional levels: Transport Ministries & Home Offices

Transport Ministries and Home Offices in all EU Member States have key roles in setting the scene in road safety, but usually also in the safety of other modes. In the road sector, they do so not only by issuing and further developing national legislation such as the Highway Code and its enforcement but also by putting forward long-term road safety programmes and strategies. As a common rule, these programmes and strategies concentrate on the classical pillars of road safety work, driver behaviour being one of them. Influencing driver behaviour is usually centred around education, campaigns, and police enforcement of traffic rules. Lesser attention is so far given to the topic of nudging drivers towards safer behaviour through targeted feedback by advanced driver assistance systems (ADAS) including through gamification and rankings among groups of (professional) drivers in various fleets, as has been successfully trialled in i-DREAMS.

It is therefore recommended to Federal and Regional Ministries of Transport & Home Offices to

- include in forthcoming **road safety programmes** and strategies supportive action for the proliferation of ADAS-based feedback to drivers as brought forward by i-DREAMS.
- make available funds in national or regional **applied research and implementation programmes** to support the practical deployment of methods and tools as proposed by i-DREAMS in specific fleets, be they public or private.
- foresee, in the mid-term, that **fleets of ministries and their contractors** should be equipped with advanced safety features that seek to keep drivers in their safety tolerance zone. This entails that award criteria of public procurement procedures grant extra points if an applicant shows that their vehicles feature i-DREAMS-related safety technologies.
- use, in addition to crash data from police records, location-based information on clusters of critical driving manoeuvres, as available in i-DREAMS event data maps, e.g., to help raising the **efficiency of targeted police enforcement**, to validate the locations of existing speed cameras and section controls, and to identify sections of crash-prone infrastructure (grey spots/zones) for treatment.
- consider the use of i-DREAMS technology as part of **Traffic Offenders Rehabilitation Programs** to monitor driving behaviour of convicted traffic offenders (similar to the use of alcohol locks).
- consider **adopting the concept of the safety tolerance zone** and adapting and applying it to the rail mode, especially when considering adding additional technologies.
- establish **new guidelines for the maritime transport industry** to provide continuous feedback to their operators (i.e. the ship crew) about their navigation behaviour;
- provide **additional training programs and workshops around the overall safety culture** and adoption of new technologies, as shown in i-DREAMS, for addressing human factors in the rail and maritime transport sectors.

2.4 Recommendations to Public Transport Authorities & Operators

Guaranteeing a safe and continuous operation - and thereby consuming as little cost-intensive energy resources as possible - are among the prime objectives of any provider of public transport. It therefore seems highly appropriate to make as many operators across

Europe as possible acquainted with the i-DREAMS products and provide them with concrete advice how to implement them. This embraces both public providers and those private operators who deliver their services under a public contract.

They are recommended to

- proactively support the building of a **safety culture** among their drivers by equipping vehicles with i-DREAMS technology – be it on a fleetwide or pilot basis
- employ **safety counsellors** who challenge teams of drivers to reach higher safety levels by making use of the i-DREAMS gamified coaching platform.
- **monitor and evaluate** the development of the numbers of incidents, crashes as well as the development of energy consumption before and after implementation, to substantiate the added value of i-DREAMS technology.
- promote that **fleets of contractors** be equipped with advanced safety features that seek to keep drivers in their safety tolerance zone. This entails that award criteria of public procurement procedures grant extra points if an applicant shows that their vehicles feature i-DREAMS-related safety technologies.
- When introducing new technology for the rail mode, consider how it integrates with the existing technologies – the concept of the safety tolerance zone and the i-DREAMS platform is a useful guide. In order to maximise adoption and compliance of new technology, involve the drivers in the process at the earliest opportunity to explain the safety benefits and understand driver issues.

➢ i-DREAMS partner POLIS – a European association with a membership of dozens of municipalities, regions, authorities and public transport providers – has already consulted with individual members and other counterparts on potential implementation scenarios of i-DREAMS technology. A presentation of i-DREAMS was made at the POLIS Annual Conference in November 2022 by i-DREAMS coordinator Hasselt University.

2.5 Corporate fleets: truckage, coach, taxi or car sharing companies as well as fleets of company cars

Many EU Members States' new car registration databases convey that corporate fleets have become the largest buyer group not only of lorries and delivery vans but also passenger cars. Like for public transport fleets, a low number of crashes (and hence maximised availability), a defensive driving style (leading, amongst other things, to lower maintenance costs) and minimal fuel consumption are among the prime objectives – not least for reasons of corporate social responsibility. Therefore, great saving potential can be assumed from the deployment of i-DREAMS technology in corporate fleets.

It is therefore recommended to corporate fleet operators to

- make **safe and defensive driving** a core objective for all users of the corporate truck, coach, taxi, sharing or company car fleet.
- support that goal by incentives such as annual or monthly **challenges** that e.g., reward the safest driver(s). In addition to pure crash data or the number of acquired police fines, the i-DREAMS gamification tools can provide valuable evidence for such endeavour, as they take account of a large number of indicators that allow for detailed analysis of driving styles and risk levels.
- where considered feasible and reasonable, employ **coaching personnel** to consolidate such incentive schemes. Practice in the i-DREAMS field trials has

demonstrated that coaching personnel is a real 'catalyst' to success in driver improvement programs, especially for the less motivated drivers.

- **monitor and evaluate** the development of the numbers such as of crashes, police fines as well as the development of energy consumption before and after implementation, to substantiate the added value of i-DREAMS technology.
- especially, but not exclusively, for operators of car sharing fleets: to consider ways how users can be made familiar with ADAS & i-DREAMS technology *before* they start their first trip with a specific make & model (such as via app, website or in-vehicle video). Thereby it can be ensured that the system(s) can unfold their full safety-raising functionality and any detrimental side-effects are largely avoided – e.g., by **distraction** through unexpected messages or alerts.

➢ Several contacts with European companies in the field of professional transport have been made by i-DREAMS partners, among them three individual truck haulage companies and two associations for the support of the logistics sector in Belgium as well as a coach operator in Portugal. A train and tram company were also involved in i-DREAMS.

➢ i-DREAMS coordinator Hasselt has been in close contact with a Belgian driver training and coaching company. The company embarked into using the app to help their clients in implementing behaviour-based coaching with staff members that are driving a company car. This shows that although i-DREAMS was initially intended as a tool to monitor driving skills, i-DREAMS can be part of a bigger picture where employees can be coached based on the results of the i-DREAMS tool. For professional drivers, i-DREAMS can thus be used to validate the driver CPC. Initial feedback further indicates that i-DREAMS is perceived as a user-friendly tool that allows flexible feedback to the end user. One point of attention is that sufficient attention should always be paid to user privacy as this is perceived as very important by the end user.

2.6 Motor insurers and their associations

Since the very start of motorised mobility, motor insurers have taken a key role in the promotion of road safety. The no-claims bonus system is the most widespread example of a premium-based incentive scheme towards safer driving, based of ex-post analysis of the number of caused crashes. Some national associations of insurers have established road safety (research) organisations, such as the German Insurer's Accident Investigation Centre UDV[4], the Finnish Crash Data Institute (OTI)[5] or i-DREAMS partner KFV (Austrian Road Safety Board)[6]. Some individual insurers have even offered to their clients´ systems that provide feedback on (risky) driving style and can serve as basis for potential tariff reductions granted to safely (defensively) driving clients. Given this obvious commitment to increasing road safety, it is trusted that the insurance sector has great potential to operationalise i-DREAMS technology by offering it to their clients.

We therefore recommend to insurers and their associations to

- offer individual **risk-based premiums** to their clients which are deducted from the regular collection and analysis of driving data (pay as you drive, pay how you drive)

[4] https://www.udv.de/udv
[5] https://www.lvk.fi/en/the-finnish-crash-data-institute-oti/oti/
[6] https://www.kfv.at/

instead of more premium assessment based on more general categories such as age or milage.

- develop existing systems further and **incorporate i-DREAMS technology** which not only processes pure driving indicators such as speed levels vs. speed limits or the number and severity of braking, turning or acceleration manoeuvres but also takes the state of the driver and driving environment into account to determine whether a driver is within the safety tolerance zone.
- require, from **client groups with a high number of caused crashes** such as delivery services, the use of technology and methods that embrace the i-DREAMS concept of the safety tolerance zone.

- i-DREAMS coordinator Hasselt has been in close contact with a Belgian insurance broker who then consulted with various insurance companies about joining an i-DREAMS-related compensation programme. Currently several pilots are set up with bus and truck companies (30 vehicle installations) by the Belgian insurance broker based on i-DREAMS technology with the objective to convert them into commercial agreements.
- In addition, Hasselt introduced i-DREAMS to several Belgian insurance companies (e.g., AXA, Ethias, TVM) throughout the course of the project to exchange views on the added value and applicability of the systems being developed in the project.

2.7 Road safety organisations at European and international level

Since the early 1990's, several European or international expert associations were established with the prime objective to saving lives and (serious) injuries by the improvement of (data & knowledge about) road safety. Among these are i-DREAMS partner ETSC (European Transport Safety Council), IRTAD (International Traffic Safety Data and Analysis Group), FERSI (Forum of European Road Safety Research Institutes), HUMANIST VCE (Federating Human Factors Research in Transport) and CIECA (International Commission for Driver Testing). Each of these associations tackle the road safety issue from a specific viewpoint, depending on the specific terms of reference and the areas of expertise of their members. It can safely be assumed that great potential lies with the communication of i-DREAMS results to members and associated partners of these associations.

We therefore recommend to European and international road safety associations to

- share with their **members** the results of i-DREAMS, especially the added value of ADAS that help keeping drivers in their respective safety tolerance zone.
- support the (pilot) **implementation** of i-DREAMS tools and concepts, be it among their members or in associated organisations or enterprises.
- support the carrying-out of **applied research** into the further development and application of i-DREAMS tools and concepts.
- **Promote** the concept of safety tolerance zone and the safety benefits of the i-DREAMS technology in their communication with **European and national policymakers** and in their discussions with fleet managers, in view of a possible widespread use.

- ETSC has continuously updated its members on the i-DREAMS project's advancements and has mentioned the technology and the project on the occasion of several meetings the organisation has had with European and national policymakers.

2.8 Federation Internationale de l' Automobile (FIA) and national automobile/mobility clubs

The substantial growth of motorised mobility over the past century was accompanied by associations of motorists offering additional services such as travel or liability insurance, breakdown services, travel planning and roadworthiness checks to their members. Some national clubs have turned to offer mobile apps to their members that analyse driving behaviour, thereby providing the basis for potential premium reductions of club-mediated liability insurances (see also previous chapter on motor insurers). We therefore regard automobile & mobility clubs and their international umbrella organisation FIA as promising partners in taking the i-DREAMS approach to a larger audience.

We recommend to automobile/mobility clubs to

- consider offering to members liability insurance that ships with technology which records driving data and provides feedback on safety-related driving style and infringements, thus making possible **premium reductions for safe drivers**.
- **implement the i-DREAMS concept** which adds states of driver and driving environment to the equation of whether safety is compromised in a specific point in time – and how often such events take place over a whole trip.

We recommend to FIA to

- foresee, in future versions of the **FIA Road Safety Index**[7] – a safety initiative targeted at industrial organisations – an option to award additional points in the so-called road safety footprint to those enterprises which apply i-DREAMS-related technology to help keeping corporate drivers in their safety tolerance zone.

➢ Concerning liability insurance, reference is made to chapter 2.6 which describes successful cooperations of i-DREAMS coordinator Hasselt with Belgian insurance companies and an insurance broker.

2.9 Original Equipment Manufacturers (OEMs)

- Data made available as part of the Fleet Management System (FMS) interface in heavy vehicles currently are focused mainly on fuel consumption, engine operation, distance travelled, tachograph information, service distance, etc. No information on the vehicle's safety critical systems / ADAS system status (e.g., time headway, time-to-collision, lane departure warnings) is currently broadcasted on the FMS interface. However, these data are essential for safety research and the understanding of human factors while driving. We urge OEM's to make such data available on the FMS interface.
- Data collected during the i-DREAMS field trials would allow OEMs to gain deeper insight into microscopic adaptations (responses to warnings in millisecond time windows) of users to the in-vehicle warnings triggered by the i-DREAMS interventions, which would allow more advanced levels of tailoring of the technology to the users' personal driving style and momentary changes in task complexity and/or coping capacity, without compromising safety (i.e., keeping drivers always within the boundaries of safe vehicle operation).
- Data collected during the i-DREAMS field trials would also enable OEMs to develop better insight into how users behaviourally adapt to the in-vehicle interventions during

[7] https://www.fia.com/news/fia-launches-road-safety-index-improve-organisations-safety-footprint

single trips, and over longer trip histories. This in turn would provide more advanced knowledge of how positive or negative behavioural adaptation occurs and under which conditions and for which user profiles this is more likely to happen (i.e. so-called ‘a posteriori acceptance’).

- OEMs could see the results on outcome and process evaluation obtained in the i-DREAMS project as an important starting point to learn more about how interventions outside a trip (i.e., pre/post-trip interventions) supported by mobile technology (e.g., app, online web dashboard) could be used to reinforce and/or sustain the impact generated by the in-vehicle warnings which are active while driving. Using these insights, OEMs could devise new business models around value-added-services to their customers.

2.10 Suppliers of sensor technologies

In-vehicle data collection is crucial for any system that aims to improve driver behaviour through coaching and interventions. However, different vehicles have distinct requirements and characteristics, making it difficult to create a universal solution. The i-DREAMS project provided valuable insight by conducting large-scale, in-vehicle data collection across different vehicles and transportation modes.

Therefore, we recommend to the suppliers and manufacturers of telematics devices:

- Devices should be modular and easily expandable in terms of peripherals. This includes the use of cameras, Human-Machine Interfaces (HMIs), ID-readers, antennas, wearables, smartphone connectivity and other (wireless) sensors.
- To facilitate installation in a wide range of vehicles, devices should have a small form factor and use prefabricated connectors for plug-and-play installation.
- Devices should be equipped with chips and firmware that enable interfacing with common vehicle data exchange protocols found in vehicles, such as On-Board Diagnostics 2 protocol (OBD2) and Fleet Management System interface (FMS).
- Devices should not rely on the presence of specific vehicle profiles in a database, to decode Controller Area Network (CAN) messages, for example. This is still useful for capturing higher frequency data, but fall-back options should be available. For instance, replacing the vehicle speed captured from the vehicle CAN-bus with the vehicle speed detected by a GPS-sensor.
- To minimize the delay between driving and post-trip interaction, devices should preferably use cellular data that provides stable data transmission regardless of location. If cellular coverage is not available, data should be buffered until stable transmission is again possible.
- To optimize the cost of data transmission, devices should allow for the distinction between critical and non-critical media and data. Critical data and media can use expensive cellular data and should be available in near real-time. Non-critical data and media should be stored on the device until low-cost data transmission, such as WIFI, is available.
- To facilitate integration of new device types, data and media from the devices should be accessible through well-documented, high-level API’s (Application Programming Interfaces). If such a system is not in place, data transfer protocols should be well documented and preferably enhanced with boilerplate code or code snippets.
- Configuration of devices, including setting thresholds and data-collection parameters should be possible remotely on an individual level.

- To ensure the required reliability, devices should allow over-the-air firmware updates. In addition, extended remote data-logging for debugging purposes should be possible.

2.11 Providers of ICT infrastructure and tools in the realm of transport safety

A wider-scale implementation of the i-DREAMS system would mean to have the technology embedded in newer vehicles, in a way that drivers already purchase a vehicle in which the i-DREAMS system operates (similar to how alco-locks are installed in some vehicles). The goal would be to keep the drivers in the safety-tolerance-zone, and provide them both with real-time, but also post-trip interventions, aiming at the improvement of their long-term driving skills.

Having this wide-scale deployment of the i-DREAMS would however be challenging on different levels: from (i) an **infrastructural** point of view (to have the adequate tools and infrastructure in place that would allow seamless communication of the different system components), from (ii) a **human** perspective (to ensure the effective human-machine interaction with the system), but also from (iii) a **regulatory** point of view (in a way that does not challenge privacy and data protection rules). Accordingly, our recommendations fall under three main categories:

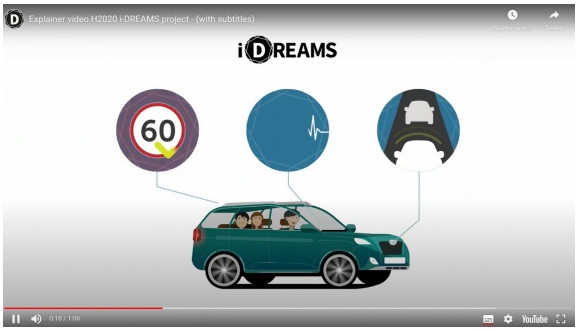
- **ICT (infrastructure)** level:
    - Sufficient connectivity is required (at least 5G, much faster speed than previous generations of wireless technology). This would be crucial for fast uploads of the data to the cloud, to be able to provide instantaneous real-time feedback for drivers.
    - Back-office system upscaling for a much larger scale deployment of the i-DREAMS technology. In the i-DREAMS project, a central back-office was used for the data collected in 5 countries for about 600 drivers. For future experiments, and an eventual commercial deployment, targeting a much larger number of drivers, it would be essential to re-scale the back-end or consider what would be the optimal way to store the data, and have it accessible for authorized personnel.
- **Human** level:
    - The **promotion** and **dissemination** of the system to the wider audience would be essential. This would apply both to **drivers** and **co-drivers** (directly impacted users), but also other **road users** (pedestrians or other road actors which in a way are **positively** impacted by the system).
    - A **promotion** of the system would ensure that **drivers** not only engage with the real-time features of the device (which might be more intuitive or expected), but also with the gamification platform. Moreover, it would improve the overall **acceptance** of the system by other **road users**, as they are more aware of the **societal benefits** and **positive externalities** the system can bring (in reducing for instance dangerous interactions with vulnerable road users, such as pedestrians).
    - An **assessment** of the system by the above actors (**drivers** and **other road users)** would be essential to evaluate the **user acceptance and acceptability** by drivers towards it (at different points of use), but also the general **societal or community acceptance**.

- **Regulatory** level:
    - **Data protection protocols** drafted within the i-DREAMS project should be extended in a very transparent way to ensure the **preservation of personal data** of **both drivers and co-drivers**, as the system implemented would have many actors and stakeholders involved (manufacturers, cloud company, etc.) It would be in particular essential to understand if a consent to collect driving data is needed at the beginning of each trip, or rather periodically (e.g., once a day/ week) Additionally, it would also be crucial to understand if consent to collect data would be needed from co-drivers and passengers as well, as geo-data might be particularly sensitive, not only to drivers, but to those who share the ride(s) with them.

3 Communication tools

The i-DREAMS project has published numerous research reports detailing the concept, its technical realization and its research results[8]. This chapter presents *non-scientific* communication tools for use by stakeholders and their networks with the aim of conveying the principles and use of i-DREAMS technology in an easily accessible way.

- **i-DREAMS explainer video**: https://youtu.be/KBSh-owbbZM
  This project video explains the i-DREAMS system and how users can operate and benefit from it in a nutshell.



- **i-DREAMS project flyer:** https://idreamsproject.eu/wp/wp-content/uploads/2020/01/Kopie-van-iDREAMS_triptych_FINAL.pdf
  The project flyer provides an overview of the research goals, the overall research and project approach as well as the anticipated outcomes.

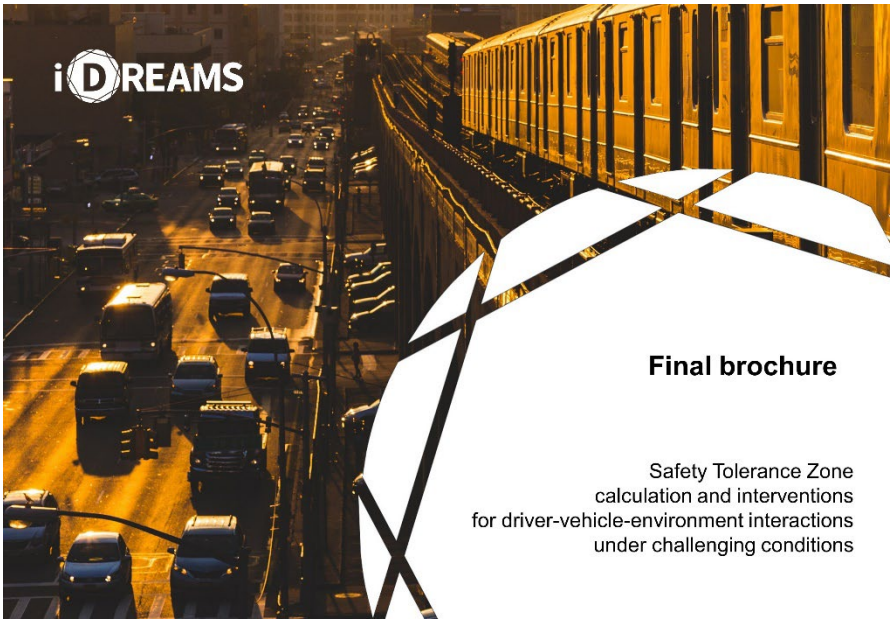
- **One PechaKucha presentation**: https://www.youtube.com/watch?v=HEwgK3M8-0I
  Practical story about a potential i-DREAMS user and the challenges he faces (e.g., a manager of a truck company) is told in 20 slides. The appropriate solutions provided

[8] Please find all available research reports on the i-DREAMS website: https://idreamsproject.eu/wp/deliverables/

by the i-DREAMS systems to mitigate concrete problems are presented in a tangible manner.

- **i-DREAMS roadmap brochure** https://drive.google.com/file/d/1uXxdkHjOts7-0X4sub-SpRmi2gIKlOG3/view

  The i-DREAMS roadmap brochure provides an outline of the consortium's research journey and depicts the essence of each public deliverable by accounts of the authors who explain the research content in their own words and in an easy-to-understand fashion.



4 Conclusions

The i-DREAMS project has developed and tested a system that provides timely interventions to keep drivers & operators of different transport modes (car, bus, truck and rail) in a so-called Safety Tolerance Zone.

Both conceptionally and in a series of field trials the project successfully showcased that a widescale implementation of its results can substantially contribute to reaching the EU's 50% reduction targets for road fatalities and serious injuries. Also in other transport modes, such as in the rail, maritime and aviation sectors, valuable contributions to safety improvements can be expected.

This document brings forward a variety of recommendations, addressing a broad range of stakeholder groups who, in their specific spheres of activities and areas of influence, can contribute to increasing transport safety in the EU by applying the concepts developed in i-DREAMS:

The **European Commission** is recommended to further explore the concept of a safety tolerance zone in forthcoming research calls and to include the i-DREAMS principles in future amendments of legislation relevant for certificates of professional competence (CPC) of professional drivers. In addition, the take-up in – and scientific exchange between – all transport sectors is encouraged, including rail, maritime and aviation.

Several areas for future search are addressed to the **European Road Transport Research Advisory Council** (ERTRAC), e.g., how assistive vehicle technologies can be made situationally adaptive and tailored to an individual's driving style, and how to increase people's willingness to make appropriate and sustained use of ADAS and higher levels of automation.

Member States' **Transport Ministries & Home Offices** are encouraged to include in safety as well as research & implementation programmes support for the practical deployment of methods and tools as proposed by i-DREAMS, including in fleets of ministries and their contractors. In addition, i-DREAMS event data maps can help raising the efficiency of targeted police enforcement, validating the locations of existing speed cameras and section controls, and identifying sections of crash-prone infrastructure for treatment.

Public transport authorities & operators are recommended to employ i-DREAMS technology to support building a safety culture among their drivers - and to promote that also fleets of contractors be equipped with advanced safety features that seek to keep drivers in their safety tolerance zone. Attention should also be given to evaluate the developments of incidents, crashes and energy consumption before and after implementation of such technology to substantiate its added value. Similar recommendations are given to **corporate fleet operators**. In addition, especially to operators of car sharing fleets, it is recommended to consider ways how users can be made familiar with ADAS & i-DREAMS technology before they start their first trip with a specific make & model. Thereby it can be ensured that detrimental side-effects, such as by distraction, are largely avoided.

The recommendations to **motor insurers and their associations** include the offering of individual risk-based premiums (pay as you drive, pay how you drive) and the take up of i-DREAMS technology in the development of such schemes. Similar recommendations apply

to **national automobile & mobility clubs**, many of which offer liability insurances to their members.

The **Federation Internationale de l'Automobile** (FIA), the automobile clubs' international umbrella organisation, is encouraged to include in future versions of the FIA Road Safety Index – a safety initiative targeted at industrial organisations – an option to award additional points in the so-called road safety footprint to those enterprises which apply i-DREAMS-related technology.

Road safety organisations at European and international level are encouraged to share with their members & networks – including European and national policymakers – the added value of the i-DREAMS concept and to support further research and implementation in the field.

Original Equipment Manufacturers (OEMs) are advised to exploit the abundance of data which has been recorded and made available by the i-DREAMS project. This would facilitate, amongst others, to gain deeper insight into microscopic adaptations of users to the in-vehicle warnings triggered by the i-DREAMS interventions and to develop better understanding on how users behaviourally adapt to in-vehicle interventions during single trips, and over longer trip histories. There is also a demand to make important safety relevant information available on the FMS interface of heavy vehicles.

Various recommendations are addressed to **suppliers of sensor technologies**, aiming to assist them in providing platform-independent solutions. This includes advice on modularity, connectivity with peripherals, data exchange protocols, and the use of well-documented, high-level API's.

Recommendations to providers of **ICT infrastructure and tools** bring forward strategies how the various challenges of a wide-scale implementation of i-DREAMS can be managed. They are centred around three pillars:

- ICT (infrastructure) level: wireless & high-speed connectivity, upscaled back-end technology
- Human level: promotion and dissemination, societal benefits, user & societal acceptance
- Regulatory level: data protection protocols – extension to drivers *and* passengers