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D5.3

Description of the on-road driving trials for identifying safety tolerance zones and the performance of in-vehicle interventions

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

iDREAMS

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Glossary and abbreviations

Word / Abbreviation	Description
ADAS	Advanced Driver Assistance Systems
CRM	Customer relationship management
ECG	Electrocardiogram
PPG	Photoplethysmography
STZ	Safety Tolerance Zone
UUID	Universally Unique identifier
WP	Work Package

Executive summary

The i-DREAMS project aims to establish a framework for the definition, development, testing and validation of a context-aware safety envelope for driving called the "Safety Tolerance Zone' (STZ). Taking into account driver background factors and real-time risk indicators associated with the driving performance as well as the driver state and driving task complexity indicators, a continuous real-time assessment will be made to monitor and determine if a driver is within acceptable boundaries of safe operation. Moreover, safety-oriented interventions will be developed to inform or warn the driver in real-time as well as on an aggregated level after driving, through an app-and web-based gamification coaching platform (post-trip intervention).

The conceptual framework of the i-DREAMS platform integrates aspects of monitoring (such as context, operator, vehicle, task complexity and coping capacity), to develop a Safety Tolerance Zone for driving. In-vehicle interventions and post-trip interventions will aim to keep the drivers within the Safety Tolerance Zone as well as provide feedback to the driver. This conceptual framework will be tested in simulator studies and three stages of field trials in Belgium, Greece, Germany, Portugal and the United Kingdom with over 600 participants representing car, bus, truck and rail drivers.

This deliverable aims to describe the on-road trials based on the development from design recommendations and specifications that were presented previously in D3.4: Experimental Protocol. This is achieved by showing the current planning and resources that have been created to fulfil the trials. As trials are being conducted across five countries and four transport modes, it is important to outline and develop protocols to ensure consistency in approach where possible. The current deliverable does not describe the outcomes (results) of the field trials, for this the interested reader is referred to future deliverables, (Deliverables 6.1-6.3 and Deliverable 7.2).

The field trials have multiple aims, all of which have been established and detailed in this deliverable to ensure any trial plans allow these to be investigated, recorded, and answered. These include field trial methodological questions (process evaluations) such as: how do incentives assist in recruiting participants for a 6-month field trial study? How acceptable is the monitoring equipment for potential field-trial participants? What are the differences in recruitment of professional vs private drivers? Do the interventions help in keeping drivers motivated for participation? And how is seamless data collection ensured during the duration of the experiments? Alongside these process evaluation questions there are research questions around the Safety Tolerance Zone (outcome evaluations) including: do the i-DREAMS interventions return the driver to the STZ phase of normal driving? How much time is needed to identify the prevailing STZ level? How much time is needed for participants to return to normal driving on average? Etc. All these questions, and many more, informed the planning of the trials and the guidelines, resources, and data collection methods detailed throughout this deliverable.

A great deal of variance in the planning and execution of the trials is to be expected given they take place in different countries and across various vehicle types. To ensure data can be combined, and research questions met, several factors will be constant across sites. These include the duration of testing: 4 weeks of baseline followed by 4 weeks for the in-vehicle intervention only, 4 weeks for intervention plus smartphone feedback, and a final 6 weeks of an additional gamified web platform as well. For similar reasons, the participant selection criteria across car trial sites will be consistent, requiring a spread of participants across 4 age groups. A minimum of 40% per gender split, driving experience of 10,000km annual equivalent and this must be across different road types (urban, rural, motorway) for at least 20% of mileage covered in each type. For commercial vehicle testing (bus, truck, rail)

there is also a consistent but less stringent requirement, the only one being at least 6 months of driving experience. All participants must use an Android smartphone to be able to access the project driver coaching application. They will also all complete the same entry and exit questionnaires but translated into the local language. The final project mandated consistency is the participant drop-out strategy whereby if a participant has driven three weeks or more in the intervention phase and drops-out they will not require replacing, any drop-out before this cut-off will be replaced.

The remainder of the planning of the trial can be entirely site-specific but, given similarities in logistics across sites, a guidebook has been developed to act as a reminder of resources that require developing and completing by participants along with procedures that may want to be followed. The guidebook forms part of this deliverable. It details the resources needed, some of which have been developed centrally include the project technology user manual, technology onboarding website, vehicle condition form, etc., A detailed step by step procedure is given which trial partners may wish to follow and tick off as completed including steps of how to: welcome a participant in a COVID-19 secure way, prepare the vehicle and evidence any prior damage, brief and receive consent from participants, handing over of incentives and evidencing of participants' receipt of these.

As the technology has previously been described in publicly available deliverables as part of Work Package 4 these are not covered in-depth in this deliverable. Instead, a user manual that has been developed for the in-vehicle technology is presented to show what a participant in i-DREAMS can expect to receive.

This deliverable describes the planning and resource development for the on-road trials, the results of these trials will be presented at a later stage in the project in Workpackage 6 and 7 deliverables.

1 Introduction

1.1 About the project

The overall objective of the i-DREAMS project is to set up a framework for the definition, development, testing and validation of a context-aware safety envelope for driving ('Safety Tolerance Zone'-STZ), within a smart Driver, Vehicle & Environment Assessment and Monitoring System (i-DREAMS). Taking into account driver background factors and real-time risk indicators associated with the driving performance as well as the driver state and driving task complexity indicators, a continuous real-time assessment will be made to monitor and determine if a driver is within acceptable boundaries of safe operation. Moreover, safety-oriented interventions will be developed to inform or warn the driver in real-time in an effective way as well as on an aggregate to give real timed level after driving through an app and web-based gamified coaching platform. Figure 1 summarises the conceptual framework, which will be tested in a simulator study and three stages of on-road trials in Belgium, Germany, Greece, Portugal and the United Kingdom with a total of 600 participants representing car driver, bus driver, truck drivers and rail drivers.

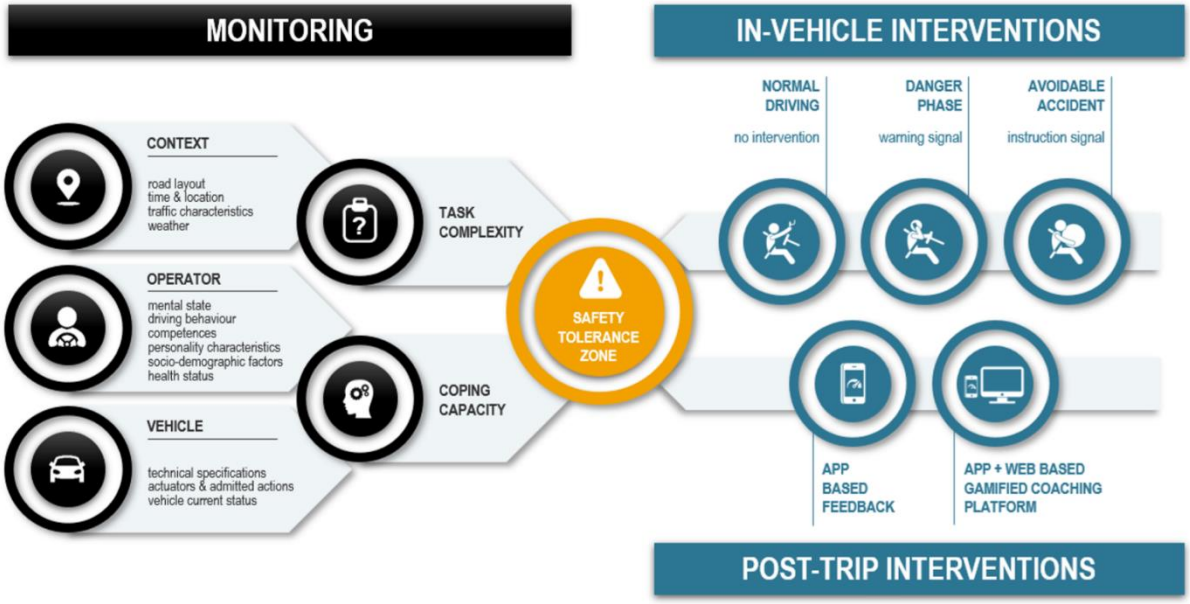


Figure 1: Conceptual framework of the i-DREAMS platform.

The key output of the project will be an integrated set of monitoring and communication tools for intervention and support, including e.g., in-vehicle assistance and feedback and notification tools as well as a gamified platform for self-determined goal-setting working with incentive schemes, training and community building tools. The technology that will be implemented includes a customised LCD capacitive touch display that communicates with the CardioID Gateway to receive the status of the STZ, giving real-time audio and visual alerts. It will also allow for driver identification upon vehicle start-up. Information coming to the CardioID Gateway is from a context-aware road monitoring system (Mobileye), and electrocardiogram (ECG), or photoplethysmography (PPG) technology (CardioWheel/ Wristband), as well as an application installed on the user's phone to monitor hand-held phone usage.

1.2 Deliverable overview and report structure

Within the i-DREAMS project, there are five technical work areas: state of the art (monitoring and interventions), methodological development, technical development, trials, and analysis. This deliverable describes the field trial experiments within the area of trials.

This deliverable (D5.3) follows directly on from them methodological development and the guidelines for on-road trials that were outlined in Deliverable 3.4: Experimental Protocol (Pilkington-Cheney et al., 2020). This deliverable is meant to be used as a roadbook during preparations for the trials and describes preparations that were already made at the time of writing. This includes the agreed consistencies in procedures across project sites, a generic guidebook for the planning and running of the trials along with an example of a user manual participants will receive, giving instructions on technology use procedures. Results of the field trials will be presented in multiple deliverables which will come out of work packages 6 and 7.

Section 2 gives details on the purpose behind the field trials, why they are designed as they are, how they relate to the simulator trials and the aims and objectives they have been designed to meet.

An example of a user manual that has been developed for the in-vehicle technology will be shown in Section 3 to illustrate what a participant in i-DREAMS can expect to receive and the level of resource development that has occurred so far. Detailed descriptions of the technology being used in the i-DREAMS field trials will not be covered in significant detail here, as these have already been covered in WP4. However, the deliverables which can be referred to will be sign posted in this section and updates on any technology specifications that have changed since the WP4 deliverables have been published will be given here also.

Section 4 describes the field trial study designs in detail including an example timeline and outline of procedures such as for participant drop-out, incentivisation etc. It also features a detailed guidebook which is a reference manual that has been developed to aid field trial partners' planning to ensure all resources and procedures have been thought through and prepared.

The tools that have been developed for trial partner communication to ensure knowledge can be shared and faults reported will be briefly described in Section 5.

1.3 The COVID-19 Pandemic

At the time of writing this deliverable, the COVID-19 pandemic is ongoing. Therefore, it is important to recognise that this situation may have potential implications for the i-DREAMS project. There may be delays to the beginning of the field trials and potential restrictions in terms of testing with human participants and social distancing measures. This may be in the form of delays in ethical approval for work with human participants, restrictions in travel (and therefore reduced data collection available given the project requires participants to be driving), or delays in recruitment. Furthermore, supply chains of electronic components are heavily disrupted due to COVID-19 and this has an impact on the production of the i-DREAMS equipment that requires the availability of critical components. Additional risk assessments will likely be required to ensure that the experiments and the trials are conducted safely. The plans and timelines presented here should be considered the planned case intended by the project and may be subject to change based on each countries' COVID-19 related restrictions and possible delays in technology acquisition and development.

2 The purpose of field trials in the i-DREAMS project

2.1. Field testing in the ADAS development cycle

In the typical automotive development cycle, field trials are usually one of the final stages. Because of the large-scale deployment, it requires a version of the technology that is closer to the final product than to earlier proof-of-concept prototypes. In many cases, field trials are also the first time the technology is handed to people outside of the development team, meaning that developers and engineers no longer have direct access to the product. Therefore, all system components must already be thoroughly tested and cured of any obvious system bugs or issues. To handle the large-scale deployment, levels of quality should already be up to acceptable standards, meaning that most of the processes for production, installation and day-to-day usage should be defined and ready for upscaling.

Because of the aforementioned reasons, iterating the design and optimising it through the previous stages of the development cycle is crucial. Typically, software and hardware are first tested in a lab environment until found to be functional. Simulators are frequently used, especially for advanced driver assistance systems (ADAS), to deploy a first real-time operational version of the software, which can also be combined with hardware through Hardware-in-the-loop simulation (Eckstein and Zlocki (2013); Galko, Rossi and Savatier (2014)). In a later stage of simulator testing, a driver can be included to gather the first user feedback and to collect data about human-machine-interaction and optimise it. The technology is usually fully deployed in a vehicle during one or multiple stages of small-scale field testing. First, in a closed environment, before moving to the actual "field." During this small-scale, in-house testing, the development team closely monitors the technology and has direct access in order to make rapid changes. When the technology reaches a point where it is stable enough to be presented to people outside of the development team, large-scale field testing can start.

There could be multiple goals to large-scale field trials. It is an ideal testbed to include a wide range of real-life conditions and situations that may not have been considered before. This helps to serve the purpose of revealing hidden issues with the design or quality. Field trials also offer the chance for the technology to be tested by individuals that have not been involved in the development and are unaware of many of the design decisions and goals of the technology. Hence, it offers a unique opportunity to gather unbiased user feedback and filter out design choices that may appear self-evident to the development team but may not be for individuals not involved with the application. On the other hand, large-scale field trials have the potential to generate large quantities of data. Big-data analysis can be used to further strengthen the case of the technology by proving its efficiency or to improve the technology itself based on the acquired data. Therefore, large-scale field trials can also be a multi-step stage in the development cycle, where the next iteration improves upon the previous by considering user feedback and findings from big-data analysis.

2.2 Overview of the rationale behind on-road trials

2.2.1 Generic design of the on-road trials

The i-DREAMS field trials are the first time that all components of the complete i-DREAMS system will be combined in a real-world setting, where it will be used by individuals and organisations outside of the i-DREAMS project. To get a realistic reflection of all the target users, there will be five different testing sites across Europe, focusing on both private and professional drivers for four different transport modes: Cars, Trucks, Buses and Rail.

As the first stage of the field trials, pilot testing will be performed for a limited number of vehicles (5) for each test site. The purpose of the pilot tests is to fine-tune the i-DREAMS technology. This includes all the processes associated with production, installation and interventions but also collection, processing and visualisation of data. In addition, it offers the chance to implement changes based on user feedback before transitioning to large-scale testing.

The objectives of the on-road trials in i-DREAMS are: to test driving behaviour and validate the STZ mathematical model, test if the i-DREAMS system influences driver safety, to assess the effect of the interventions (developed as part of the i-DREAMS system) for both real-time and post-trip warnings and to obtain user feedback about the acceptance and acceptability of the i-DREAMS system. Considering the extent and the size of the i-DREAMS project, i.e., five transport modes across five countries (see Figure 2), it is essential to systematically design the on-road trials to avoid experimental errors causing delays or biases. As a result, the on-road trials in i-DREAMS are designed based on several proven principles derived from previous literature focusing on testing interventions to assist drivers in maintaining the safety tolerance zone, whereby the i-DREAMS interventions have been subdivided into three consecutive stages (i.e., real-time warnings alone vs. real-time warnings + feedback via app vs. real-time warnings alone + feedback via app + gamified feedback via app & web-dashboard). As such, there is literature indicating that, since some adaptive ADAS systems ignore variation between and within drivers, this generates 'false positives', resulting in irritation, and even (accelerated) non-use (e.g., Fleming et al., 2019). Different from that, the i-DREAMS in-vehicle warnings are situationally adaptive (i.e., they account for driver-vehicle-environment variation). Even though exploratory studies show this ameliorates user acceptance, most of this work is based on self-reports, and it is not really known whether this results in more sustained use over time (e.g., Panou, 2018). Therefore, in intervention Stage 2 of the field trials, feedback via app is combined with in-vehicle warnings. There are studies that demonstrate how addition of such app-based feedback can indeed stimulate user engagement, but usually after 3-4 weeks, positive effects stagnate or decline. Motivation often seems to be the main issue in terms of user retention (e.g., Toledo et al., 2008). Therefore, in the third intervention stage of the field trials, gamification features are added to the app, with additional support of a web-dashboard. Gamification features (such as group incentives) have indeed been shown to extend user retention up to 10 weeks (or more) (e.g., Musicant & Lotan, 2016).

In its essence, the i-DREAMS project focuses on calibrating the subjective experience of coping capacity and task demand in driving. According to Horrey et al. (2015), the interaction between these concepts is best investigated by applying a combined nudging-coaching approach. This combined approach is used as the blueprint of the on-road trials' experimental design.

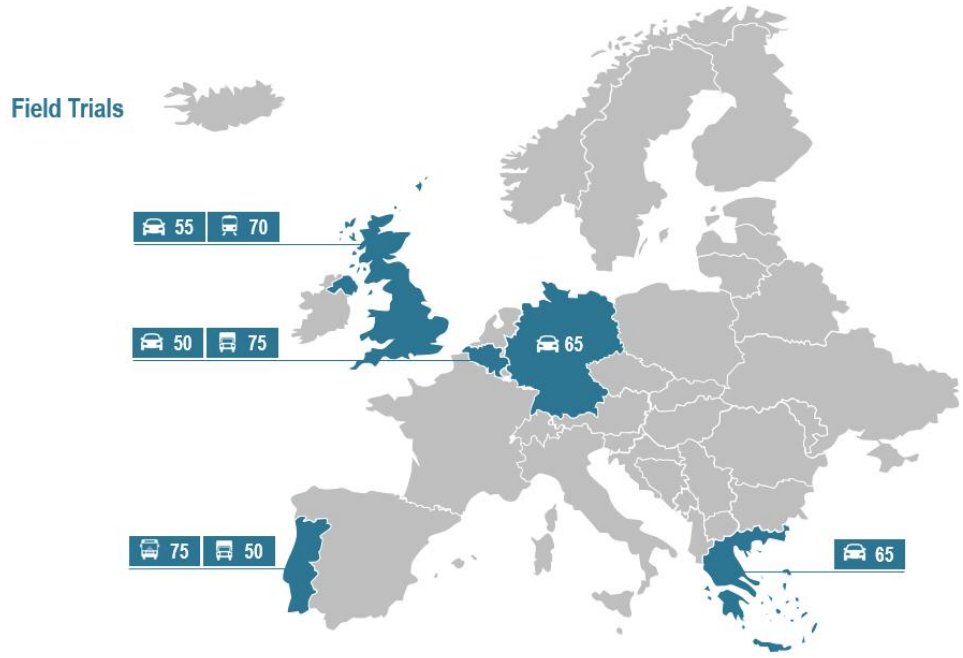


Figure 2: Map highlighting the location and target participant numbers for the i-DREAMS on-road study

To allow for continuous improvement, the process of baseline monitoring followed by intervention monitoring will be repeated to create two rounds of field trials with unique users. During the second round, improvements to the i-DREAMS technology can be made based on findings and feedback from the first round.

The on-road trials will focus on monitoring driving behaviour and the impact of real-time interventions (i.e., in-vehicle warnings) and post-trip interventions (i.e., post-trip-feedback & gamification) on driving behaviour. The experimental design of the i-DREAMS on-road study is displayed in Figure 3 and consists of four stages:

- Baseline measurement
- Stage 1 intervention: real-time intervention
- Stage 2 intervention: real-time intervention + post-trip feedback
- Stage 3 intervention: real-time intervention and post-trip feedback + gamification

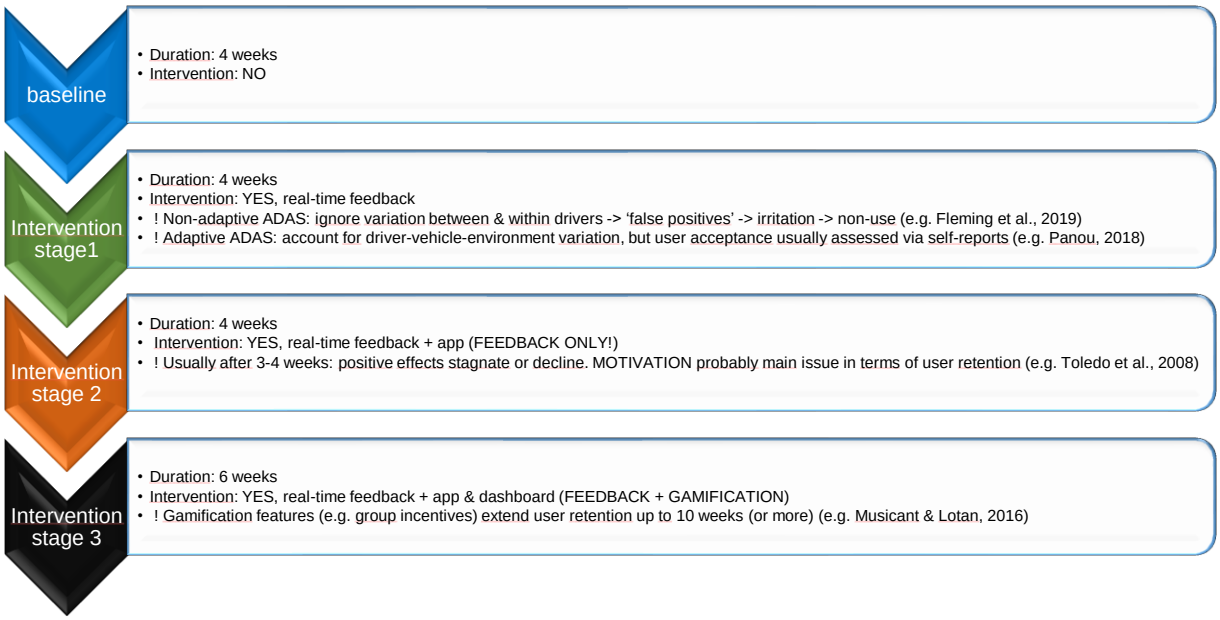


Figure 3: Overview of experimental design of the i-DREAMS on-road study

2.2.2 Monitoring

In the first stage of the on-road trials, driving behaviour will be monitored while encountering various dangerous and safe traffic events without receiving any interventions. In this way, a baseline measurement of driving behaviour can be obtained, which can be compared with driving behaviour when receiving real-time (in-vehicle warnings) and post-trip interventions (feedback and/or gamification). This baseline measurement is essential for the validity and reliability of the i-DREAMS on-road study as it allows to establish the possible effects of the real-time and post-trip interventions on driving behaviour. The baseline stage will last four weeks.

2.2.3 Real-time interventions

After the baseline stage, the four-week real-time intervention stage will start. These interventions will be offered by using an in-vehicle warning system. The i-DREAMS system will provide real-time feedback on the driver's actions in case he/she encounters unsafe traffic situations or behaviours. With real-time interventions, it is essential to make a distinction between non-adaptive and adaptive ADAS. Non-adaptive ADAS use 'fixed thresholds' to determine the status of the STZ (to determine when they should give a warning).

Consequently, non-adaptive ADAS ignore the variation between and within drivers when they give a warning. This leads to 'false positives' and irritation among the drivers and will, in the end, result in a non-use of the ADAS use (Fleming et al., 2019). Adaptive ADAS use flexible thresholds to determine the status of the STZ. They are more dynamic in the sense that they account for driver-vehicle-environment variation, leading to fewer 'false positives' and a higher user acceptance (Panou, 2018). The system that is tested in the i-DREAMS on-road trials belongs to the category of adaptive ADAS.

The purpose of the i-DREAMS interventions is to effectively **increase driver safety** by supporting drivers in their driving task. To this end, information used within the interventions will be based on the safety tolerance zone (STZ). Based on the STZ, a driver can be in three different phases: (1) normal driving phase, (2) danger phase, and (3) avoidable accident phase.

In case a driver can be situated within the first phase of normal driving, no real-time interventions are necessary. In the second phase (i.e., danger phase), a warning signal (e.g., visual warning like a message) will be presented. In the third phase (i.e., avoidable accident stage), a more intrusive / instruction signal (e.g., visual warnings like flashes and auditory warnings like beeps) will be offered. More details on the design of these warning signals can be found in Deliverable 3.3 'Toolbox of recommended interventions to help drivers maintain a safety tolerance zone' (Brijs et al., 2020).

The purpose of the i-DREAMS interventions is to ensure that the driver remains in the first phase as long as possible. In case this is not possible, and the driver transfers to the second phase, to prevent that, a driver subsequently would transfer from the second phase to the third phase in the STZ.

These interventions aim to improve the outcomes proposed in the logic model of change. These outcomes target four different levels of driver safety. The highest level targeted by the interventions is the **safety outcomes**, such as the likelihood of crash occurrence (e.g., forward crashes and rear-to-end crashes). The second-highest level is the **safety promoting goals**. These are the behaviours that need to change for the safety outcomes to be realised. The second-lowest level is the **performance objectives**. These are the more specific actions or behavioural parameters that need to change for the safety promoting goals to be achievable. The lowest level is the **change objectives**. These are the underlying behavioural determinants that need to change for the performance objectives to become realisable. For a detailed description, see Deliverable 3.3 (Brijs et al., 2020).

With real-time interventions, drivers have almost no time to think about their actions. Hence, a **nudging approach** is used for these kinds of interventions. Nudging strategies are operational *during* a trip and primarily meant to steer vehicle operators' decision-making *while driving*. In the context of the i-DREAMS on-road trials, **a nudge is understood as any aspect of the choice architecture (in the case of the i-DREAMS real-time interventions, this refers more specifically to the i-DREAMS in-vehicle warning system) that can influence a vehicle operator's choice of particular behaviour at a specific time and the spot where the nudge is implemented.**

2.2.4 Post-trip interventions

The last two stages of the on-road field trials consist of a combination of real-time and post-trip interventions. Post-trip interventions can be classified as a coaching approach. Schulte et al.(2014, p.46): describe coaching as "[…] *designed to improve existing skills, competence and performance, and to enhance [coachees'] personal effectiveness or* ***personal development*** *or personal growth.*" Furthermore, coaching strategies are operational *before or after* a trip and primarily meant to empower vehicle operators in taking appropriate decisions while driving. In the context of the i-DREAMS on-road trials, the i-DREAMS post-trip interventions will be technology-mediated to a substantial extent. More in detail, the i-DREAMS post-trip interventions can be qualified as digital- or internet-based interventions, running on a combination of an app and a web-based dashboard and are to be understood as **combining e-coaching with virtual coaching.**

For four weeks, drivers will receive real-time feedback (in-vehicle warnings) combined with post-trip feedback in the smartphone app. Post-trip feedback has beneficial effects on safe driver behaviour; however, prior research has shown that after 3-4 weeks, the positive effects stagnate or decline because the feedback no longer motivates drivers to behave safely (Toledo et al., 2008). To remedy this, the last six weeks of the on-road trials combines real-time interventions with post-trip feedback and gamification features. The difference with the previous stage lies in the fact that drivers are rewarded or receive benefits when they keep

applying safe driving behaviour. Research has indicated that gamification features extend user retention up to 10 weeks (or more) and lead to a more robust and sustainable behavioural change (Musicant & Lotan, 2016).

In sum, **the i-DREAMS platform will integrate nudging strategies (i.e., real-time interventions) and coaching strategies (i.e., the post-trip interventions) to keep vehicle operators within the STZ**, preferably even in the normal driving phase. Nudging and coaching are complementary in a sense that **nudging** aims to improve the vehicle operator's safety via manipulation of the driving context (i.e., **creating a safer driving environment**) while **coaching** aims to enhance the vehicle operator's safety via manipulation of the human operator him or herself (i.e., **creating a safer driver**).

2.3 Field trials in relation to the simulator trials

In the i-DREAMS development cycle, simulators have been extensively used in preparation for the on-road field trials. In an early stage, software-in-the-loop and hardware-in-the-loop simulation have been used to accelerate the development and testing of the i-DREAMS real-time interventions. Later on in the development cycle, simulator trials were used to pilot test the interaction between drivers and the i-DREAMS real-time interventions.

The i-DREAMS field trials start when most of the i-DREAMS simulators trials have been fully conducted. The findings and outcome of the simulator trials serve as an input for the field trials. In total, five different simulator trials are being performed across Europe, for five different transportation modes (car, truck, bus, tram, and train). In the highly controllable and safe environment of driving simulators, participants are invited for a first-time experience with the i-DREAMS real-time interventions. Participants are subjected to pre-defined conditions that influence driver capability and task demand. This is combined with carefully chosen risky situations considered in the i-DREAMS mathematical model, and outside of the safety tolerance zone. Participants are asked about how they experienced the real-time interventions, while relevant driving parameters are collected by the driving simulator. This is performed for three different settings of the i-DREAMS system: no interventions, with interventions and with interventions modified by a condition like fatigue, bad weather or distraction. The combination of subjective user feedback and objective results, acquired from driving parameters, is used as input to further optimise the effectiveness and acceptance of the i-DREAMS real-time interventions.

2.4 Evaluation (outcome, process and concept)

Both outcome and process evaluation are the evaluation perspectives that will be conducted during the on-road trials.

2.4.1 Outcome evaluation

Outcome evaluation, also known as effect evaluation, measures the effectiveness of the intervention. More specifically, it assesses whether the targeted factors of the on-road trials changed as a result of the intervention or not. The outcome evaluation of the on-road trials will examine whether the i-DREAMS interventions influenced the following four outcomes/variables: **"safety outcomes", "safety promoting goals", "performance objectives", and "change objectives".** These four outcomes are part of the logic model of the change behind the i-DREAMS interventions. For a detailed description, see deliverable 3.3 (Brijs et al., 2020). Ideally, we would like to detect a statistically significant impact on the

safety outcomes (e.g., crash occurrence). However, this not being very likely to detect during the on-road trials due to the rare nature of crashes and because the on-road trials have a total duration of only five months, it is more likely that the i-DREAMS interventions will impact the three underlying outcome variables (safety promoting goals, performance objectives and change objectives).

2.4.2 Process evaluation

Process evaluation assesses which parts of the intervention were effective and which not. More specifically, the quality of implementation and adoption of the intervention is investigated. The RE-AIM Framework variables (Glasgow et al., 1999) are the main focus of the process evaluation of the on-road trials. RE-AIM is a widely known framework for process evaluation and stands for: Reach, Effectiveness, Adaption, Implementation and Maintenance, as shown in Figure 4. For a detailed description, see deliverable 7.1 (Katrazakas et al., 2020).

Figure 4: the RE-AIM Framework

Furthermore, the seven key process evaluation components defined by Linnan and Steckler (2000) will be applied to conduct a process evaluation of the on-road trials. These components are:

1. **Context**: Aspects of the larger social, political, and economic environment that may influence intervention implementation.

2. **Reach**: The proportion of the intended target audience that participates in an intervention. If there are multiple interventions, then it is the proportion that participates in each intervention or component. It is often measured by attendance. Reach is a characteristic of the target audience.
3. **Dose delivered**: The number or amount of each intervention's intended units or each component delivered or provided. Dose delivered is a function of the efforts of the intervention providers.
4. **Dose received**: The extent to which participants actively engage with, interact with, are receptive to, and use materials or recommended resources. Dose received is a characteristic of the target audience, and it assesses the extent of engagement of participants with the intervention.
5. **Fidelity**: The extent to which the intervention was delivered as planned. It represents the quality and integrity of the intervention as conceived by the developers. Fidelity is a function of the intervention providers.
6. **Implementation**: A composite score that indicates the extent to which the intervention has been implemented and received by the intended audience.
7. **Recruitment**: Procedures used to approach and attract participants. Recruitment often occurs at the individual and organisational/community levels.

User acceptability and acceptance will be a key-component to be investigated in terms of process evaluation. Adopting a new in-vehicle safety technology can only be successful if the technology effectively reduces the target risk and when it is also used efficiently by the driver. If the driver does not accept the technology, misuse or disuse of the technology is evident (Parasuraman & Riley, 1997). It is therefore essential to measure and reach a high level of acceptability and acceptance. Consequently, the outcome evaluation will also assess the "user acceptance" and "user acceptability" of the i-DREAMS system. Acceptability applies to whether drivers intend and are open to using the system, whereas acceptance relates to how drivers experience a new system's actual use. Both aspects are essential for the adaptation and effectiveness of interventions.

2.4.3 Conceptual framework

Figure 5 shows the conceptual framework to develop research questions for the i-DREAMS intervention assessment. At the top of the figure, the different components (i.e., safety outcomes, safety promoting goals, performance objectives) constituting the logic model of change behind the real-time intervention offered during the on-road trials are shown. The participants of the on-road trials will receive three different intervention formats:

1. Real-time intervention via an in-vehicle warning system
2. Real-time intervention via an in-vehicle warning system and post-trip intervention via a smartphone app consisting of feedback (i.e., scores indicating driving performance)
3. Real-time intervention via an in-vehicle warning system and post-trip intervention via a smartphone app + web dashboard consisting of both scores and gamification elements.

These different intervention formats are all linked to these outcomes of the i-DREAMS model of change (i.e., safety outcomes, safety promoting goals, performance objectives and change objectives). It is essential to take potential moderators and mediators into account. Moderators affect the relationship between two variables, whereas mediators explain the relationship between two variables. The possible variables that could moderate or mediate

the intervention format's impact on the outcomes appearing in the i-DREAMS model of change are technology acceptability, safety culture/climate, and participant profile. **Technology acceptability** is "the degree to which an individual incorporates the system in his/her driving". **Safety culture/climate** applies to "an organisation's approach to safety" and is primarily applicable to professional drivers like truck and bus drivers and train and tram operators. While "safety culture" mainly refers to individual and group values, attitudes, perceptions, competencies regarding safety, "safety climate" is primarily used to describe the expressed ideas, the tools and techniques used in general by the organization to confirm its compliance to safety. **Participant profile** describes "the characteristics of a person".

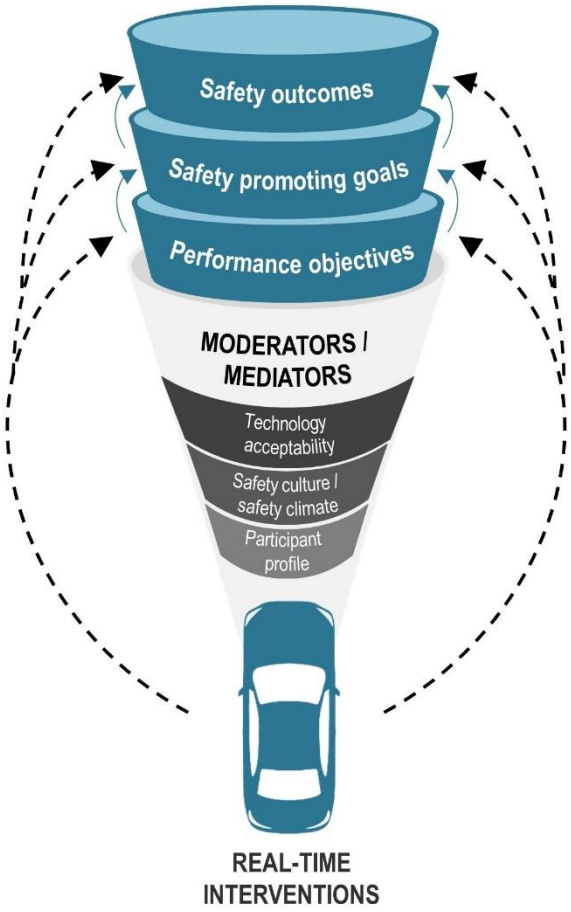


Figure 5: Conceptual framework for research questions

2.5 Research questions, indicators and measures, and methodological design

This section focuses on the research questions that will be attempted to be answered with the field trials, as well as the necessary indicators, measurements and methodological designs needed to obtain such answers.

The purpose of the field trials is to collect the necessary data, which will lead to the identification of the STZ and the correlated conditions, to predict and explain the prevailing level of road safety and driving behaviour. As a result, research questions associated with the field trials are linked with the procedure and preparation of the field trials as well as the identification and explanation of the STZ levels, as a preparation for the analyses in subsequent work packages (i.e., WP6 and WP7)

2.5.1 Field trials procedures (process evaluation)

- How do incentives assist in recruiting participants for a 6-month field trial study?
- How acceptable is the monitoring equipment for potential field-trial participants?
- What are the differences in recruitment of professional vs private drivers?
- Do the interventions help in keeping drivers motivated for participation?
- How is seamless data collection ensured during the duration of the experiments?

2.5.1.1 Indicators and measures

For research questions related to the procedures of preparing and performing the field trial experiments, indicators that could be used are statistics gathered throughout the experiments such as monitoring participation, the drop-out percentage, as well as the details included in the exit questionnaires of participants. With regards to the last question, logging of erroneous measurements or contingency planning for faulty equipment would also assist in identifying the success of the field trials.

2.5.1.2 Methodological design

Analyses of Variance (i.e., ANOVA and ANCOVA) will be conducted to investigate the acceptance of equipment and incentives, as well as differences between private and professional drivers. Descriptive statistics will also be utilised to obtain a high-level picture of participation, motivation and drop-out rates.

2.5.2 STZ identification (operational evaluation)

- Do the i-DREAMS interventions return the driver to the STZ phase of normal driving?
- How much time is needed to identify the prevailing STZ level?
- How much time is needed for participants to return to normal driving on average?
- Which are the most crucial measurements for the prediction of the normal/dangerous/avoidable accident phase STZ level?
- Which are the most crucial measurements that indicate change by the post-trip and gamification platforms?
- What is the impact of the real-time interventions on the STZ level?
- What is the impact of the post-trip interventions and the gamification platform on the STZ level?
- How do users evaluate the real-time/post-trip interventions offered to them in terms of acceptability (with the inclusion of the intention to use the interventions)?
- How are the above questions different in private vs professional drivers?

2.5.2.1 Indicators and measures

For the identification of the STZ level, as well as the time spent in each of the STZ levels and the most crucial measurements, D3.2 and D4.2 (in their corresponding Table 1), have provided the necessary measurements to be used.

2.5.2.2 Methodological design

The analytical models for STZ identification have already been described in previous project deliverables (i.e., 3.2 and 4.2). In summary, Dynamic Bayesian Networks (DBNs), Long-Short-Term-Memory networks (LSTMs), as well as Hybrid Choice Models and Structural Equation modelling can be used for STZ identification and explanation of measurement impacts. Furthermore, a plethora of analytical tools have been already documented within WP6 to be able to predict or explain safety risk and the impact of interventions (see Figure 6).

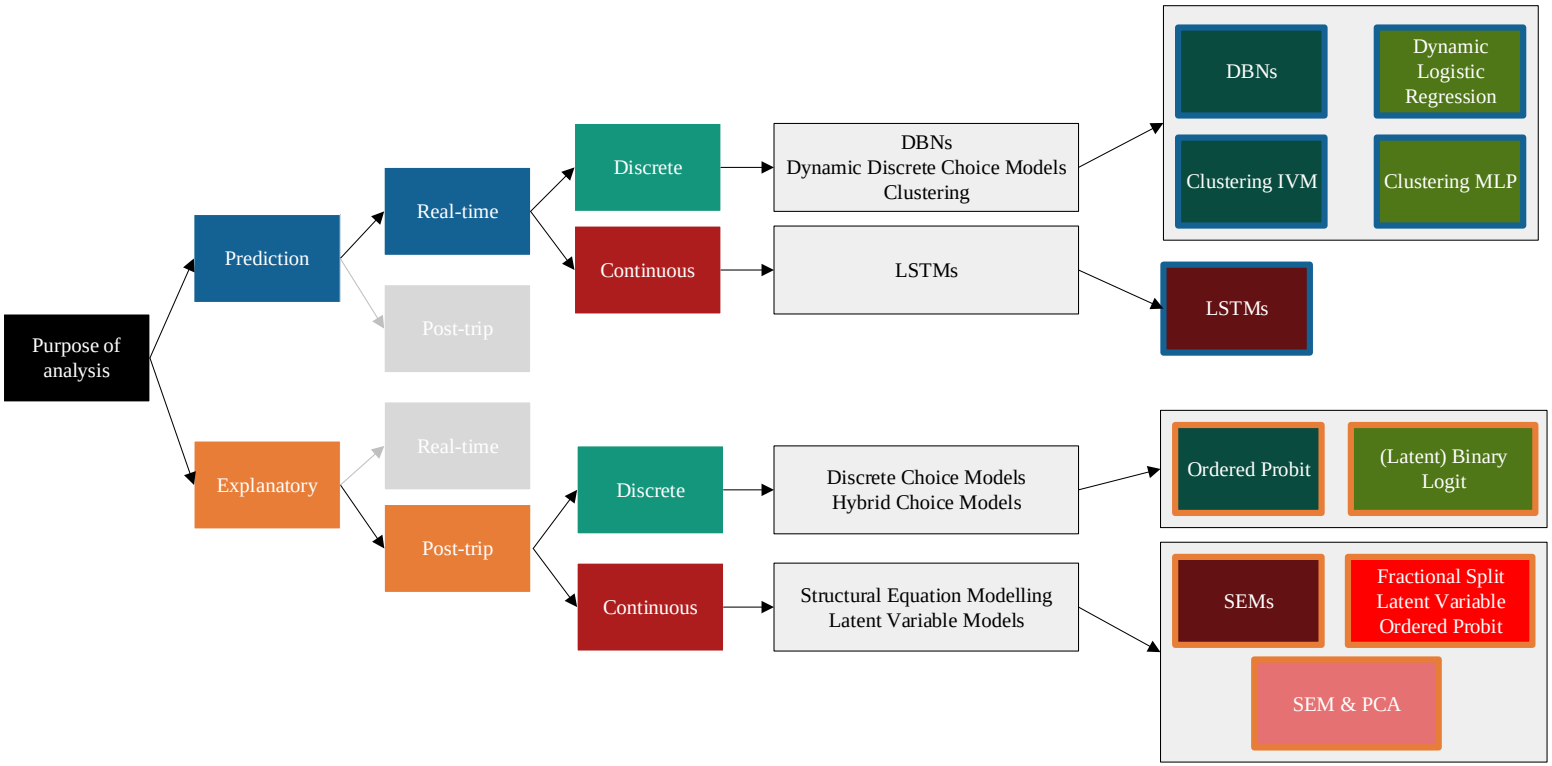


Figure 6:Prediction and explanation of safety risk and impact of interventions

With regards to the user evaluation of the real-time and post-trip acceptability, analyses of variance (i.e., ANOVA or ANCOVA) can be performed.

3 Technology overview

There is a complex suite of technology being used in the field trials which includes equipment giving feedback in-vehicle in real-time as well as coaching tools offering advice and goal setting once a journey has finished.

This technology has already been covered in detail in Work Package 4 deliverables and therefore will not be repeated in detail here but instead sign posted to where more detailed descriptions can be found.

Since those deliverables have been published a user manual for the in-vehicle technology has been created and will be shown in this section to both illustrate the level of detail participants will receive when starting the trial and to also give the reader an indication of the project technology without the need to locate and read the WP4 deliverables.

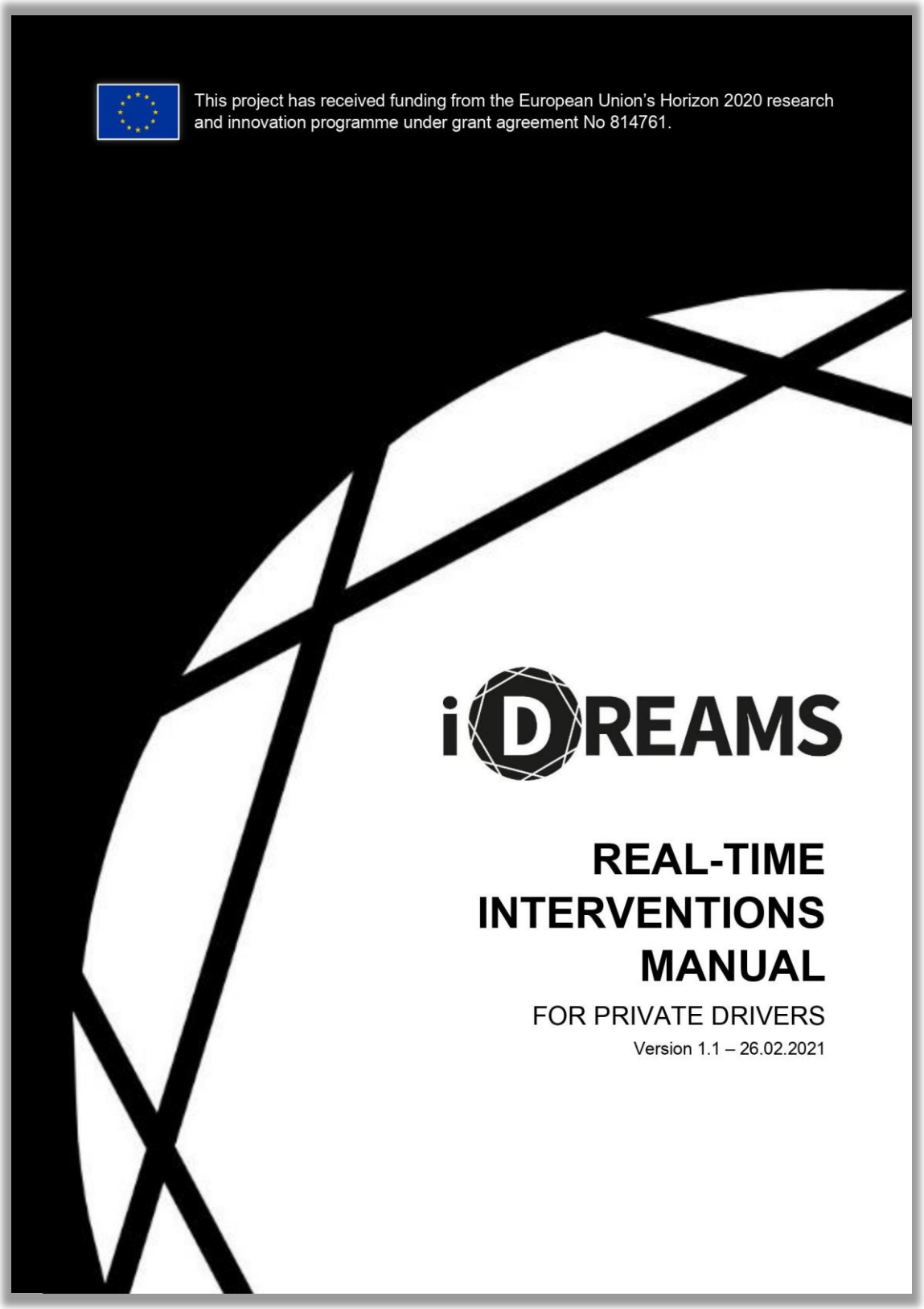
Please note, for further information on the project technology please refer to the following deliverables:

- D4.1 and D4.4 for the in-vehicle technology description.
- D4.5 for the smartphone application description.
- D4.6 for the web dashboard description.
- D4.7 for details on how to operate the web dashboard.

There have also been minor modifications made to the technology since these deliverables have been published. For the in-vehicle technology, the visual display will now warn the driver if they are attempting to use their phone in a hand-held way while driving, the in-vehicle display will show a symbol to remind them of the dangers of this. The in-vehicle display screen designs have also been upgraded, the manual below shows the new display screen designs as well as the hand-held phone use symbols.

3.1 In-vehicle technology example user manual

A user manual has been created for the in-vehicle technology for private drivers, a separate example has also been made for commercial drivers as the technology used varies slightly. There will be a similar manual for the use of the post-trip application, the in-vehicle example is used to illustrate what an i-DREAMS trial participant can expect to receive.


This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 814761.
iDREAMS
REAL-TIME INTERVENTIONS MANUAL
FOR PRIVATE DRIVERS
Version 1.1 – 26.02.2021

DEAR PARTICIPANT,

Thank you for your participation in the i-DREAMS field trials. We appreciate your willingness to install our intervention equipment in your vehicle. This system is a driver assistance system that is based on the concept of a "Safety Tolerance Zone" (STZ). The STZ keeps the driver and vehicle within safe operating conditions. To achieve this, the system uses sensors to collect data in real-time from the vehicle, the driver and the environment. The system provides real-time visual and auditory interventions to warn the driver in potentially dangerous situations where action is required.

Before using the i-DREAMS system you should read this manual carefully and keep it for future reference.

While driving, data collected by sensors are coded, encrypted and uploaded to the i-DREAMS cloud where they are securely stored and analyzed and can be accessed for post-trip feedback and replay of dangerous events.

Yours respectfully,

THE i-DREAMS TEAM

TABLE OF CONTENTS

This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 814761

SYSTEM COMPONENTS

Your car will be equipped with some technology that will allow us to monitor you, your vehicle and the environment you are driving in. Below, we give you an overview of the different technologies we use and explain what they are used for. **The intervention device and the wearable tracker are components that require some additional actions from you.** The other components operate fully automatically.

GATEWAY

The gateway (which is actually a small computer) collects data from all sensors. It calculates the Safety Tolerance Zone in real-time to trigger alerts when potential risk is identified. It is installed under the dashboard and is equipped with a built-in speaker for auditory signals.

MOBILEYE

This is a smart camera that monitors the roadway environment (traffic signs, lanes…) and other road users (pedestrians, distance to other cars…). It also collects (limited) data from the vehicle CAN-bus that enables real-time communication.

DASHCAM

The dashboard camera captures video fragments of a few seconds before and after a potentially dangerous event (e.g. harsh brake, collision warning). In some countries the dashcam is disabled due to legal constraints.

INTERVENTION DEVICE

It is a small touch-screen device that is used to provide visual intervention alerts and information. This device is also used for driver identification.

GPS ANTENNA

This is the antenna used for GPS geolocation in the i-DREAMS system.

4G ANTENNA

This antenna provides mobile connectivity. It connects the in-vehicle i-DREAMS system to the i-DREAMS cloud.

WEARABLE TRACKER

This wearable tracker measures driver sleepiness by analyzing heart pulses. It connects via Bluetooth with the i-DREAMS gateway. It should be worn while driving.

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SERVICE AND INSTALLATION

All services and installations should be and will be performed by a **certified i-DREAMS technician**.

During the installation of the equipment, a qualified technician fully calibrates the system, connects the different components and routes the cables behind the interior panels. **Do not attempt to open or (re)move any of the components or unplug any of the cables**. Doing so might cause damage to the system and its calibration.

If you are experiencing issues or problems with the i-DREAMS system, please contact your local service/installation points. The contact details are provided on the last page of this manual.

INTERVENTION DEVICE

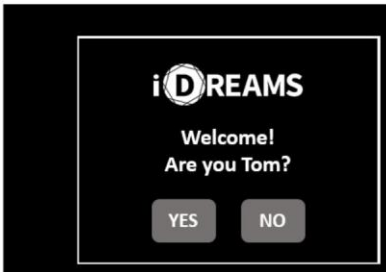
DRIVER IDENTIFICATION

The i-DREAMS system starts up automatically when the vehicle is started. A short moment later, the intervention device switches on.

i-DREAMS provides a personalized experience that is tailored for each individual driver while driving data are also collected, analyzed and linked to a personal profile. To be able to do so, it is essential for the system to know the driver's identity.

Manual identification is needed before the i-DREAMS system can generate real-time interventions while driving. Manual driver identification is automatically prompted every time the vehicle starts. Through the intervention device, it is possible to confirm the last known driver, select another driver that is known to the system, or indicate that the current driver is not enrolled in the i-DREAMS trials.

This procedure of driver identification should be executed before setting off (i.e. not while driving).



STARTUP SCREEN – The system remembers the last known driver and asks whether this is you.

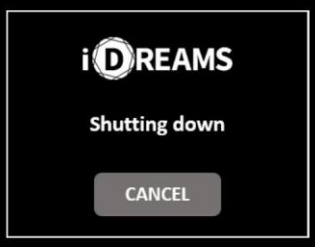
Selecting **Yes** starts the i-DREAMS system.

Selecting **No** will open a list of drivers to choose from with all the drivers that are known to the system.

SELECTION SCREEN – This screen shows all the frequent drivers of the current vehicle that are registered on the i-DREAMS platform. Selecting "**your name**" starts the i-DREAMS system.

"**Other**" can be selected when the current driver is not registered on the i-DREAMS platform. In this case, the i-DREAMS system will NOT start and the trip data are NOT collected and stored.

WELCOME SCREEN – After the driver identification has been confirmed, the welcome screen is shown until the i-DREAMS gateway has been fully booted. The driver is reminded to wear the wearable tracker.



DRIVER UNKNOWN – When the current driver is unknown to the

i-DREAMS system, the intervention device automatically shuts down and real-time in-vehicle alerts are disabled.

This screen is visible for a short time, during which the shutdown procedure can still be cancelled. Pushing the cancel button will re-initiate the driver identification procedure.

REAL-TIME INTERVENTIONS

Real-time interventions are provided through the intervention device (visually) and the speakers on the i-DREAMS gateway (auditory). The interventions are aimed to keep the driver within the "Safety Tolerance Zone". There are multiple risk conditions that are constantly being monitored by the i-DREAMS system. Each risk condition has its own specific warning symbol and auditory message. For most risk conditions, there are multiple **stages of interventions**, with increased intrusiveness for increased risk.

Note: Depending on your vehicle, some interventions may not be active

Home screen

After driver identification has been completed, the intervention device displays the home screen. The home screen provides the driver with information about the status of the different monitoring systems. It displays information such as the current speed limit, whether a vehicle is detected ahead and whether lane marking is being detected by the smart camera.

Warning symbols

Forward Collision Warning

Avoidable accident ahead, brake immediately!

Flashing icon, accompanied by auditory signal.

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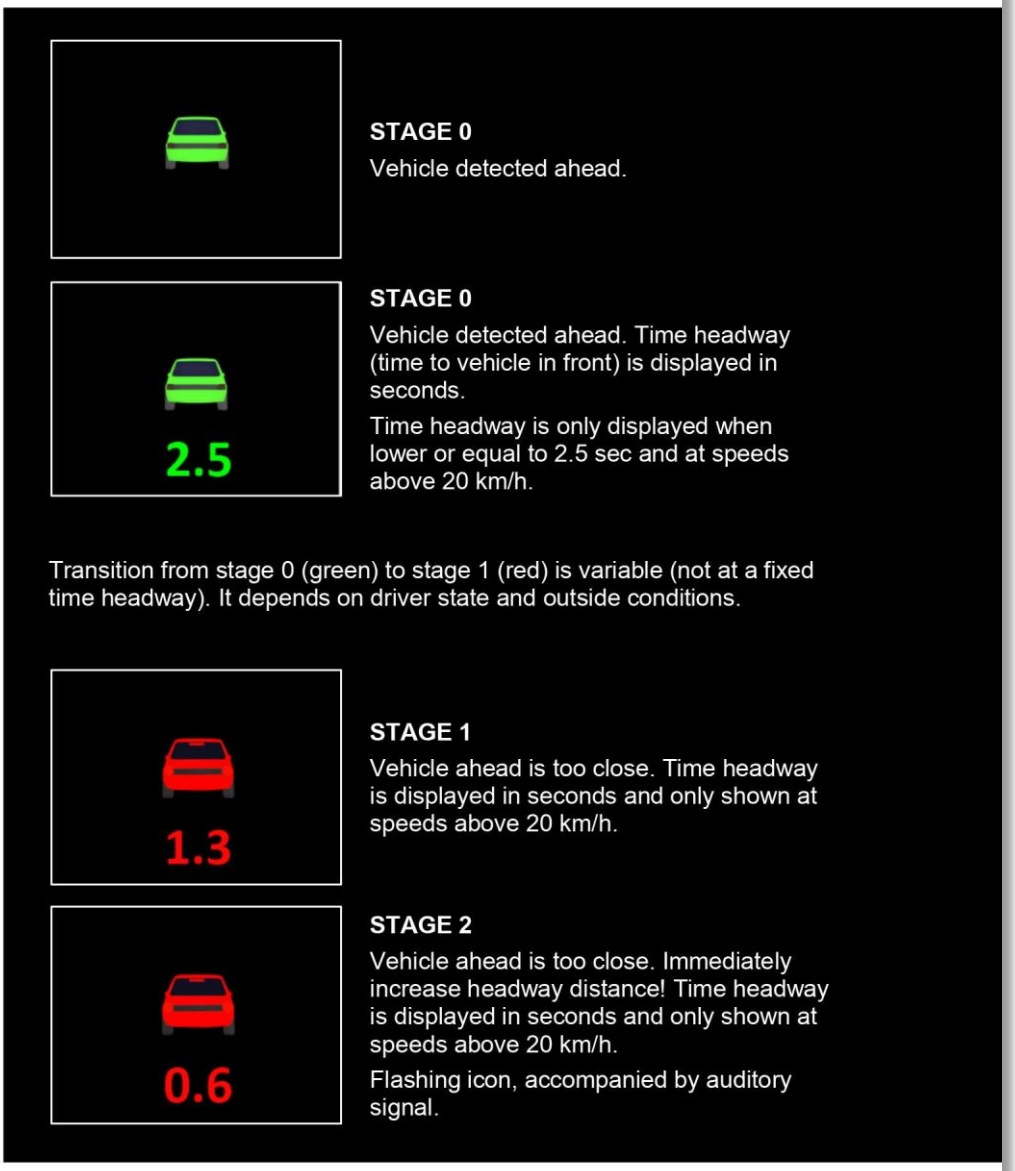
Headway Monitoring



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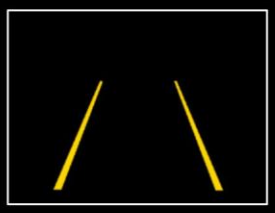
Lane Monitoring

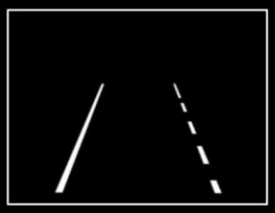


STAGE 0

Lane monitoring unavailable. This occurs when no road marking is detected or the vehicle speed is below 65 km/h (40 mph).

STAGE 0

Lane monitoring active and lanes detected



STAGE 1

Lane departure warning. A dotted line appears on the side where the vehicle is leaving the road lane without using the turn indicator.

Warning symbol accompanied by auditory signal

Vulnerable Road User Monitoring

STAGE 1

Vulnerable road user detected in danger zone.

STAGE 2

Avoidable accident with vulnerable road user is imminent, brake immediately!

Flashing icon, accompanied by auditory signal.

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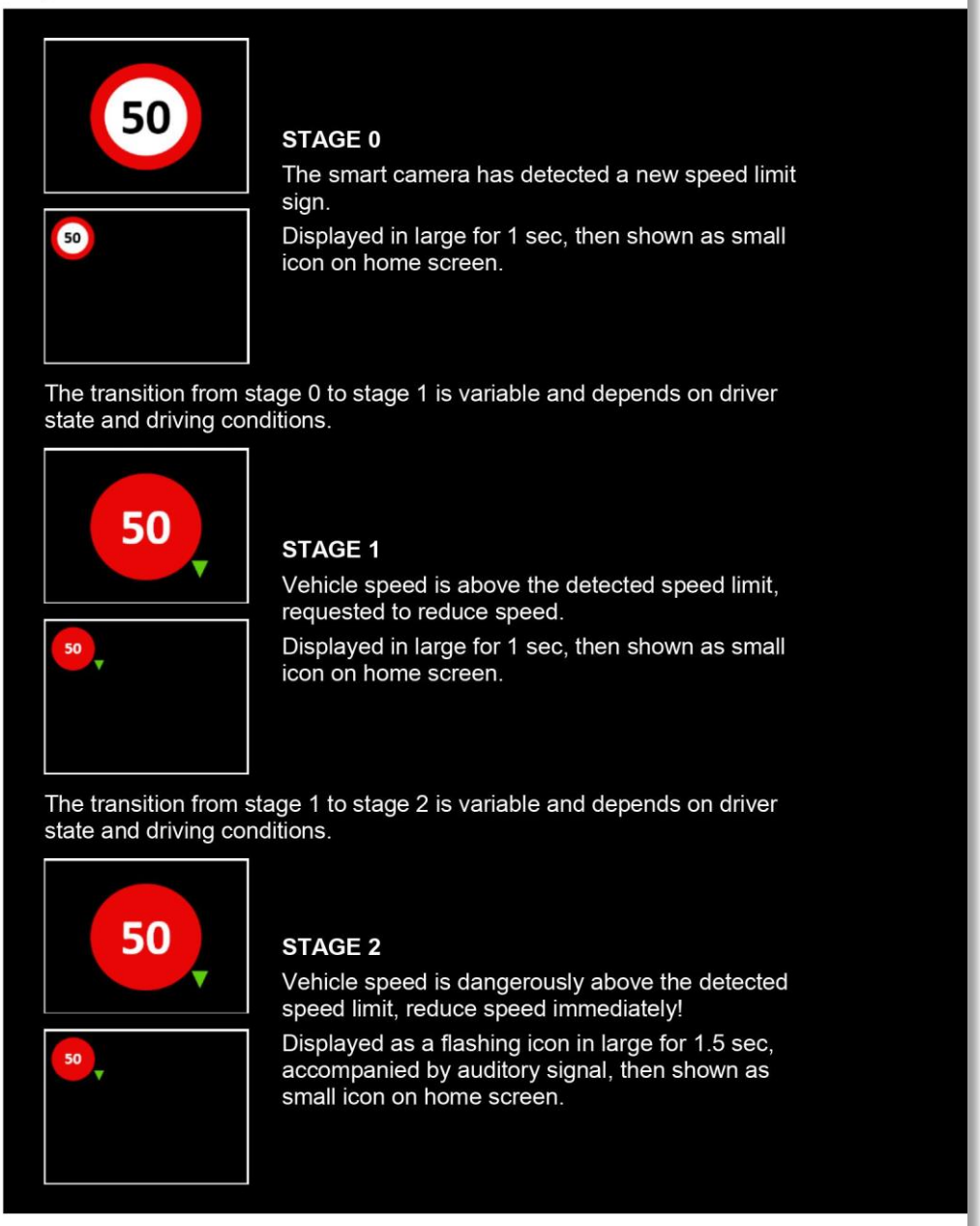
Speed Limit Indication



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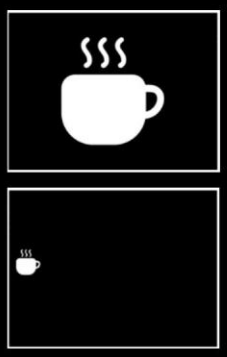
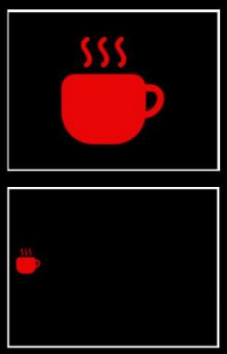
Fatigue and Sleepiness Monitoring



STAGE 1

First signs of fatigue or sleepiness are detected, driver is requested to take a break (at least 15 minutes).

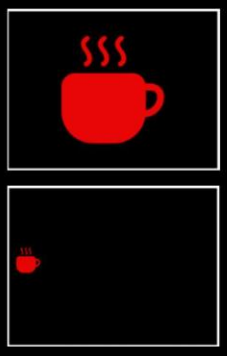
Displayed in large for 1 sec, then shown as small icon on home screen.



STAGE 2

Elevated levels of fatigue or sleepiness are detected. Driver is urged to take a break (at least 15 minutes).

Displayed in large and flashing for 1.5 sec, then shown as small icon on home screen. Warning symbol accompanied by auditory signal.



STAGE 3

Dangerously high levels of fatigue or sleepiness are detected. Take a break immediately (at least 15 minutes)!

Displayed in large and flashing for 1.5 sec, then shown as small flashing icon on home screen. Warning symbol accompanied by auditory signal.

If the driver continues, the symbol is displayed in large again.

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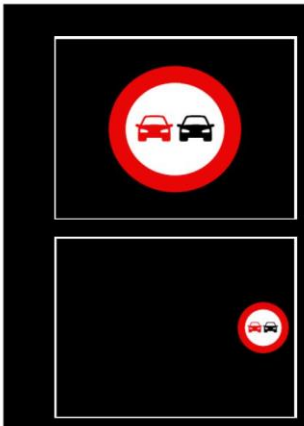
Illegal Overtaking



STAGE 0

The smart camera has detected an overtaking limitation sign.

Displayed in large for 1 sec, then shown as small icon on home screen.

STAGE 1

An overtaking manoeuvre in a no-overtaking zone has been detected.

Displayed in large for 1 sec.

STAGE 2

An overtaking manoeuvre in a no-overtaking zone has been detected, combined with harsh acceleration.

Displayed as a flashing icon in large for 1.5 sec.

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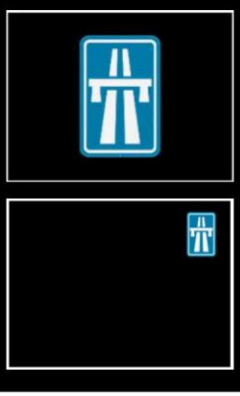
Traffic Sign Recognition



The smart camera can read several traffic signs (and undersigns). Whenever a new traffic sign is detected, it is displayed as a large icon for 1 sec together with the type of undersign, then it is shown as a small icon on the home screen in the top right corner.

The traffic sign recognition is informational only, if another intervention is already displayed while the traffic sign is detected, it is not shown on the display.

Distraction Monitoring

The system can detect distraction by smartphone usage while driving. When detected, a symbol is displayed in large for 1 sec, then shown as small icon on the home screen until smartphone usage has no longer been detected

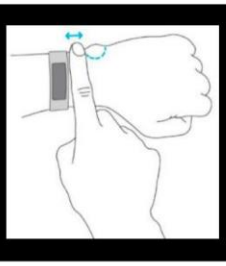
End of trip

After a trip, when the vehicle ignition has been turned off, the system remains active for a short time during which trip data is being processed and uploaded to the cloud. The display will show a shutdown screen for a few seconds until it turns off automatically.

WEARABLE TRACKER

HOW TO OPERATE THE WEARABLE TRACKER?

Placement



Place the device approximately one finger width from your wrist knuckle. The strap should be tight enough that the device does not slip with normal movement.

On-Off

Press and hold the button for 2 seconds. The device vibrates and the display turns on. The display turns off after a few seconds. Press the button once to wake it up again.

Press the button repeatedly to cycle through the display menu until a battery symbol appears. If the depicted battery is empty, charge the device.

To completely turn off the device, press and hold the button until the display turns off (the shutdown symbol appears approximately 10 seconds into pressing the button).

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Active mode

When a trip starts, the in-vehicle gateway connects to the wearable and starts the active mode. When this happens, the device vibrates and shows a small arrow on the top left of the heart symbol.

After a while, the device starts to measure heart rate.

After the trip, the device will go back to the standby mode, with a vibration. If this does not happen automatically, press and hold the button until the device vibrates.

Charging

Remove the device from the flexible wristband and locate the micro-USB port. Connect the provided USB cable and use a common USB phone charger to charge the device.

The device is charged when the battery symbol is full (approximately 2 hours).

Disconnect the cable and place the device back in the wristband.

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WEARABLE TRACKER SAFETY INSTRUCTIONS

Risk of explosion if the battery is replaced by an incorrect type. Dispose of used batteries according to instructions and local regulations.

Do not immerse in water. Clean with soft dry cloth, without the use of water, detergent, or other chemicals.

Do not expose to excessive heat sources, sunshine, fire, or the like.

No user replaceable parts inside, refer servicing to a manufacturer specified agency or qualified service personnel.

Only use accessories and/or batteries specified by the manufacturer.

Disposal of all electrical and electronic products, including batteries, should be disposed of separately from the municipal waste stream via designated collection facilities appointed by the government or the local authorities.

IMPORTANT

Do not operate the i-DREAMS system while driving, be safe first!

The i-DREAMS technology is a driver assistance system, it does not in any way replace the driver or take over any driver tasks. At all times it is still the drivers' responsibility to control the vehicle and act appropriately in each situation. When no warning or intervention is provided by the i-DREAMS system, it doesn't necessarily mean that there is no danger.

i-DREAMS is an ongoing research project, the technology installed in your vehicle is considered as testing equipment 'as is' and is not commercially available.

The quality of interventions and information (e.g. video footage) provided by the i-DREAMS system is dependent on various uncontrollable factors. It is very important to know and understand that the interventions and technology cannot be 100% accurate under all conditions or at all times. The factors below can affect the warning functions:

- Conditions of the road and lane indications (e.g. harsh shadows or damaged roadway pavement; obstructions on the road that may block the view of divider lines; misaligned or missing lane divider lines due to wear or construction; extremely narrow, wide or winding roads; obscured lane divider lines due to snow, rain, fog, dirt, sand, salt, etc.)
- Vehicle speed
- Obscured camera view due to objects, reflections, rain, snow, fog or frost on the windshield
- Light conditions (e.g. headlight or taillight glare from sun or other elements, dark or low-light environments)
- Camera misalignment, which may result in no warnings or false warnings
- 3G/4G coverage

Traffic sign and speed limit recognition is a tool that is made available to the driver, but under all circumstances will it still be the drivers' responsibility to read traffic signs and know the traffic laws and road code that are applicable. The traffic sign and speed limit recognition is (mostly) vision based, it is unavoidable that the smart camera detects certain objects as traffic signs while in reality they might not be, or it doesn't read all the traffic signs or is mistaken in reading and/or interpretation of traffic signs and speed limits. The system only recognizes valid road signs as defined in the Vienna Convention.

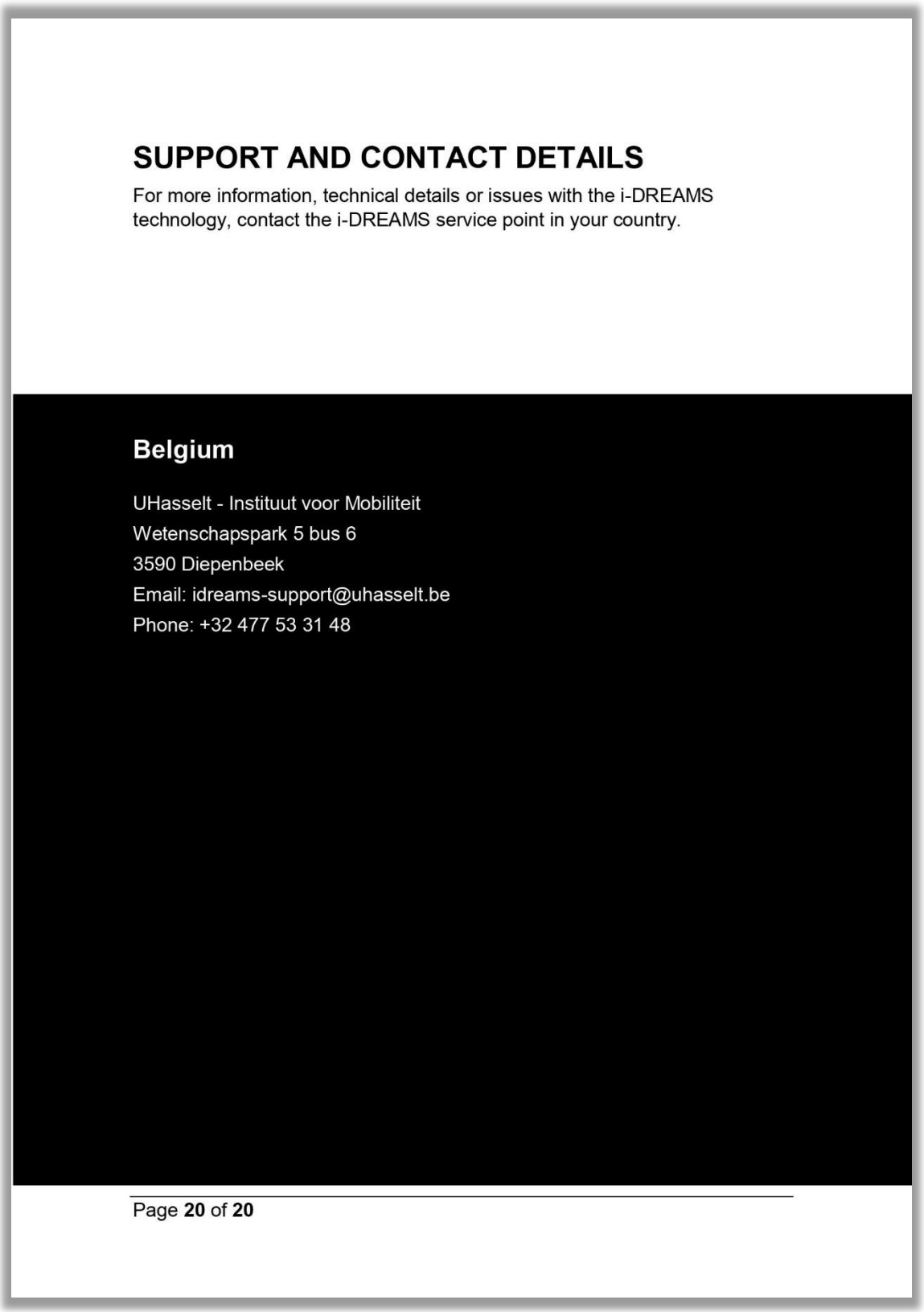
In no way should the i-DREAMS fatigue and sleepiness detection systems (or the lack off) be seen as an excuse or encouragement to continue driving when feeling tired, sleepy or fatigued. It remains the drivers' responsibility to judge whether they are fit to drive a vehicle in traffic.

The i-DREAMS equipment is not water resistant, never allow any form of liquid to come in contact with the equipment.

Do not expose the device to extremely high or low temperatures.

Do not use the unit if you suspect that it is damaged. Do not try to open or repair the unit yourself. To avoid considerable subsequent damage to the device, only let a qualified i-DREAMS expert repair the unit.

Keep the device away from children, it is not a toy.



SUPPORT AND CONTACT DETAILS

For more information, technical details or issues with the i-DREAMS technology, contact the i-DREAMS service point in your country.

Belgium

UHasselt - Instituut voor Mobiliteit
Wetenschapspark 5 bus 6
3590 Diepenbeek
Email: idreams-support@uhasselt.be
Phone: +32 477 53 31 48

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Per field trial partner, the contact information is adjusted.

4 Field trials plans and procedures

4.1 Introduction

Due to their complex nature, the field trials require detailed planning and organisation to be successfully implemented. This section represents a template for such planning, covering the resources and procedures that will be used. This includes the agreed parameters around recruitment, drop-outs, payments etc., as well as the template for documents which, through completing, partners will ensure they are prepared for the trials. There will be differences across partners due to having different modes of transport, number of vehicles to install etc. However, this section gives an indication of the stages that will be followed by all partners to implement the trials. It should be noted the examples here mostly relate to cars as more sites are carrying out trials for this vehicle type, there will be variations needed for buses, trucks and rail but the information and stages it prescribes are still largely applicable.

The procedures which follow will be tested first in the pilots, these aim to validate the complete instrumentation of equipment and configuration (from participant and vehicle reception, i-DREAMS system installation to data collection) and the corresponding procedures. Just like the actual field trial, the pilot is divided into several successive steps where there will be a baseline period followed by Stage 1, with just the in-vehicle display active, Stage 2 will see the application being used and finally Stage 3 will have the gamified elements of the application to engage with also, each stage will run for 1 week. Any learning points from these pilots will then be implemented in the main trials.

4.2 Study Design

An overview of the study design and rationale have been covered in previous sections of this document. A very brief overview follows.

In the i-DREAMS project, field experiments with a group of 490 drivers/operators in total will be carried out in 5 EU countries. Figure 7 shows how these are split across countries and transport types. Table 1 shows the phases of the study, it can be seen most phases of the trial run for 4 weeks but the phase including the gamified web platform and app runs for 6 weeks. The rationale for this extended period is that the web app has several stages built-in which require time to interact with, it also aims to test the web platform's ability to maintain engagement so a sufficient opportunity for boredom and disengagement is required to test its effectiveness.

It should be noted that due to a restriction in the number of sets of equipment many trial sites will be running the trials across two groups. Each of the groups will go through all of the trial phases but Group 1 will go first, complete the entire trial then be de-installed. The same set of equipment will then be installed into Group 2, which will then undergo the full trial before being de-installed also.

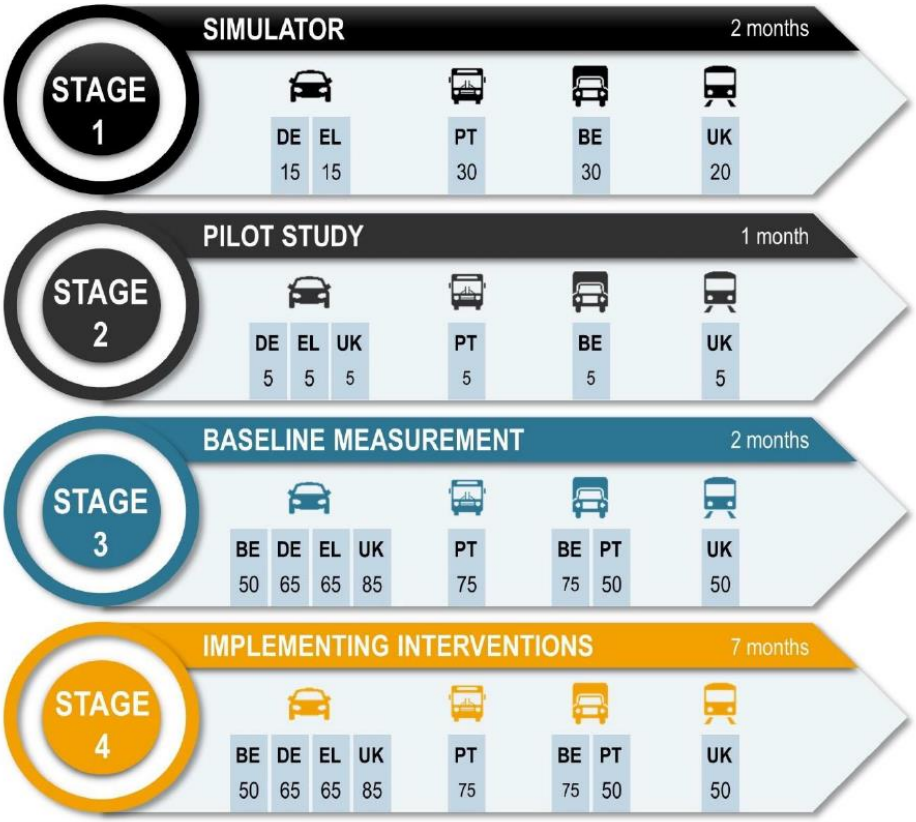

Figure 7: Stages of the field trials

Table 1: Durations of each phase of Stages 2- 4.

Description	Duration per participant
Pilot testing	4 weeks
Baseline measurement (no interventions)	4 weeks
In-vehicle intervention	4 weeks
Post-trip feedback on the smartphone	4 weeks
Post-trip feedback on smartphone + gamified web platform	6 weeks

4.3 Participant inclusion criteria

The following participant inclusion criteria and quota will be applied in the i-DREAMS field trials.

4.3.1 Driving experience

To guarantee that enough data will be collected during the field trials, potential participants must meet the minimum annual driving distance criterion. The following specifications are set:

- Car: a minimum yearly driving distance of 10,000 km is recommended for the principal driver. This requirement does not apply to any additional driver of the same vehicle.
- Bus: drivers who have at least 6 months of driving experience. However, the participating fleets/companies will determine which drivers will participate in the trials.
- Rail: drivers who have at least 6 months of driving experience. However, the participating fleets/companies will determine which drivers will participate in the trials.
- Truck: drivers who have at least 6 months of driving experience. However, the participating fleets/companies will determine which drivers will participate in the trials.

4.3.2 Age

Age is a known factor that can influence driving behaviour. Therefore, four age groups are defined to guarantee a spread of the age distribution: 18-25, 26-45, 46-64, 65+. The following specifications are set:

- Car: all trials with cars should comply with the four age categories.
- Bus: no minimum requirement for age as the participating fleets/companies will determine which drivers will participate in the trials. However, the researchers aim to have all age groups represented in the sample if possible.
- Rail: no minimum requirement for age as the participating fleets/companies will determine which drivers will participate in the trials. However, the researchers aim to have all age groups represented in the sample if possible.
- Truck: no minimum requirement for age as the participating fleets/companies will determine which drivers will participate in the trials. However, the researchers aim to have all age groups represented in the sample if possible.

The following age group are defined for car drivers 18-25, 26-45, 46-64, 65+. To drive a bus/truck/tram/train, you need to be 21. Car drivers can start at 18 to exclude the least experienced. The age groups for car drivers are also applied for professional drivers. The minimum age depends very much on the type of driving license and whether one has a professional competence certificate. In practice, it will probably be the case that professional drivers are often more than 21 years old. Most truck and bus drivers are even older (average age is 50+). Finding young drivers of professional vehicles (up to the age of 25) will not be easy.

Furthermore, although every effort will be made to have the right balance concerning gender and age, for professional drivers, this will not be straightforward. There will likely have to be an adjustment to the age and gender ratio that exists in practice in this sector.

4.3.3 Gender

The following specifications are set for the drivers:

- Car: based on a recommendation of a previous study (Lai et al., 2013; Martin et al., 2017), a minimum of 40% per gender is recommended to avoid an overly skewed gender factor. If the possible equal division between genders is desired.
- Bus: no minimum requirement for gender as the participating fleets/companies will determine which drivers will participate in the trials. However, the researchers aim to have both genders represented in the sample if possible.

- Rail: no minimum requirement for gender as the participating fleets/companies will determine which drivers will participate in the trials. However, the researchers aim to have both genders represented in the sample if possible.
- Truck: no minimum requirement for gender as the participating fleets/companies will determine which drivers will participate in the trials. However, the researchers aim to have both genders represented in the sample if possible.

4.3.4 Multi-driver access

This is a recommended participant selection criterion for the field trials to enlarge the sample size of the car, bus and tram drivers. Based on a recommendation of previous studies (Lai et al., 2013; Martin et al., 2017), the aim is to have at least 25% of the cars, buses and trams in each country participating in the field trials to have multiple drivers. This criterion is not applied to trucks as it is expected that a truck is not a multi-driver access vehicle.

Note: The project policy for cars is that a second driver will not count towards participant numbers, they are there as a chance to collect extra data. There may be a few exceptional circumstances, such as both drivers covering the minimum mileage individually and therefore may be counted as two participants and drive for the whole trial duration (across both Groups 1 and 2) to qualify as two participants.

4.3.5 Environmental exposure

Participants in the field trials should have a mixed driving pattern across urban, rural and motorway environments. It has been decided that a minimum of 20% of exposure to the three road environments is required for car drivers, as shown in Table 2. There is no minimum requirement for environmental exposure for trucks, buses, trams, as the participating fleets/companies will determine which drivers will participate in the trials. Drivers often operate in the same road environment (e.g., long-haul drivers undertaking a lot of motorway driving versus construction material transport doing more short distances on interurban, urban and rural roads).

Table 2: Summary of required participant characteristics

	Car	**Bus**	**Rail**	**Truck**
Driving experience	10,000 km per year	Minimum of 6 months experience	Minimum of 6 months experience	Minimum of 6 months experience
Age	18-25, 26-45, 46-64, 65+	N/A	N/A	N/A
Gender	40% per gender	N/A	N/A	N/A
Multi-driver	At least 25% of the cars in each country with a minimum of 2 drivers per car	At least 25% of the buses with a minimum of 2 drivers per bus	At least 25% of the trains/trams with a minimum of 2 drivers per tram	N/A

Exposure	20% annual mileage in urban, rural and motorway environments	N/A	N/A	N/A

4.3.6 Vehicle selection criteria

The vehicles in the trials will be selected based on how easy they will be for the installation team to fit the i-DREAMS technology to them. CardioID has provided an initial list tailored to each country by looking into the most popular cars and cross-checking as to how difficult installation will be, those that were deemed easy were then made part of the list. Once recruitment has taken place it is also possible to go through the list of cars that have been volunteered and check them on an individual basis also, to ensure only those which are simpler to install will then be selected.

Some partners have chosen to additionally sample based on the technology in the vehicle. The aim is to ensure there is not a duplication of technologies between those being installed and that which is already present in the car. Other partners are forgoing this step but allow the participants to choose to turn off the duplicated in-built systems, if they so choose, once the trial starts.

For buses, trucks, and trams, no specific requirements regarding vehicle make and model apply as the participating fleets/companies will determine which vehicles will participate in the trials.

4.3.7 Location of participants

Participants will be selected within a 1-hour travel radius of the field trial base to ease the installation/de-installation or solve technical problems concerning the data collection system.

4.3.8 Participant restrictions:

In theory, participating tram, train, bus and truck drivers could also participate as car drivers. There is no objection to inclusion in 2 groups, although it may not be self-evident to find people who would participate in both. Theoretically, it is possible, and scientifically there is no problem with including the same participant in two groups. Each field trial partner can independently decide to apply this.

4.3.9 Expected change of vehicle

The participant should not have plans to change his/her vehicle during the trial period. This is an inclusion criterion as otherwise there is a risk that the participant buying a new vehicle and sells their old vehicle, resulting in a need to install and de-install the equipment twice for the same participant.

4.3.10 Smartphone type

The participant must have Android version 6 or higher, the i-DREAMS application is not yet designed to work on iPhones, so applicants are not eligible to take part if this is their only type of device.

4.4 Recruitment strategy

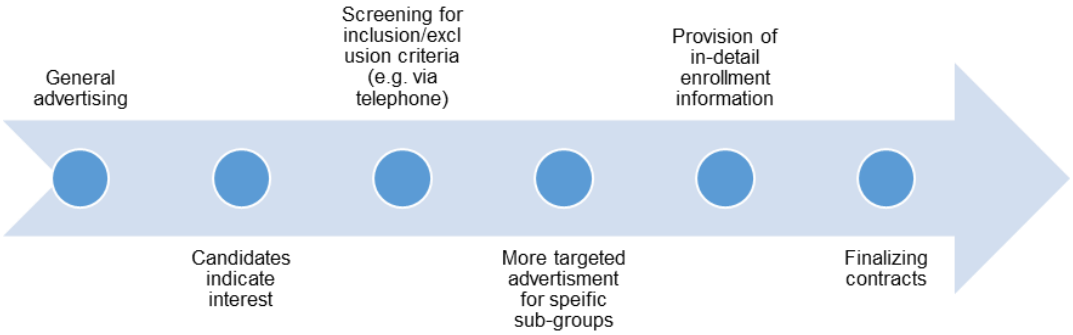

Figure 8: Recruitment process

Figure 8 represents the process that should be followed during recruitment, showing there may be a need for a primary drive for recruitment followed by a secondary targeted one to meet the required sub-sets (such as age, gender etc.).

The following may be used as the initial recruitment drive for the trials:

- ***Own recruitment database***: Databases or lists of possible participants from previous experiments can be used as a starting point for recruitment.
- ***Personal references:*** Personal contacts of the researchers such as relatives, acquaintances, friends, colleagues, etc.
- ***Motorist clubs***: Driver and vehicle organisations operate as a platform to exchange information and interests of their members. In that respect representatives of local driver or vehicle organisations can also be approached to assist in the recruitment process.
- ***General media***: Press releases may be used to generate interest in the study.
- ***Social media***: Social media may help to distribute advertisements to a broader audience; however, this may also come with certain biases. Various media for recruitment should be used.
- ***Vehicle fleets***: Contacting fleet operators is a useful way to recruit potential participants for field trials as this makes it easier to quickly find participants that fit the criteria. However, attention should be paid that the sample is not biased by trying to achieve a gender and age distribution similar to that detailed in Table 2 where possible.

Once potential participants have expressed an interest in taking part, they will receive an initial screening questionnaire. Those who are deemed eligible will then either have a more detailed questionnaire to complete or a follow-up phone call to allow for a final selection decision to be made.

For trial sites where there are two different installation periods, it will be necessary to allocate participants to each group, for example, based on their indicated preference for the testing period or when they are likely to be covering the most mileage. There will also be a need to have a reserve list in case those allocated to Group 2 drop out in-between time or have a

second recruitment drive nearer to Group 2's installation period to recruit or replace those recruited but dropped out.

4.5 Incentives

The incentive payment will vary by trial site and mode of transport. For commercial vehicles incentives are likely to be less or non-existent given the data recording will take place as part of the driving task they conduct for their job anyway.

An example of payment strategy in Belgium's car driver incentive policy is below. Other sites will have similar procedures, but incentive values may vary across trial sites based on regulations and individual choices in that country.

For participating in the Belgium car i-DREAMS field trials the overall incentive is €250. This compensation is paid on a vehicle basis. In case two or more drivers decide to participate with the same vehicle, only one payment of € 250 will be paid.

To keep participants motivated and to reduce drop-out, the incentive is paid in instalments:

- Participants receive €50 at the start of the field trials (they fill in a reimbursement form at the initial briefing)
- After 2 months, they will receive an additional €75 (a reimbursement form is sent to participants)
- After 4.5 months, they will receive the final payment of €125 (they complete a reimbursement form at the de-briefing)

Participants only receive the total payment of €250 if:

- They have completed all the questionnaires.
- They have participated in the entire duration of the study (4.5 months). Data must have been collected from the vehicle during this period without any hindrance or interruption of the data collection due to the participant's interference.

Participants will be informed that they need to report the received incentives in their income tax declaration. This will be mentioned in the participant agreement/consent form.

4.6 Installation

Equipment installs for cars is estimated at a maximum of 3 hours per vehicle. De-installation is estimated at a maximum of 1 hour per vehicle.

The installation processes will vary across trial sites with some partners training staff in-house to conduct the installations and others using outside contractors. All installers will be Mobileye install certified and have received training from CardioID on how to install the i-DREAMS specific suite of technology.

4.7 Participant drop-out strategy

A project-wide drop-out strategy has been devised for cars. This was required as there are multiple phases to the trial as well as multiple groups in some countries. It therefore would not always be possible to replace a participant for logistical reasons, as doing so could have a knock-on effect on the installation timing for the second group and overall trial period running length.

The following drop-out strategy will therefore be applied in the i-DREAMS field trials.

The i-DREAMS field trial study consists of different phases:

- Baseline,
- Real-time intervention,
- Real-time intervention plus post-trip interventions

In the baseline, the driving behaviour is just logged without interference from the equipment, any drop-out at this point will be replaced.

It is expected that most drop-outs will probably occur at the start of the real-time intervention phase because this is where the driver is first confronted with the equipment giving warnings. If a participant drops out when they have driven less than three weeks in the real-time intervention phase, the driver will be considered a drop-out that needs to be replaced.

When a participant has driven three weeks or more during the real-time intervention phase, or anytime thereafter, and decides to stop participating, they will not be replaced. In the latter case, enough data will be considered to have been collected to do meaningful analyses and the effect on timings for the study overall is too severe to replace them.

4.8 Trial timings

The Grant agreement showed an intended start date of February 2020 for equipping and March for actual data collection. However, due to COVID-19 related delays, as a result of lockdowns affecting the ability to install equipment as well as setbacks on manufacturing intervention devices, a delay to starting is now anticipated. Initial timeline plans show that for a testing site of 50 participants at least 48 operational weeks (approx. 11 months) is required due to there only being budget for 25 sets of equipment, necessitating Group 1 to be de-installed for the same equipment to then be installed into Group 2.

The proposed timeline includes all phases of data collection and pilot study. It is assumed that all ethics approval, protocol developments and recruitment has taken place before the timeline starts. The coloured boxes in the timeline below correspond with the table, aiding in understanding the estimated time required.

The below example timelines are based on the UK's car field trials estimates for their 5 pilot participants followed by two separate groups of 25 participants, whereby one group must take part in the whole trial and be de-installed before Group 2 can then do the same. Other

trial partners may have a different timeline due to different numbers of participants, installers, mode of transport etc. The following is just an example of timescale planning.

Table 3 shows the estimated times for installations of pilots and main trials and how they were calculated.

Table 3: Calculations for time required for installs and de-installs

Install for pilot	De-install pilot	Install Group 1	De-install Group 1/ install Group 2
1 to 2 days (max. 4 cars per day at an estimated 3 hours per install plus contingency)	**1 day** (5 cars per day at an estimated 1 hour per de-install)	**2 work weeks**- estimated 4 per day for 25 installs= 6 days (approx. 4 per day) plus a contingency of 4 days	**3 work weeks**. 25 de-installations at 8 per day is around 4 working days. 25 installs at 4 per day is around 10 workdays (approx. 6 days plus 4 contingency). Overall, around 14 workdays

Table 4 shows an example of how the installations along with trial running periods can be used to calculate an estimated full run time for the main trials.

Table 4: Timeline for on-road car trials in table form

	W1-4	W5	W5-6	W7-8	W8-12 (4 weeks)	W12-16 (4 weeks)	W16-20 (4 weeks)	W20-26 (6 weeks)	W26-29 (4 weeks)	W29-34 (4 weeks)	W33-37 (4 weeks)	W37-41 (4 weeks)	W41-47 (6 weeks)	Total: 47-48 weeks*
Install pilot (5) – 1 to 2 days	Run pilot	De-install pilot – 1 day	Prep / learning time from pilot – 2 weeks	Install Group 1 (25)	Baseline measure	Real time only	With post-trip smart-phone info	Gamified web platform in use too	De-install G1 / install G2 (25)	Baseline measure	Real time only	With post-trip smart-phone info	Gamified web platform in use too	De-install Group 2

*Inc. de-install group 2

Figure 9 shows an example of a Gantt chart used for the UK's car trials planning based on a start of pilot testing in April 2021. This is just an example date and may not be representative of the actual trial start. Note that an overlap is shown for the trial sections due to participants' trial times starting when they are equipped. For all participants to have covered the full testing period this has to include those equipped on the last day hence why, for example, 'real-time intervention' must run for 4 weeks but is shown over 5 weeks.

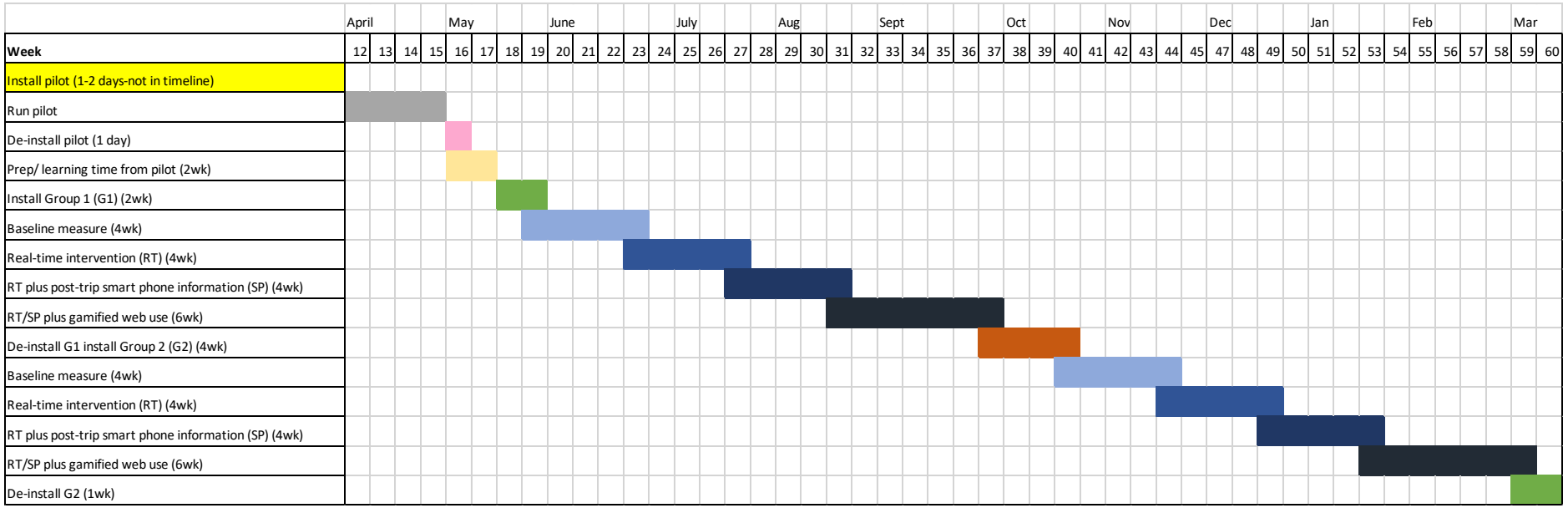

Figure 9: Example trials timing Gantt chart

4.9 Field trial required documents and resources

This section offers a template for trial partners to use to ensure they have all the required resources before undertaking the field trials. By completing the tables, they can assign responsibilities for the checking, or creation of, each resource to a particular team member or an external organisation.

4.9.1 Documents and strategies

Table 5: Resources required for trials

Name	Purpose	Responsible persons	When
Briefing presentation	Presentation to be made to each participant. before they agree to participate in the study. It shall present: • The i-DREAMS project • The overall organisation of the field trial (including an explanation of different stages) • The vehicle instrumentation and the data it collects • The overall content of the questionnaires (topics addressed) • Smartphone user app & wearable • The legal and ethical framework • Field trial partner and participants engagements • rights and obligations. • The content of contractual documents • Participant liaison: contact details in case of questions/problems • The incentives payment principle and organisation		To be presented at participant briefing (start of trial).
Invitation to briefing and de-briefing	Set up an e-mail to invite participants to the (de-)briefing moment. In this e-mail, a list of everything the participants need to bring with them will be included.		Before the start of the trial and before the end of the trial.
Questionnaires	***Entry and exit questionnaires***: Questionnaires are translated into the local language, and electronic versions are implemented.		The participant fills in the entry questionnaire during the briefing (start of trial) The participant fills in the exit questionnaire during de-briefing (end of the trial)

Documents for participant handling	***Participant consent form***: Covering specificities on the experiment's conditions, the participant's rights, logistics, data protection issues, incentive payments principle, etc. The document is translated into the local language and is signed in twofold.		Is filled in by participant during the briefing (start of trial)
	Drop-out strategy: a document describing how to handle participant drop-out and when it is necessary to replace a participant or not.		During the trial
	Communication plan/liaison strategy: document/plan covering how contact with participants should be maintained and how participants' complaints/questions/problems are handled.		During the trial.
	Contact information sheet for participants: one-pager with the contact details of the field trial responsibilities in case of questions/problems.		Provided to the participant at the briefing meeting.
	Helpline log: A spreadsheet containing a log of **all** interactions with participants through e-mail/telephone: date of call/e-mail, question/topic addressed, answers given, next call appointment, answer pending (yes/no), the status of issue (open/closed), etc. This document must enforce a process where no question can remain unanswered or no issue pending.		During the trial.
	Consent form for installation of the i-DREAMS system. The document is translated into the local language and needs to be signed in twofold.		It is filled in by participant and field trial responsible during the briefing (start of practice)
	Participant and vehicle drop-out form: to be filled in if the participant wishes to leave the study prematurely. The document is translated into the local language and needs to be signed in twofold.		It is filled in by participant and field trial responsible during the trial (in case of drop-out)
	Participant and vehicle exclusion form: to be filled in if the field trial partner notices that the participant does not keep his engagements to the study. The document is translated into the local language and needs to be signed in twofold.		It is filled in by the participant and field trial responsible during the trial (in case the field trial responsible notices that the participant is not doing his best).
	Driver unique ID (using a universally unique identifier-(UUID))		The participant receives this ID during the briefing (start of trial)
	Reimbursement form: a form that the participant needs to sign and submit to receive the incentive payment.		The incentive is paid in instalments to reduce drop-out.

Guide	**User manual for in-vehicle equipment**		At the briefing (start of trial), the participant receives this and is advised to keep this document in the car.
	A practical guidebook for the field trials		Internal document for field trial partners
Documents for vehicle handling	***Confirmation form: correct installation of the i-DREAMS system***. To be filled in after installation of equipment. The document is translated into the local language and needs to be signed in twofold.		It is filled in by participant and field trial responsible during the briefing (start of trial)
	Confirmation form: proper removal of the i-DREAMS system. To be filled in after removal of equipment. The document is translated into the local language and needs to be signed in twofold.		It is filled in by participant and field trial responsible at the end of the trial (during de-briefing)
	Garage information notice: description of the i-DREAMS system for garage. It contains instructions on how to disconnect/reconnect the system from the vehicle, which might be necessary. This notice describes the data collection system, including instructions on how to disconnect/reconnect the system from the vehicle, in the local language and mentions the telephone number of the corresponding installation team, for any garage that would need to do vehicle maintenance during the collection phase.		Provided to the participant during the briefing (start of trial). The participant is advised to keep this document in the vehicle.
	Vehicle condition report/damage form: this is used to enter the vehicle condition (scuffs, dents, broken, cracked, etc.). It has to be signed both by the installation team and the vehicle owner before and when instrumentation is completed.		This form is implemented in the installation app and filled in during briefing and de-briefing.
Smartphone user app	For driver monitoring purposes		Participant installs app during the briefing (beginning of the trial)

4.9.2 Suitable facilities

For the briefing of the participants, the briefing room should be organised as follows:

- A room that conforms with the COVID-19 measures
- Receive 1 participant at a time
- Wear a face mask at all times
- The following elements should be provided:
    - Briefing presentation (computer, projector, white screen).
    - Documents to sign (table + writing materials)
    - Face masks and disinfectants
    - Questionnaires (separate tablet/laptop for participant). The laptop is disinfected after each participant
    - The chair and desk are disinfected after each participant
    - Beverages

4.10 Field trial and pilot test procedures

The following section details the procedures which need to be thought through and carried out to ensure trial partners are ready for the trials to begin and that no stages are omitted.

4.10.1 Preparation of briefing meeting

Table 6: Checklist for participant briefing meeting

What		Person responsible	Status
Field trial location responsibilities and teams are identified and briefed about how the field trials will proceed			
Vehicles and participants are selected			
Briefing invitation is ready and sent to participants			
All equipment of the i-DREAMS system is delivered			
Suitable facilities to receive participants are prepared.	Briefing presentation: computer, projector, white screen		
	Documents to sign: table + writing materials		
	Face masks and disinfectants		
	Questionnaires (separate tablet/laptop for participant). The laptop is disinfected after each participant		
	Beverages		

Briefing presentation	Ready and translated in local language		
Driver ID: UUID	Is ready for each participant. The UUID will be used as a unique participant identifier and will also be the ID that the participant needs to fill in on the questionnaires		
Smartphone user app Procedure: 1. Prior to briefing meeting: Invite the participant to the onboard website Participant: receives an email with the invitation link 2. Day of installation/briefing meeting: Installation of user app together with participant App is synchronised with the gateway 3. From week 9: start of interventions and notifications in app			
What		**Person responsible**	**Status**
Necessary participant related documents are ready in the local language and are printed in twofold	Participant consent form		
	Entry questionnaire (if not provided digitally; only 1 copy required per participant)		
	Consent form for installation of the i-DREAMS system		
	Contact information sheet with the details of who to contact in case of questions/problems (only 1 copy per participant)		
	Reimbursement form		
Necessary vehicle-related documents are ready	Confirmation form: correct installation of the i-DREAMS system (in local language + printed in twofold)		
	Garage information notice (in local language + only 1 copy is printed per participant)		
	Vehicle condition report/damage form (implemented in the installation app)		
Necessary documents and	Confirmation form: proper removal of i-DREAMS system		

strategies are ready (in the local language if necessary)			
	Drop-out strategy		
	Helpline log: a log to handle participants questions/complaints/problems		
	Communication plan/liaison strategy with participants		
	Participant and vehicle drop-out form		
	Consent form for the removal of i-DREAMS system		
	Participant and vehicle exclusion form		
	User manual for in-vehicle equipment		
	Installation manual		
	Practical guidebook for the field trials		

4.10.2 Start of field trial

The following section acts as a checklist for trial partners to use when conducting the trials to ensure no stage is forgotten.

4.10.2.1 Vehicle registration

Table 7: Vehicle registration checklist

Phase	Documents/tools	Actions	Done
Reception of vehicle and participant	Not applicable	• Welcome the participant • The participant and researcher wear a face mask at all times (we have masks available if the participant does not have one). • Answer any questions from the participant.	
Monitoring of the participant's vehicle before installation	This damage form is implemented in the installation app. The consent form for installation of the i-DREAMS system is printed twofold (participant and field trial responsible sign two copies: 1 for the participant + 1 for the field trial partner).	• In the participants' presence, the installation team monitors the participant's vehicle to detect any malfunction. The vehicle condition/damage report (with pictures of the vehicle) is used to establish the vehicle condition (scuffs, dents etc.) before installation. • Go through the installation consent form with the participant and sign the consent form (2x). Both the participant and the field trial responsible need to sign the form to have a legal basis • This installation consent form is signed by the installation team and the vehicle owner.	
Handover participant to briefing team	Consent form for installation of the i-DREAMS system	• Handover all forms to the participant and send him to the briefing team	

4.10.2.2 Participant's registration, briefing, forms and questionnaires

Table 8: Participant registration checklist

Phase	Documents/tools	Actions	Done
Reception of participant	Not applicable	• The participant and researcher wear a face mask at all times (we have masks available if the participant does not have one). • Thank the participant for his cooperation and put him/her at ease. • Before the briefing starts, ask if the participant wants to use the restroom or wants something to drink. • Regarding COVID-19: (explain that we work following the government's guidelines so that everything can proceed safely (in briefing room + the vehicle).	

Briefing	Briefing presentation
	Smartphone user app
		• Brief the participant using the briefing presentation mentioned above (laptop, projector and presentation are already activated when the participant enters the room).
		• Encourage the participant to ask questions in case something is unclear.
		• Additionally, participants should be informed
		  ○ To (optionally) notify their insurance of their participation in the project to make sure that their insurance was not affected
		  ○ About their liability to report in their tax declaration the income from the incentive money received for participation
		  ○ Contact the field trial responsible in case of the following circumstances: not using the vehicle for a predefined duration due to holidays or illness, damage to the vehicle or equipment (including traffic accidents)	

		• Assist participant in the installation of the smartphone user app	
Driver unique ID	Not applicable	• The participant receives his/her driver unique ID: the UUID • Explain that this unique ID is used to identify the participant anonymously throughout the entire field trials (driving data, questionnaires, documents, etc.)	
Form: are printed in twofold (participant and field trial responsible sign two copies: 1 for the participant + 1 for the field trial partner).	Participant consent form	• Go through the participant consent form with the participant and sign the consent form (2x). Both the participant and the field trial responsible need to sign the form to have a legal basis. • Answer any questions from the participant	
Questionnaires	Entry questionnaire	• Let the participant fill in his/her driver ID (the UUID) • Ask the participant to fill in the digital entry questionnaire • Answer any questions from the participant	
Sign reimbursement form	Reimbursement form: printed in twofold (participant and field trial responsible sign two copies: 1 for the participant + 1 for the field trial partner).	• Participant and field trial responsible sign reimbursement form to receive the first incentive payment.	
Documents handover	• Contact information sheet with the details of who to contact in case of questions/ problems • User manual for in-vehicle equipment • Garage information notice • Duplicate participant consent form	• Go through the contact information sheet, user manual and garage information notice • Mention that the user manual and garage information form should be kept in the vehicle (in the vehicle instruction manual). • Handover all documents and forms to the participant and send him back to the installation responsible so that the participant can receive the installed vehicle.	

	• Duplicate consent form for installation of the i-DREAMS system • Duplicate of the reimbursement form		

Pilot:

- Briefing presentation: Remarks from pilot participants are taken into account in the final briefing presentation version. Answers to their most common questions are also integrated into the presentation.
- Entry questionnaire: Remarks from pilot participants are taken into account in the final version of the entry questionnaire.
- Consent forms and other documents: Remarks from pilot participants are taken into account in the final version of the different forms and documents.

4.10.2.3 Vehicle instrumentation (simultaneously with participant briefing)

Table 9: Vehicle instrumentation checklist

Phase	Documents/tools	Actions	Done
Installation	Installation manual	• The installation team installs the i-DREAMS system according to the installation manual	
Monitoring of the participant's vehicle after installation	• This damage form is implemented in the Installation app. • Confirmation form: correct installation of the i-DREAMS system (printed and signed 2x)	• After installation, the participant and installation team check the installed vehicle against the initial vehicle condition report (filled in before installation). • The participant and the installation responsible sign the confirmation form: correct installation of the i-DREAMS system (2x)	
Test drive with vehicle	Not applicable	• The installation team performs a test drive with the vehicle to check if the installed equipment works as intended.	
Handover vehicle to the participant.	Not applicable	• After a successful test drive, the vehicle is handed over to the participant.	

Pilot:

- Consent forms and other documents: Remarks from pilot participants are taken into account in the final version of the different forms and documents.
- The installation process is monitored and reviewed if necessary for the actual field trials

4.10.3 During the field trial

Table 10: Field trial checklist for once it is running

Phase	Documents/tools	Actions	Done
Liaison/communication with participants	Communication plan	• Informal contacts to minimise drop-outs • Regular (e.g., two-weekly) informal contacts with participants to check if everything is OK, if the equipment still works, to provide feedback/updates about their driving behaviour and progression if an accident occurs in which one of the behaviours/elements that the i-DREAMS systems monitors played a role this can also be mentioned in the two-weekly "newsletter" to make participants aware of the possible risks and consequences. • Few days before the intervention phase starts -> send a reminder to participants.	
Continuous general support	Helpline log	• Participant contacts the participants handling responsible with a non-technical question/problem/complaint. • The participant handling responsible lists the question/problem/complaint in the helpline log and strives to solve the issue asap to minimise drop-out (i.e., contacts colleagues to address the issue etc.). • Once the question/problem/complaint is solved, the solution and status are added to the logbook.	

Continuous technical support	Helpline log	• Participant contacts the technical support team through the contact details listed in the contact information sheet with the details of who to contact in case of questions/problems. • The technical support team lists the question/problem/complaint in the helpline log and strives to solve the issue asap to minimise drop-out. • In case physical access to the vehicle is necessary to troubleshoot an issue or repair the data collection system, an appointment with the participant should be arranged. • Once the question/problem/complaint is solved, the solution and status are added to the logbook.	

Drop-out	Drop-out strategy
	Participant and vehicle drop-out form (printed and signed in twofold)
		• In case a participant wants to quit the study prematurely, the guidelines of the drop-out strategy are followed.
		  ○ Based on these guidelines, it is decided if it is necessary to contact a participant from the spare list to replace the drop-out.
		  ○ If a replacement is necessary, a participant from the spare list is contacted to make further arrangements.
		• The participant is contacted to make an appointment to remove the i-DREAMS system.
		• During the removal of the i-DREAMS system, the participant and vehicle drop-out form is filled in and signed in twofold	

Participant exclusion	Participant and vehicle exclusion form (printed and signed in twofold)	• In case a participant does not meet his/her engagements (no data logged for quite some time, intentionally damage equipment etc.), the field trial coordinator can decide to exclude the participant prematurely from the study. • The field trial coordinator contacts the participant to notify him/her of this decision. • The participant is contacted to make an appointment to remove the i-DREAMS system.	

		During the i-DREAMS system's removal, the participant and vehicle exclusion form is filled in and signed in twofold. • Depending on how far the field trials advanced, it is decided if the excluded participant is replaced or not (some rules apply here as for participant drop-out). • If a replacement is necessary, a participant from the spare list is contacted to make further arrangements.	
Sign reimbursement form	Reimbursement form: send to the participant after two months of participation (by mail or e-mail) printed in twofold (participant and field trial responsible sign two copies: 1 for the participant + 1 for the field trial partner).	• The participant signs the reimbursement form to receive the second incentive payment and sends the form back to the field trial responsible. • Field trial responsible signs reimbursement form and sends a copy of the form back to the participant. • The second incentive payment is paid after it is verified that everything is going as planned.	

Pilot:

- Remarks from pilot participants are taken into account in the final version/application of the different forms, documents, and procedures.

4.10.4 Preparation of de-briefing meeting

Table 11: De-brief meeting preparation checklist

What		Person responsible	Status
De-briefing invitation is ready and sent to participants			
Suitable facilities to receive participants are prepared.	Documents to sign: table + writing materials		
	Face masks and disinfectants		
	Questionnaires (separate tablet/laptop for participant). The laptop is disinfected after each participant		
	Beverages		
Necessary participant related documents are ready in the local language and are printed in twofold	Exit questionnaire (if not provided digitally; only 1 copy required per participant)		
	Consent form for de-installation of the i-DREAMS system		
	Reimbursement form		
Necessary vehicle-related documents are ready in the local language	Vehicle condition report/damage form (implemented in the installation app)		

4.10.5 End of field trial

4.10.5.1 Vehicle reception

Table 12: Vehicle end of trial reception checklist

Phase	Documents/tools	Actions	Done
Reception of vehicle	Not applicable	• Welcome the participant • The participant and researcher wear a face mask at all times (we have masks available if the participant does not have one).	
Monitoring of the participant's vehicle before removal	This damage form is implemented in the installation app.	• The installation team in the participant's presence monitors the participant's vehicle to detect any malfunction. The vehicle condition/damage report (with pictures of the vehicle) is used to establish the vehicle condition (scuffs, dents etc.) before removal. • This report is signed by the installation team and the vehicle owner.	
Handover participant to de-briefing team		• Send the participant to the de-briefing team	

4.10.5.2 Participants de-briefing, forms and questionnaires

Table 13: Participant de-brief checklist

Phase	Documents/tools	Actions	Done
Reception of participant	Not applicable	• The participant and researcher wear a face mask at all times (we have masks available if the participant does not have one). • Thank the participant for his cooperation and put him/her at ease. • Before the de-briefing starts, ask if the participant wants to use the restroom or wants something to drink. • Regarding COVID-19: (explain that we work following the government's guidelines so that everything can proceed safely (in de-briefing room + the vehicle).	
De-briefing (Participants have the opportunity to offer feedback on the field trials)	Exit questionnaire (Qualtrics) Remove the smartphone user app	• Let the participant fill in his/her driver ID (the UUID) • Ask the participant to fill in the digital exit questionnaire (Qualtrics) • Participant removes the app from smartphone • Answer any questions from the participant	
Sign reimbursement form	Reimbursement form: printed in twofold (participant and field trial responsible sign two copies: 1 for the participant + 1 for the field trial partner).	• Participant and field trial responsible sign reimbursement form to receive the final incentive payment. • The final incentive payment is paid after it is verified that the participant completed the trials as required.	
Handover participant to the installation team	Documents (translated in local language + printed in twofold): • Confirmation form: proper removal of the i-DREAMS system. • Reimbursement form	• Handover all forms to the participant and send him to the installation responsible	

Pilot:

- Exit questionnaire: Remarks from pilot participants are taken into account in the exit questionnaire's final version.
- Remarks from pilot participants are taken into account in the final version/application of the different forms, documents, and procedures.

4.10.5.3 Vehicle de-instrumentation (simultaneously with participant de-briefing)

Table 14: Vehicle de-installation checklist

Phase	Documents/tools	Actions	Done
Removal of i-DREAMS system	Not applicable	• The installation team removes the i-DREAMS system	
Monitoring of the participant's vehicle after removal	• This damage form is implemented in the smartphone installation app. • Confirmation form: correct removal of the i-DREAMS system (printed and signed 2x)	• After de-installation, the participant and installation team check the de-installed vehicle against the initial vehicle condition report (filled in before removal). • The participant and the installation responsible sign the confirmation form: correct removal of the i-DREAMS system (2x)	

Pilot:

- Remarks from pilot participants are taken into account in the final version/application of the different forms, documents, and procedures.
- The removal process is monitored and reviewed if necessary for the actual field trials

5 Communication plan

5.1 Pre-trial communication

In order to progress trial organisation and share learning and experiences from the simulator trials and pilots Task 5.1 has continued to run featuring regular online meetings for such exchanges. These meetings will continue once the main trials are underway, but a more formalised process will also be set up to log incidents and issues with CardioID, these are detailed below.

5.2 Communication procedures between partners during on-road trials

The communication among partners, in particular with CardioID who are responsible for the hardware development and the supervision of the hardware installation, will be centralised on a web back-office platform.

This platform was created to support the installation of the CardioGateway, and the management of the installed equipment in each vehicle. It allows each country coordinator to list all the vehicles and verify the status of each CardioGateway, see Figure 10.

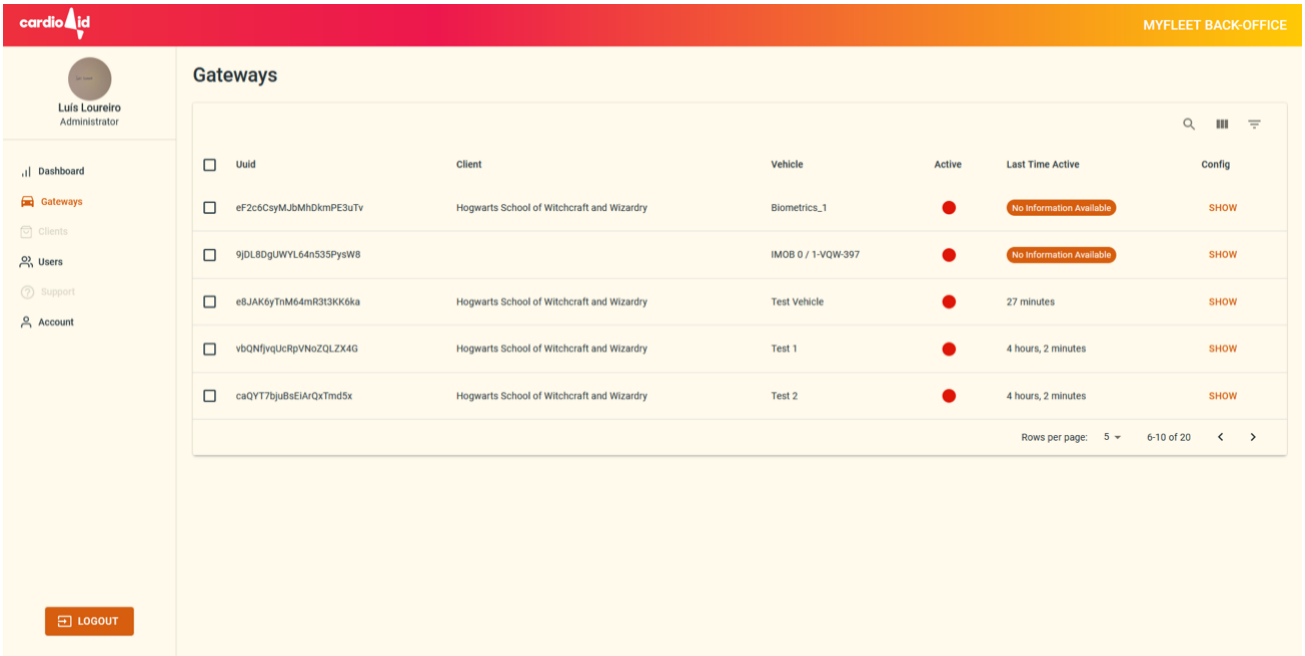

Figure 10: Back office front-end

For each gateway, there is the possibility to identify the vehicle and check if it is active. it also allows the supervisor to change the configuration of the gateway (Figure 11).

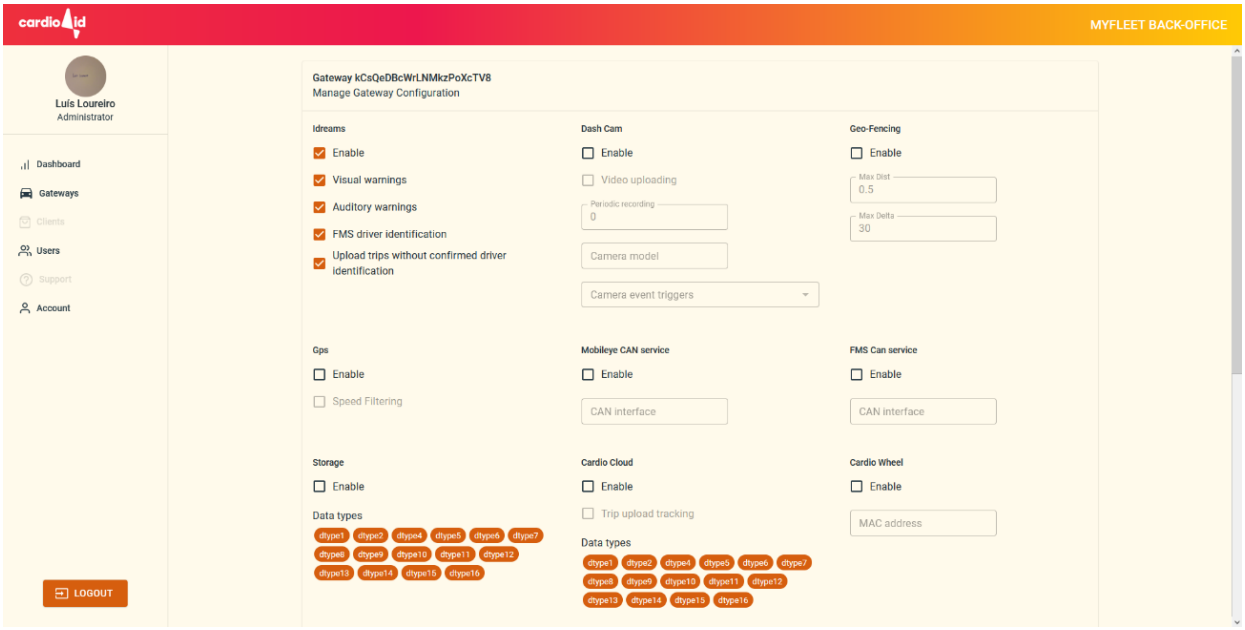

Figure 11: Gateway configuration

The platform also allows the creation of users, according to their roles: installer, supervisor, etc., (Figure 12).

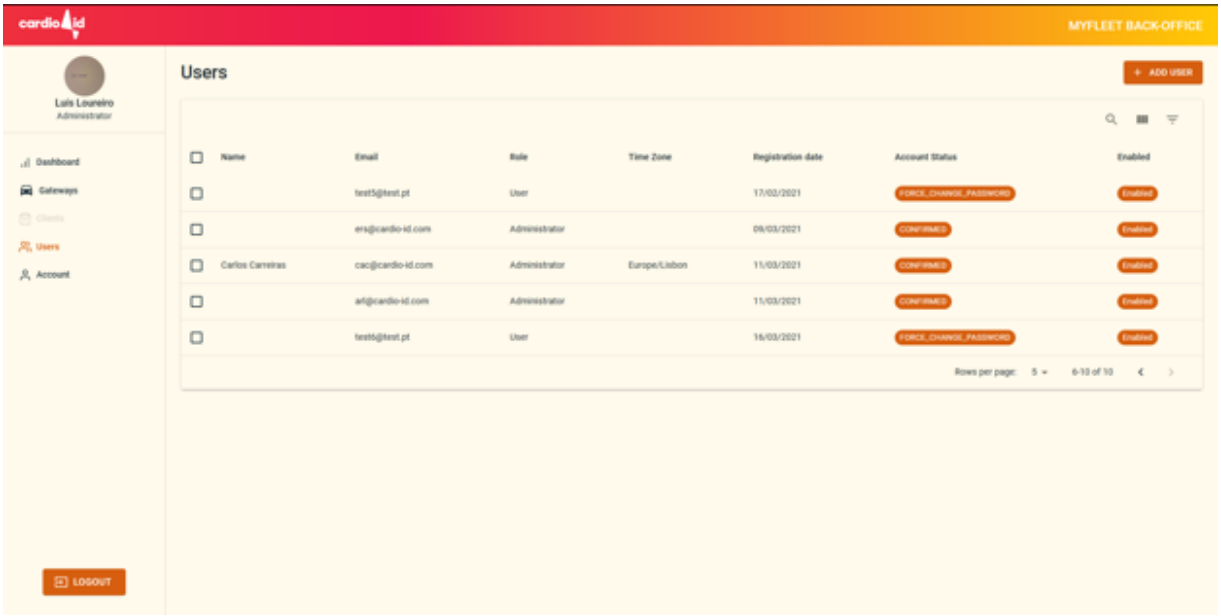

Figure 12: Role designation

The back-office system allows the creation of a ticket for each gateway requiring technical support, should any problem arise during the experiments. The tickets are then aggregated on CardioID's internal customer relationship management (CRM). This will be the main process for communicating faults between partners and technology providers and allows not just for a formalised system but also for after-the-event analysis of issues that arose and the effects on participant engagement and satisfaction.

6 Conclusions/ Current and next steps

The purpose of this deliverable is to describe the field trials that are part of WP5 in the i-DREAMS project. It builds on the specifications and recommendations that were outlined in D3.4: Experimental protocol. This document should be used as a guideline in preparation for the field trials and thus includes useful resources related to this.

Section 2 covered the rationale behind the overall study design and how field trials related to the simulator trials. Importantly it also established the aims which the field trials are designed to meet, these were separated between process and outcome evaluations. Process evaluations investigate what element of the method worked well and what can be learnt including questions such as: how do incentives assist in recruiting participants for a 6-month field trial study? And how acceptable is the monitoring equipment for potential field-trial participants? Etc. Alongside these process evaluation questions were research questions around the Safety Tolerance Zone (outcome evaluations) including: do the i-DREAMS interventions return the driver to the STZ phase of normal driving? And how much time is needed to identify the prevailing STZ level? Etc. All these questions, and many more, informed the planning of the trials and the guidelines, resources and data collection methods detailed throughout this deliverable.

As the technology had previously been described in publicly available deliverables as part of Work Package 4, they were not covered in-depth in this deliverable. Instead, a user manual that has been developed for the in-vehicle technology was presented showing what an i-DREAMS participant could expect to receive. This also acted as a quick reference for the reader to get an idea of the in-vehicle technology suite. A general update on the technology specification was also given, as developments had taken place since the publishing of the WP4 deliverables. These changes included the addition of a distraction indicator on the interface alerting a driver if they attempt to use their phone hand-held while driving, along with updated interface designs for the in-vehicle display.

Section 4 gave an in-depth description of procedures that would be followed across all sites consistently including the duration of testing: 4 weeks of baseline followed by 4 weeks for the in-vehicle intervention only, 4 weeks for intervention plus smartphone feedback and a final 6 weeks of an additional gamified web platform as well. The participant selection criteria across car trial sites all require a spread of participants across 4 age groups, a minimum of 40% per gender split, driving experience of 10,000km annual equivalent and this must be across different road types (urban, rural, motorway) for at least 20% of mileage covered in each type. For commercial vehicle testing (bus, truck, rail) there was also a consistent but less stringent requirement, the only one being at least 6 months driving experience. All participants must also use an Android smartphone to be able to access the project driver coaching application and complete the same entry and exit questionnaires but translated into the local language. The final project mandated consistency was the participant drop-out strategy whereby if a participant has driven three weeks or more in the intervention phase and drops-out they will not require replacing, any drop-out before this cut-off will be replaced.

The remainder of the trial's planning would be entirely site specific but, given similarities in logistics across sites, a guidebook was developed to act as a reminder of resources that require creating and completing by participants along with procedures that may wish to be followed. The guidebook was shown in full in Section 4 and is considered the most useful part of the deliverable in terms of it being used as a roadbook reference for trials planning. Finally, the internal communications planning was in Section 5, showing an initial website design for partners to log faults, it was noted how this was useful during the trial but also

afterwards where issues logged can be matched to participant satisfaction responses to measure any impact technology faults have on their opinions.

The resources in this deliverable will aid in the next steps of conducting the road trials themselves. Planning and implementation of such trials involving multiple vehicle types, countries and advanced technology will never be simple so resources provided, and conducting all the tasks noted in the guidebook, will be essential to aid in their smooth running. The results of these trials (both outcome and process-related) will be published in future WP6 and 7 deliverables.

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