Adapting driver behaviour for lower emissions

MODALES D6.2: Trial Management

WORK PACKAGE	WP6: User trials and Evaluation
TASKS	T6.2: Trial ramp-up and pilot; and T6.3: Large–scale user trials
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Revision and history chart

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0.1	02/03/2022	D. Margaritis	First draft of the deliverable with an initial Table of Contents and plan for each section to be discussed with partners
0.2	28/05/2022	D. Margaritis	Update of the deliverable structure. Major contribution to all chapters
0.3	29/05/2023	D. Margaritis	Graphical presentation of information
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1.0	17/06/2023	Andrew Winder	Final quality check and submitted version

Legal disclaimer

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Glossary of terms

Term	Description
Eco-driving	The practice of driving in such a way as to minimise fuel consumption and the emission of carbon dioxide (CO_2)
Low-emission driving	The practice of driving in such a way as to minimise the emission of pollutant emissions (such as CO, NO_X, PM and PN)
MODALES	This EU Horizon 2020 project: "Modify Drivers' behaviour to Adapt for Lower Emissions" (2019-2022, http://modales-project.eu)
Phase 1	Baseline phase of the MODALES trials, before the training, in which drivers drove with the app in data collection mode only
Phase 2	Treatment phase of the MODALES trials, after the driver had viewed the training video and is using the app in full mode (giving on-trip and post-trip feedback)

List of abbreviations and acronyms

Abbreviation	Meaning
APP	Application
CINEA	European Climate, Infrastructure and Environment Executive Agency
DoA	Description of Action
DPF	Diesel Particulate Filter
EATS	Engine after-treatment system
EC	European Commission
EOBD	European On-Board Diagnostics
EU	European Union
FOT	Field Operational Test
GPS	Global Positioning System
HDV	Heavy Duty Vehicles
HMI	Human-Machine Interface
M	Month
NRMM	Non-Road Mobile Machinery
OBD	On-board diagnostics
PEMS	Portable Emissions Measurement Systems
PM	Particulate Matter
PN	Particle Number
RQ	Research Question
TWC	Three-Way Catalyst
UC	Use Case
WP	Work Package

Executive Summary

This deliverable describes testing and evaluation procedures with trial ramp-ups and real-world pilots for MODALES driving assistance tools, their functionality and effects on driver acceptance and performance. Measurable demonstrations related to different aspects of these components provided results for the following aims:

- Validation of the complete system in real test facilities using real platforms, such as the MODALES app.
- Testing in a concise and inclusive way driver-related outcomes, through the use of common and appropriate subjective and objective evaluation measuring tools against common evaluation objectives and success thresholds which were set in the MODALES Evaluation Plan (D6.1).
- Iteratively testing and optimising applications/functionalities developed in Work Package 5 of the project (Guidelines and tools for low-emission driving), HMI concepts and elements as well as system "intelligence" through iterations of user trials in real-life conditions with 170 OBD dongle-equipped and non-equipped cars in 8 test sites located in 7 different European countries and in China, assessing different vehicle types and different user experience.
- Assessing the technical performance of the MODALES Smartphone app, its acceptance, usefulness and its penetration potential for different user groups.

An initial trial ramp-up phase covered aspects including the choice of vehicles, selection and briefing of participants, management of trial participants (procedures, mitigation measures to deal with participants who drop out or do not participate as expected), choice of driving routes and timing of the trials.

The full trial sample group consisted of 170 individuals, including both private and professional drivers. During the initial phase, referred to as the baseline period or Phase 1, drivers did not utilise any MODALES tools. The duration of this period varied between 1 and 3 months due to the delayed availability of the app. Some drivers who started earlier had an extended baseline period while awaiting the full version of the app, which included driving advice.

At the end of Phase 1, the participant had to follow a video course that has been developed in WP5. The curriculum included a general introduction and common methodologies for all types of vehicles with subsections for pre-trip, trip and maintenance aspects aiming at low emission driving.

Phase 2 lasted approximately 2 months on average, but for certain users who joined later, it had to be condensed into as little as two weeks. In this phase, drivers were required to use the MODALES tools, which involved using the app on smartphones with an installed OBD reader whenever possible. The data collected during this phase was stored on the device and regularly transmitted by the user or the mobile device itself to the central server at MODALES partner LIST, located in Luxembourg.

To gain a deeper understanding of the impact of the MODALES driving assistance tools and to quantify the extent of emissions reductions in real-world driving scenarios, two additional field tests were carried out, which were not originally included in the project plan (MODALES DoA). The first field test was conducted in Finland by partner VTT, specifically focusing on Portable Emissions Measurement Systems (PEMS) measurements with and without the utilisation of the MODALES app. The second test

was conducted in Greece by partner CERTH, with the objective of measuring the concentration of particulate matter (PM) ranging from 0.3 to 10.0 µm in diameter.

Three surveys were conducted among the MODALES trial participants. The first was the driver selection survey, which was administered individually by each participating project partner. The second survey followed the viewing of the training video by each participant and focused on their understanding and acceptance of the video, the extent to which they learnt good practices and any other feedback. 85 % of the respondents found the content of the video very clear. 61 % answered that the information provided by the video was very useful and very complete. Overall, the feedback on the training videos was very positive and they are a useful resource that can and will be disseminated more widely.

The final survey, after the end of Phase 2 of the trials, was on the use of the MODALES app and the extent to which drivers felt their driving style and behaviour had changed. A total of 69 users from various European trial sites completed the final questionnaire. However, participants in China were excluded from the distribution of the questionnaire due to legal restrictions preventing them from using the app. The analysis of the questionnaire results can be found in the MODALES D6.4 – Impact Assessment Report.

1. Introduction

1.1 Project overview

The MODALES project worked towards reducing air pollution from all types of on-road vehicles by encouraging adoption of low-emission driving behaviour and proper maintenance choice.

MODALES pursued a user-centric approach to addressing all the challenges which on the one hand enhance low-emission practices and on the other hand suppress high-emission behaviour by researching, developing and testing several innovative and complementary solutions in four key areas (driver, retrofits, OBD and inspection) in order to reduce vehicle emissions from three main sources: powertrain, brakes and tyres.

The scope of vehicles covered by MODALES comprises passenger cars, light- and heavy-duty vehicles (buses and trucks) and Non-Road Mobile Machinery (NRMM).

The main activities of MODALES have been:

- Measurement of real-world vehicle emissions and driving behaviour to produce accurate correlation between them using advanced mathematical and statistical techniques
- Exploration of the most advanced technologies for retrofits designed to substantially reduce powertrain emissions from all types of vehicles and to validate their effectiveness under different real-world traffic and environment conditions, and by various drivers
- Undertaking an in-depth analysis of OBDs, periodic inspection and legal issues on tampering in Europe to help regulatory authorities put in place effective anti-tampering legislation, and to help owners properly maintain their vehicles
- Conducting low-emission user trials (with both driving and maintenance practices), supported by awareness campaigns, to enhance public engagement and help drivers better understand the impact of their driving and maintenance behaviours in all situations.

1.1 Scope

1.1.1 Scope of MODALES WP6

This deliverable is part of Work Package 6 on User trials and Evaluation, which is one of the five technical Work Packages of MODALES (the two "non-technical" WPs are WP1 on Project Management and WP7 on Awareness, Communication and Dissemination). The four WPs whose results feed into WP6 are:

- **WP2**: Defining low-emission factors, which explored driving behaviour variability using existing available data, as well as a data collection campaign using an on-board data acquisition setup with access to powertrain data (PEMS measurements - portable emissions measurement system). This WP delivered a first approach on driving behaviour patterns and powertrain emissions. It also addressed the state-of-the-art in retrofits, inspection and maintenance and legal issues regarding tampering in various EU Member States.
- **WP3**: Impact of user behaviours, which undertook a series of measurement campaigns to establish the interconnection between driving behaviour and powertrain exhaust emissions, as well as fine

particulates from brakes and mass-loss from tyres. Measurement campaigns were also carried out to address the impact of poor maintenance and deliberate tampering of the emissions control system.

- **WP4**: Effectiveness of inspections and depollution systems, which used the findings of WPs 2 and 3 as a base to investigate and propose solutions that will contribute to emission monitoring via the EOBD protocol and systems that detect lack of maintenance and tampering. It also investigated the potential of enhancing existing retrofit systems for diesel vehicles.
- **WP5**: Guidelines and tools for low-emission training, which took into consideration results from the above WPs in order to define guidelines for low-emission driving and to specify the technical requirements for a smartphone application. The app was developed and tested in this WP. Training courses were also designed in order to ensure consistency with existing learning processes and serve as input for on-road trials and awareness campaigns.

The **main objective** of **WP6** was to develop an evaluation plan and to test and evaluate with real-world trials the functionality of the innovations developed in MODALES, their effects on driver acceptance and performance, and their potential wider impact (in particular their predicted overall effects on vehicle emissions).

WP6 is broken down into five tasks, with this deliverable reporting on the output of T6.2 and T6.3:

- T6.1: Evaluation plan (this deliverable, which serves as a tool to direct the subsequent tasks);
- **T6.2: Trial ramp-up and pilot**;
- **T6.3: Large scale user trials**;
- T6.4: Analysis of trial data;
- T6.5: Impact assessment.

1.1.2 Scope and intended audience of this deliverable

The main objective of this deliverable is to describe the necessary procedures for testing and evaluating with trial ramp-ups and real-world pilots, with regard to MODALES driving assisting tools, their functionality and effects on driver acceptance and performance, according to the evaluation plan (D6.1). Breaking down this objective into measurable demonstrations the aim was:

- To have validated the complete system in real test facilities using real platforms, such as the MODALES app.
- To test in a concise and inclusive way driver-related outcomes, through the use of common and appropriate subjective and objective evaluation measuring tools against common evaluation objectives and success thresholds which were set in D6.1.
- To iteratively test and optimise WP5 applications/functionalities, HMI concepts and elements as well as system “intelligence” through iterations of user trials in real-life conditions with about 200 OBD dongle-equipped and non-equipped cars in 8 test sites located in 7 different European countries and in China, assessing different vehicle types and different user experience.
- To assess the App’s technical performance, acceptance, usefulness and its penetration potential for different user groups.

Even though the present deliverable was initially planned as confidential one (CO), the consortium has decided to make t public (PU), as no sensitive information has been disclosed.

The figure below shows how this deliverable (D6.2) fits into the project and highlights related deliverables which will consider its content.

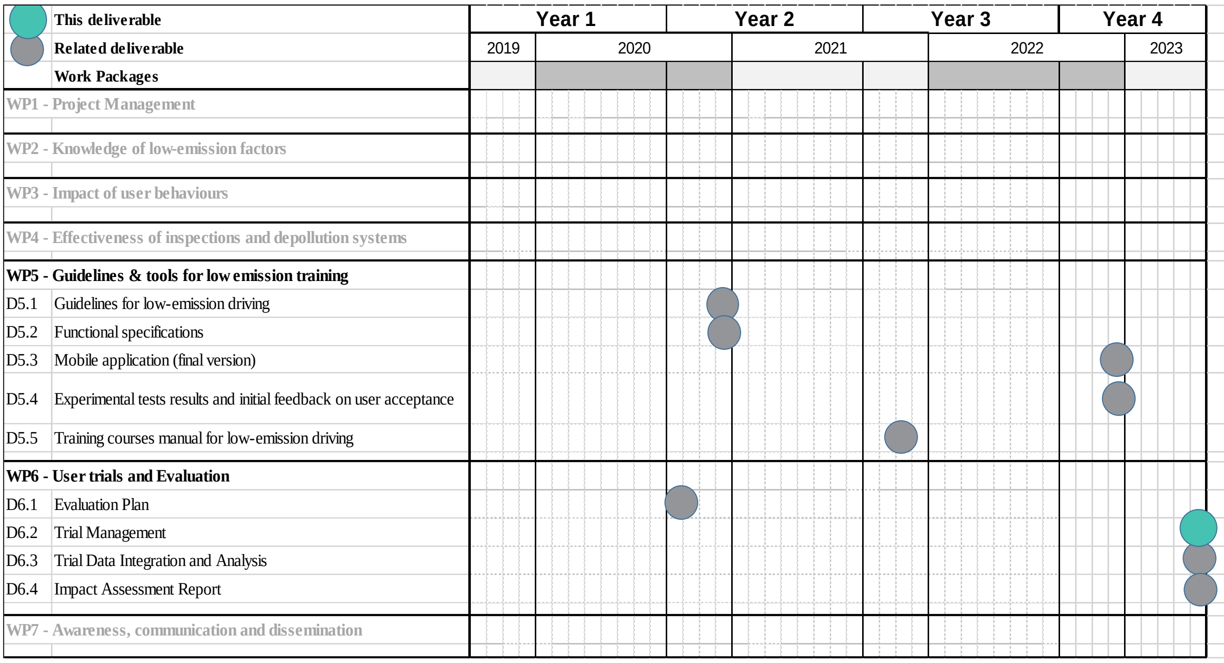


Figure 1: D6.2 in the context of related MODALES deliverables

1.2 Deviations from the Description of Action

1.2.1 Alignment with the DoA and content deviations

The content of the deliverable is fully aligned with the text in the MODALES Description of Action (DoA). However, more sections have been added, regarding the user experience, that have not initially planned for this deliverable. The consortium has decided that there is a strong connection between the trails and the user feedback, thus the survey results and findings were more appropriate to be reported in this document allowing for a full picture of the whole pilot testing task.

A deviation in the trials planning that should be noted is the number of participants who used the app at the end. In total 150 people from Europe accepted the MODALES invitation (excluding the 20 volunteers from China) to participate in both Phases 1 and 2. This number is less than half that proposed in the DoA (50 people in 7 EU sites equals to 350). The number is significantly less that the potential participants' number in the initial sampling group list, before the COVID pandemic. After COVID, fewer people were keen to participate in any trials that required interaction with people not known to them. However, the 150 participants around Europe is a satisfactory sample in order to validate the app and the training material and to draw reliable conclusions about their effectiveness and impact to emission reduction. Moreover, due to the COVID restrictions, the consortium decided to replace the physical trainings for low-emission driving with short videos that would help pilot participants to follow them at their pace. The videos would also remain for future use and exploitation to different kinds of audiences (general audience, professional drivers etc.).

1.2.2 Time deviations

This deliverable has been submitted with a delay of five months, because although the baseline trials were underway at the scheduled time of this deliverable (end of November 2022), the MODALES app was still under finalisation, which did not allow Phase 2 (treatment phase) of the trials to start until February 2023. This fact also caused a delay in the users' feedback (through the surveys) until both phases had been finalised and the participants could share their experience having interacted over a sufficient time period with the MODALES solutions.

2 Methodological approach

2.1 Research questions and hypothesis

A set of high-level Research Questions (RQs) was set early in the project (presented in D6.1 – Evaluation Plan; a confidential deliverable). Each research question was associated with one or more hypotheses and each hypothesis measured by one or more performance indicators.

Table 1: Research Questions and Hypotheses related to the trials

Research Question(s)	Hypotheses
Do drivers using the app and training reduce emissions?	Powertrain NO_x and PN emissions are reduced following using the MODALES app and training compared to the baseline
	Modelled brake and tyre emissions are reduced following using the MODALES app and training compared to the baseline
How well do drivers accept the app and follow the recommendations?	The app is easy to understand and use The app does not distract from driving The app provides useful and relevant information The app provides personalised (contextualised) recommendations Drivers apply the recommendations in the app Amount users are willing to pay to get the full version of the app (with OBD/in-vehicle data logger)
Do drivers using the app and training reduce energy consumption?	Energy consumption is reduced following using the MODALES app and training compared to the baseline
To what extent does using the app affect the speed of the user?	Variability of speed is reduced when following the MODALES-recommended driving style
Can exhaust emissions be correlated with driving variability?	Exhaust emissions are correlated with different styles of driving
Can brake emissions be correlated with driving variability?	Brake emissions are correlated with different styles of driving
Can tyre emissions be correlated with driving variability?	Tyre emissions (mass-loss) are correlated with different styles of driving
How does performance vary by driver profile?	When following MODALES recommendations, there is no significant difference in driving performance change between: - male and female drivers - age groups - different trial sites - different types of roads (urban, rural, motorway).

2.2 Use cases

Even though the MODALES trials were not designed taking into account certain Use Cases, we can identify the following high-level ones. The Use Cases would limit the number of participants even more after the COVID pandemic, and it was decided to include as many participants as possible without prioritizing specific vehicle usage scenarios. The high-level UCs are:

- Participants using their passenger cars for daily activities, not related to work (e.g. shopping, leisure, etc.).
- Participants using their passenger cars for work.
- Usage of commercial vehicles (light- and heavy-duty) for transporting cargo.

2.3 Data collection tools

The MODALES App served as the primary data collection module for the trials. To facilitate data collection, OBD (On-Board Diagnostics) dongles were provided to the users. Essential vehicle performance information was gathered through the dongles and relayed/stored in the MODALES App.

In addition to the data collected through the MODALES App, the consortium also administered questionnaires to the users at different stages of the trials. The selection questionnaire helped to gather initial information about the participants, ensuring a diverse range of individuals with varying driving routines and levels of experience.

To involve commercial drivers in the trial, MODALES reached out to local organisations or businesses. The local partner approached commercial drivers and encouraged their participation in the trials. Their input and experience contributed to the overall effectiveness of the study.

Three crucial questionnaires, the baseline questionnaire, an interim questionnaire on the training video and the final evaluation questionnaire on using the App, were administered to users. The baseline questionnaire was completed at the beginning of the trials to establish a baseline understanding of participants' driving habits, preferences, and experiences. The interim questionnaire took place after the users had viewed the training video and were starting Phase 2 of the trials. The final evaluation questionnaire conducted at the end of the trial gathered feedback and assessed any changes in driving behaviour or perceptions.

To maintain effective communication channels with the local partners and trial participants, MODALES established various methods for reporting problems, questions, comments, and other inquiries. Users could reach out to their respective local partners for immediate assistance or clarification. Their feedback was valued, and the project encouraged open communication throughout the trial period.

MODALES committed to ensuring a smooth and efficient data collection process while addressing any concerns or queries that might arise. The MODALES App, along with the OBD dongles and questionnaires, provided comprehensive data to be considered during the analysis phases.

2.3.1 Internal reporting platform for trial site and data management

The data collected via the mobile app were, after post-processing on the LIST (Luxembourg Institute of Science and Technology) servers, stored in a PostgreSQL relational database. This data format was suitable for storage, but sharing it with trial site leaders and project partners managing the impact assessment activities was not ideal. Furthermore, it was necessary to filter the data by trial site and to follow, in a simple and graphical way, the evolution of the data collection and the participation for each trial site. This platform comes with multi-rights management of users, as well as the possibility to define new trial sites (see also D5.3 – Low Emission driving assistance tools). As defined in the project's

Data Management Plan (D1.3, confidential deliverable), users are affiliated with a trial site according to their ID, provided by the trial site leaders when they registered.

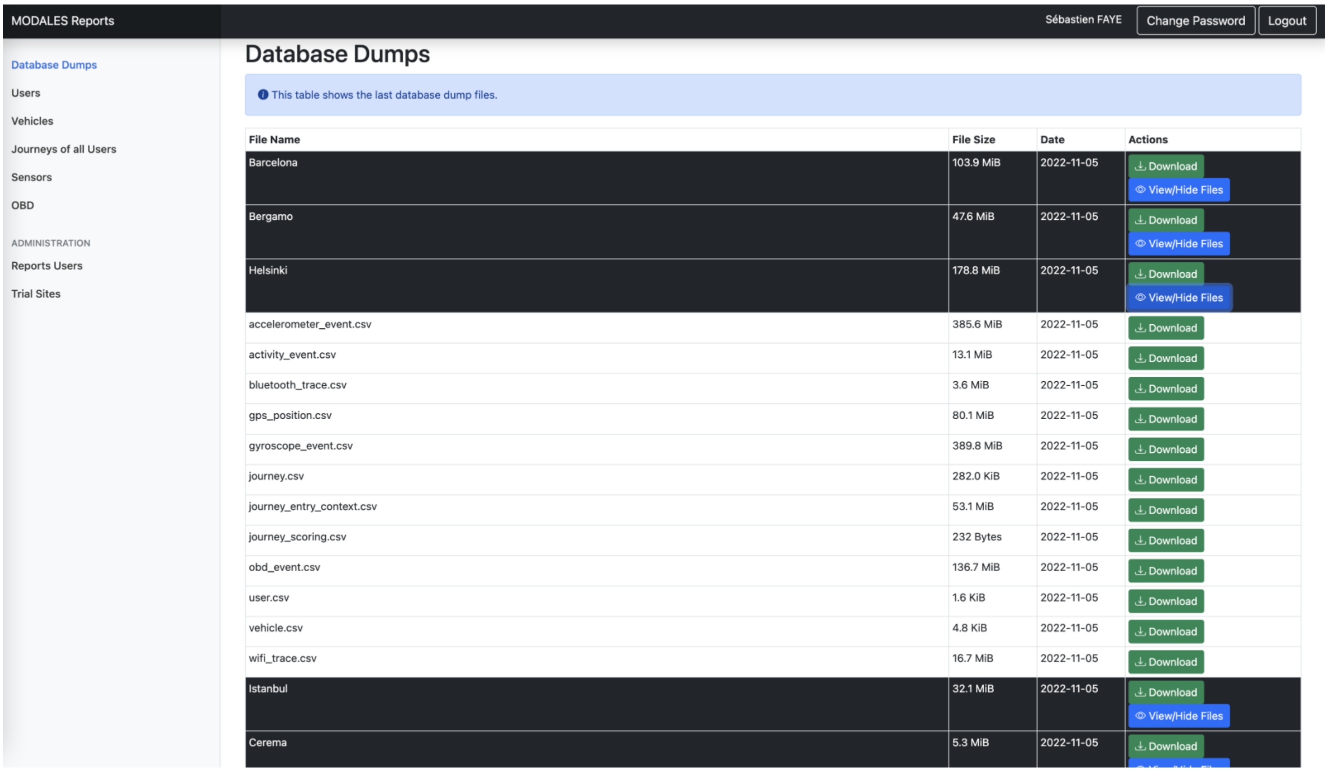


Figure 2: MODALES Reporting platform: Dataset download for each trial site

2.4 Recruitment

2.4.1 End users

MODALES conducted a selection process to gather participants for a trial involving various vehicles and driving routines. The goal was to include individuals from all age groups, ensuring as equal as possible representation of both men and women, as well as accommodating different levels of driving experience. The trials encompassed rural areas, urban areas, and motorways, catering to different driving routines.

The consortium aimed to involve professional drivers in all trial sites, including those working in the taxi and construction industry. Furthermore, we were seeking participants who had experience with Light Duty Vehicles (LDVs) and Heavy Duty Vehicles (HDVs) (example of the Chinese site). While there were no preferences for certain vehicle types, all vehicles were accepted for the trials.

The consortium experienced difficulties in engaging professional drivers because of the technology selected. Some companies do not provide their drivers with mobile phones for a professional use or use restricted mobile computer (Zebra) on which it is difficult to install easily the MODALES app. Additionally, some others already use another system for emission reduction (including driver guidance and feedback), while it is technically difficult to test a new solution for a limited period of time.

The MODALES partners kicked off the recruitment process just before the COVID spread in Europe and approached shippers with a global leading role and SMEs. COVID was unprecedented for such companies and the discussions were put on hold. Problems that were faced during recruiting especially professional drivers included the hardware (smartphones available or updated), drivers' availability (some months were super busy), already existing solutions, etc.

2.4.2 Vehicles in the trials

In terms of vehicle specifications, it was preferred that vehicles comply with Euro 3, 4, and 5 emission standards, but Euro 6 vehicles were also accepted, as being quite popular in northern EU countries. Additionally, all types of fuel were accepted, accommodating a range of engine technologies.

2.5 Data privacy measures

Data privacy management was a crucial aspect of the trials (as defined in MODALES D6.1 – Evaluation Plan). The consortium implemented stringent measures to protect participants' personal information. Consent forms (see Annex 8) were provided to ensure that participants understand the trial's purpose and grant permission for their data to be used. Each trial site designated a local data management officer responsible for handling data privacy concerns and ensuring compliance with relevant regulations.

To ensure the confidentiality of participant identities, MODALES anonymised the collected data. Only the local partner associated with each trial site had access to the identity of the user. This practice further protected participants' privacy and maintained the integrity of the trials.

3 Trial ramp-up

The piloting phase (Task 6.2) included the following aspects: ensuring all requirements for the user trials were in place, planning the trials and conducting a small-scale pilot. This phase did not verify the tool (app) itself as this was done in Task 5.4. Task 6.2 commenced well before the completion of T5.4 (as well as T5.5., which was the training development) in order to allow baseline trials to start in a timely manner. This task developed and verified the experimental procedure for the trials based on the requirements in the Evaluation Plan developed in T6.1 (Deliverable D6.1).

The trial ramp-up covered aspects including the choice of vehicles, selection and briefing of participants, management of trial participants (procedures, mitigation measures to deal with participants who drop out or do not participate as expected), choice of driving routes and timing of the trials. Although MODALES is not a Field Operational Test (FOT), as it does not focus on the wide-scale testing of systems, the FESTA methodology which was developed for FOTs (FESTA Handbook, 2014) was used to some extent. This covers all aspects of the timeline and administration of an FOT, with advice regarding a need's analysis in the beginning to the integration of the collected data. The piloting phase, which is defined by FESTA as a "small scale version, or trial run, done in preparation for the major study" assessed the feasibility of the full-scale study and tested the research protocol, in particular the extent to which the sampling frame and technique were effective.

The recruitment approach for volunteers was a key part of this trial, and lessons learnt from any difficulties or potential risks coming out of this small-scale pilot were considered in order to ensure the success of the large-scale trials. Collection and processing of preliminary data ensured that there were no major bugs or anomalies as well as verified what resources (finance, staff) were needed for the full trials. It was also an opportunity to train the project researchers so that they all have a common understanding of the data collection and analysis needs as well as ethical and data protection issues.

The ramp-up was also intended to rectify the potential problems and repeat earlier steps of the preparation of the main study. This process involved the iteration of feedback loops in order to ensure a smooth and successful conduction of the large-scale user trials, as follows:

1. Functional assessment with real users (understanding of HMI, etc.)
2. Data logging and quality verification
3. Experimental procedure verification
4. Last chance for changes
5. Ethical issues regarding public participation (recruitment and informed consent procedures)

The piloting was done in two European sites (Barcelona and Luxembourg). The main characteristics of the sites are described below:

- **Barcelona**

  - 16 users interested, 9 recruited (Android smartphones), 6 actively engaged in this trial.
  - The App was used as a data collection module only.
  - No recommendations to drivers were available.
  - No OBD dongle was used during this phase.
  - Feedback was given on aspects of the App operation.
  - The baseline questionnaire was completed.

- **Luxembourg**

  - 10 users recruited, 7 engaged at the end.
  - The OBD and the App were used as data collection modules only.
  - No recommendations to drivers were available.
  - A 2nd ramp-up phase took place later with the new release of the App.
  - The baseline questionnaire was completed.

The ramp-up trials took place from September 2021 to November 2021. The delay was due to COVID-19 restrictions, which limited the amount of driving most people could do, as well as practical considerations such as meeting participants to brief them.

4 Large–scale user trials

4.1 Introduction

User pilots were a key aspect for testing with end-users and validating test development as well as for creating a large data collection system to profile a driver’s behaviour as WP3 identified. The pilots also implemented an application that acted as a demonstration platform for the project's key objectives, and opened it up for future exploitation after project completion.

This task aimed to validate all the hypotheses and models developed in the project. The main way to measure these aspects was via the mobile app and the web platform developed in WP5, which allowed the collection, analysis and recommendation of actions to be performed by a particular driver profile.

The studies deployed in the following sites: Barcelona area (Spain), Bergamo area (Italy), Helsinki area (Finland), Istanbul area (Turkey), Leeds/Yorkshire (UK), Luxembourg, Thessaloniki area (Greece), and Nanjing (China). It had originally been planned to also have a limited site in Romania, focusing more on awareness raising (proposed by FIA), but in the end this was not possible due to the lack of a local partner in this country and COVID restrictions preventing visits by other partners.

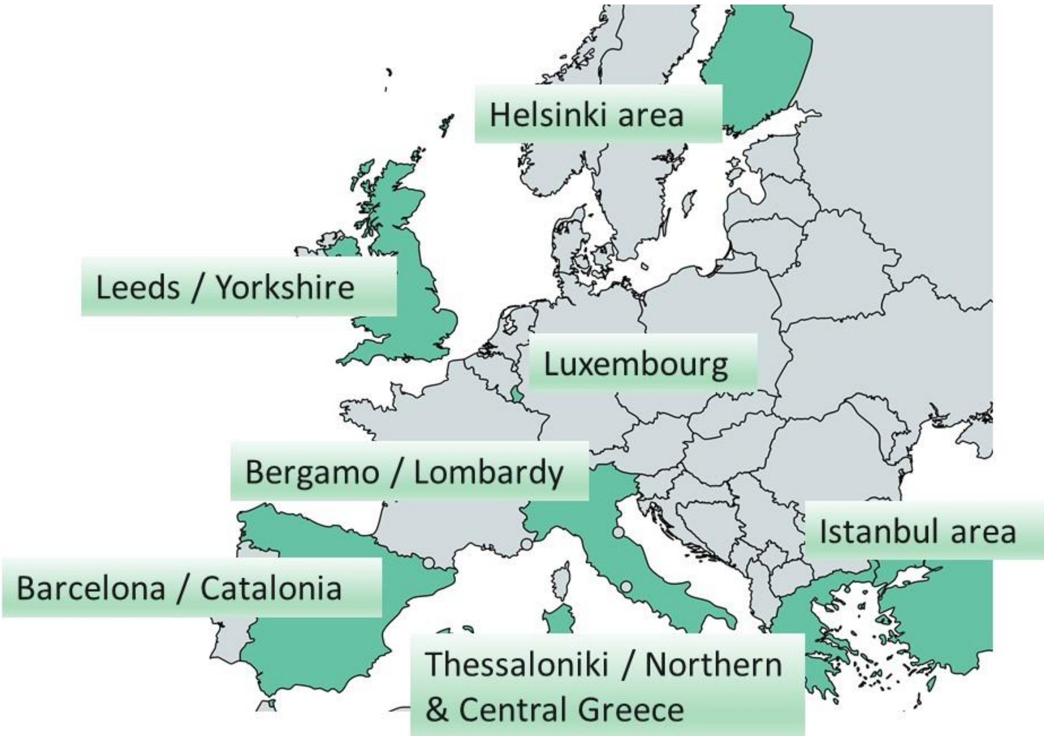


Figure 3: The trial sites in Europe

4.2 Trial phases

170 people composed the sample group which consisted of both private and professional drivers. In the first period of recorded driving (baseline), the drivers did not use any MODALES tool, and this period lasted between 1 and 3 months. The reason for this variation was the delayed availability of the app, meaning some drivers who started earlier had a prolonged baseline period while awaiting the full version of the app (with driving advice). The second period lasted on average 2 months, but for some

users who started later this had to be condensed into as little as two weeks. In this phase, the drivers had to use the MODALES tools (app on smartphones with an OBD reader installed when possible). The data was stored on the device and frequently sent by the user and/or the mobile device itself to the central server at LIST for filtering and time series interruption checks. The drivers were reminded to use the application through frequent follow ups.

The baseline measurements of the driving style of each participant were recorded and analysed in order to create a personal driving style record before any interaction with the MODALES tools. For the validation of the training material as well as the interaction of the user with the app, subjective scales and questionnaires were filled in by the volunteers at the end of the Phase 1 and at the end of the trials period. The trials were planned to involve volunteers of random driver pools; however, in order to assure their commitment for the duration of a long-term measurements, they were followed up with frequently as stated above.

4.2.1 Driver training

The development of training for low-emission driving relied on the use of guidelines, tools and all the knowledge accumulated in WP5 as an input to design the training courses carried out in WP6. The initial planning was for physical classroom trainings, however due to the COVID uncertainty, the MODALES team decided to produce 3 videos that can work in two ways: training of the pilot participating drivers and dissemination of the project results to the target audiences through channels such as IRU and FIA, social media etc. The curriculum includes a general introduction and common methodologies for all types of vehicles with subsections for trip preparation, actual driving - trip and maintenance aspects. Another common element is the use of the MODALES app. In addition, tailor-made training courses were derived from these guidelines for various road vehicle users, types and configurations of vehicles. The three main driver training categories are:

- Private car drivers
- Professional drivers of LDVs (incl. taxis)
- Professional drivers of HDVs.

The latter two categories focus on professional drivers with prior experience in driving and similar eco-driving trainings. All three videos are approx. 15 minutes in length and feature a combination of animation and in-vehicle footage with narration and subtitles available in the following languages:

Video for all types of drivers (with focus on **cars**):

- Voice-over: English, French, Italian, Spanish
- Subtitled English version: Finnish, Greek, Turkish, Chinese

Video for **Taxi and LDV** drivers:

- Voice-over: English
- Subtitled English version: Chinese

Video for **HDV** drivers:

- Voice-over: English
- Subtitled English version: Chinese

A private company was procured to help the partners with footage and editing of the video, while the script and all the concept was built by the project partners. IRU's member DB Schenker kindly provided the HDV and warehouse facilities at Mechelen (Flanders, Belgium) during a weekend, while a private car was used and a taxi was hired in Brussels.

The videos were restricted to trial participants during the trial, but are publicly available after MODALES final conference (May 2023) via the MODALES website at https://modales-project.eu/media in accordance with the Awareness Campaign outlined in MODALES Deliverable D7.4. The videos are uploaded on YouTube and dissemination by the project partner is continuing.

Figure 4: Example of the training video with subtitles in English and in Greek

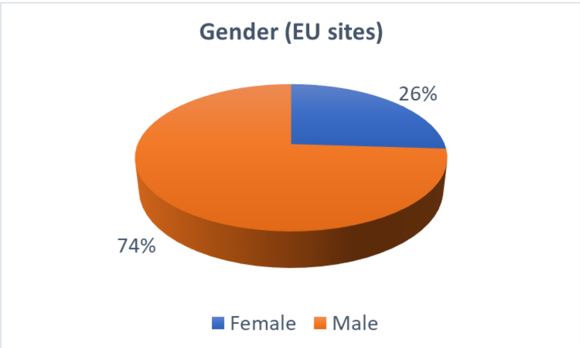
4.2.2 Aggregated information about the participants and the vehicles

As already stated in Section 1, the pilot testing took place with less participants, in addition to what was planned in the DoA. The pandemic was the catalytic parameter for this major deviation that could not be controlled by the consortium. Even though the number of the potential participants in Europe was more than 250, this picture changed after COVID. Table 2 summarises the participants sample per site, including the special focus user and vehicle groups.

Table 2: Summary table of trial sites

Site location	Number of participants	Focused user groups and vehicle types
Barcelona (ES)	26	• Car drivers • Logistics operator • Taxi drivers • Driving instructors • Young drivers • Coaches, refuse trucks, cleaning truck drivers
Bergamo (IT)	11	
Helsinki (FI)	26	
Istanbul (TR)	21	
Leeds (UK)	33	
Luxembourg (LU)	19	
Thessaloniki (GR)	14	
Nanjing (CN)	20	

More than 70 % of the drivers were men. The target was to have an equal distribution of both men and women which was not achieved at the end because the users who committed to participate and drive long distances in a short period of time (Phase 2) were more commonly men.



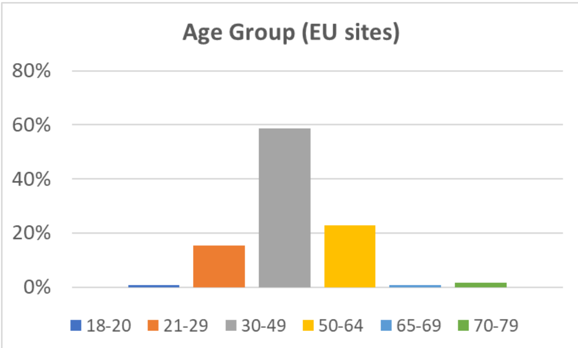


Figure 5: Gender and age distribution of the EU drivers' sample

Concerning the age groups, the dominant group was 30-49 years of age. The consortium put effort to include young drivers, too (18-29 years old to study the effect of the project solutions to the young generation and less experienced drivers.

As expected, the dominant groups of the vehicle fuel types are the petrol and the diesel. The consortium tried to also included electric and hybrid powertrain technologies, however the sample was low. Regarding the electric vehicles, the OBD dongle had a low contribution to vehicle data transmission, mainly providing data about the speed which was already given by the smartphone itself.

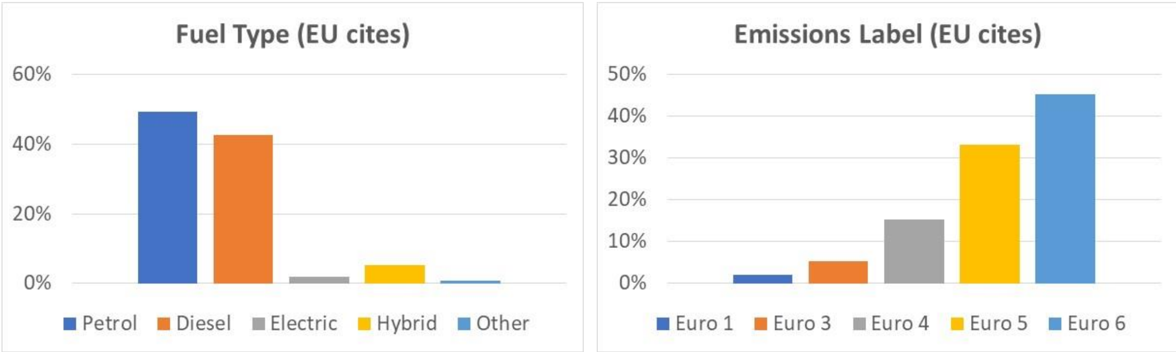


Figure 6: Fuel type and Euro Standards distribution of the EU vehicles' sample

As stated earlier in the report, the main focus regarding the Euro emissions label was on vehicles of Euro 3-5 classification. 53 % of the vehicles which participated fell in these technologies. However, a significant number of vehicles were of Euro 6 technologies, mainly coming from more economically developed countries such as Finland, UK, Luxembourg, Spain (see also the country-by-country analysis below).

4.2.3 General trials' statistics

During the course of MODALES, a database was set up at LIST to collect data from the trials. Details of the implementation of the project tools, the driver assistance application and the database itself are given in deliverables D5.2 and D5.3, which define the specifications of these tools and the types of data collected. In total, and from October 2021 to April 2023, more than **25,671,678 accelerometric events** have been recorded, as well as more than **1,316,218 activity events**, enabling data collection to be started and stopped automatically. In total, over **14,618 journeys** were recorded, distributed as shown in the figure below. As we can see, the data collection will have gone through two main phases and lasted longer than initially planned, in particular to obtain a suitable number of participants and deal with the inconveniences resulted by the COVID pandemic.

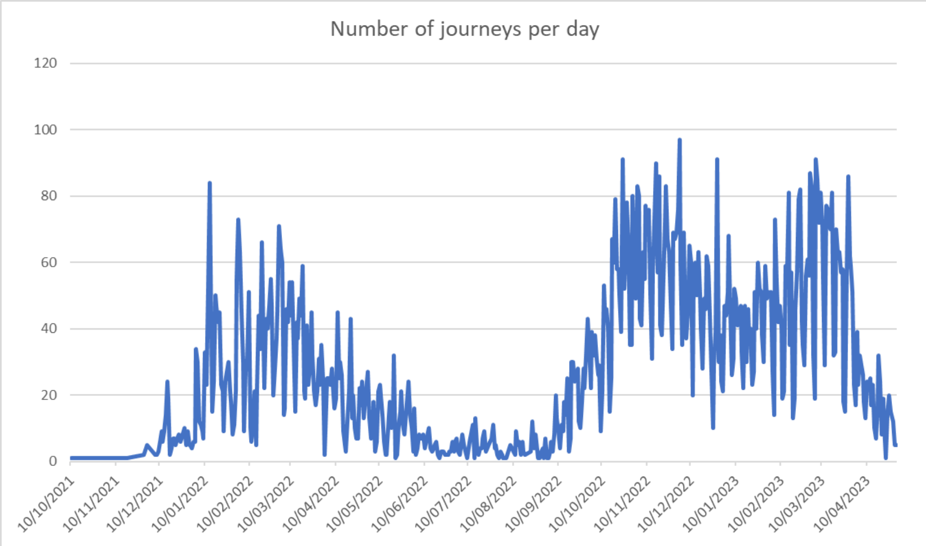


Figure 7: Data collected during the project – number of journeys per day

In early 2022, an initial test campaign was carried out, involving Luxembourg in particular, but also Greece, Spain and Finland. **Peaks of up to 80 journeys** were recorded in a single day. The project's official data collection campaign then began at the end of 2022, with two phases - as detailed in the rest of the document. The first phase included pure data collection, with no influence on user behaviour, and the second one involved the training and recommendations. We can see a slight reduction in journeys at the end of the year, during the transition between the two phases, but the overall levels were similar between the two. The number of driving hours per day followed broadly the same pattern, with an extensive test period in early 2022. **A peak of 250 cumulative driving hours per day** was recorded at this time, as shown in the figure below.

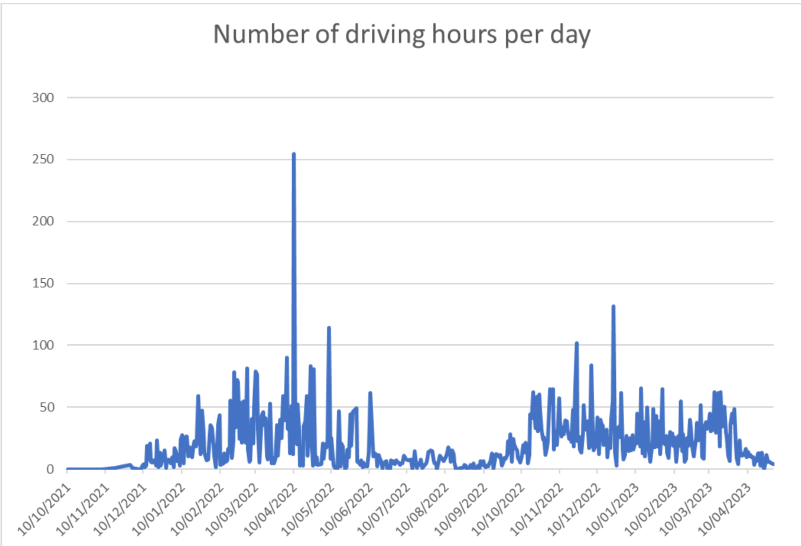


Figure 8: Data collected during the project – number of driving hours per day

Finally, the number of vehicles using the mobile application on a daily basis follows the logic of the previous two plots, with a much larger and more frequent number during the project's official campaign - with peaks of more than 35 vehicles on a single day at the end of the collection campaign. In total, the system registered 359 different vehicles - surpassing the project's initial targets.

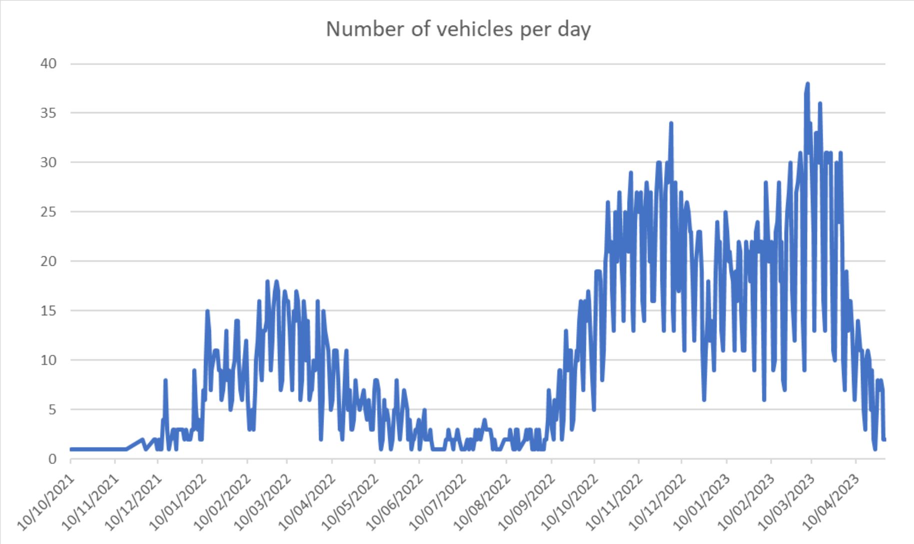


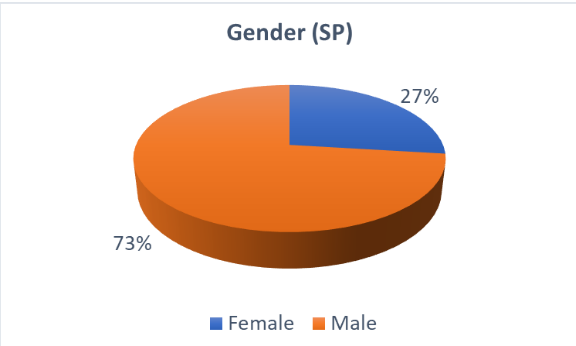
Figure 9: Data collected during the project – number of vehicles per day

4.3 Trial sites

4.3.1 Spain (Barcelona)

The city of Barcelona is compressed between the mountains and the sea. The traffic congestion and air pollution are the main challenges the city and its metropolitan area are facing. As a main strategy to improve air quality, in 2020 the city launched a Low Emission Zone (ZEB) that forbids access for older and highly polluting vehicles, while encouraging the electrification of cars, buses and taxis. As complementary policies to address mobility and air quality, the city is also implementing additional strategies such as lowering speed limits from 50 km/h to 30 km/h on many streets, increasing public space for pedestrians and cyclists by reducing vehicle lanes, and designing a new and more efficient bus network. Furthermore, a new pricing scheme for public transport favourable to regular users has been implemented.

Information about the participants and their vehicles



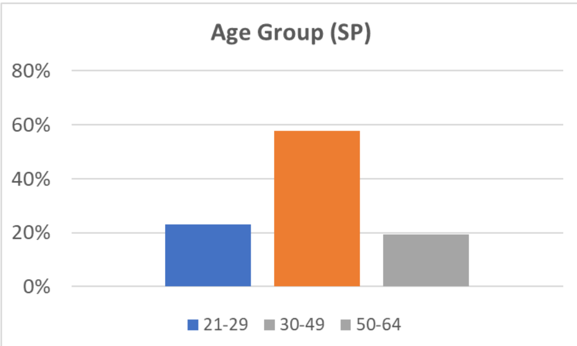


Figure 10: Gender and age distribution of the Spanish drivers' sample

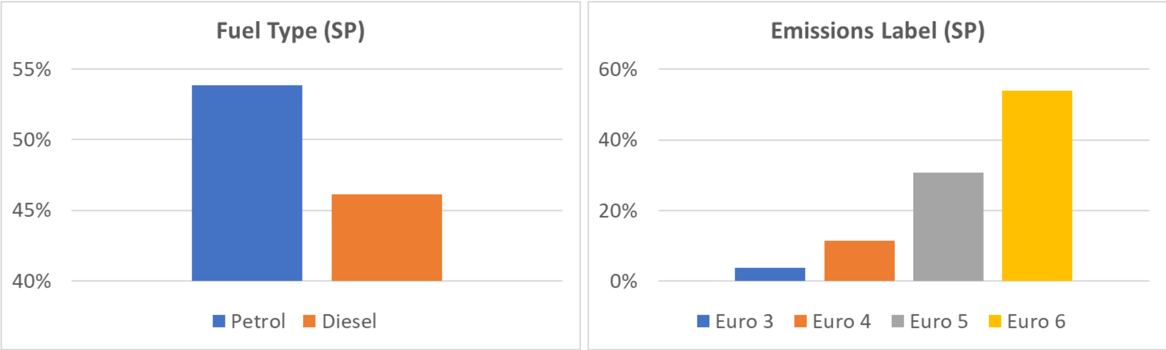


Figure 11: Fuel type and Euro Standards distribution of the Spanish vehicles' sample

4.3.2 Italy (Bergamo)

Bergamo is a medium-sized city in Northern Italy. The climate is temperate but the temperatures are affected by the mountains nearby. Due to the particular conformation of the area, the road network around the city is a combination of urban and ascending/descending roads on the hills. Moreover, the motorway A4 connects Bergamo with major cities in Northern Italy such as Milan, Turin, Verona and Venice.

Information about the participants and their vehicles

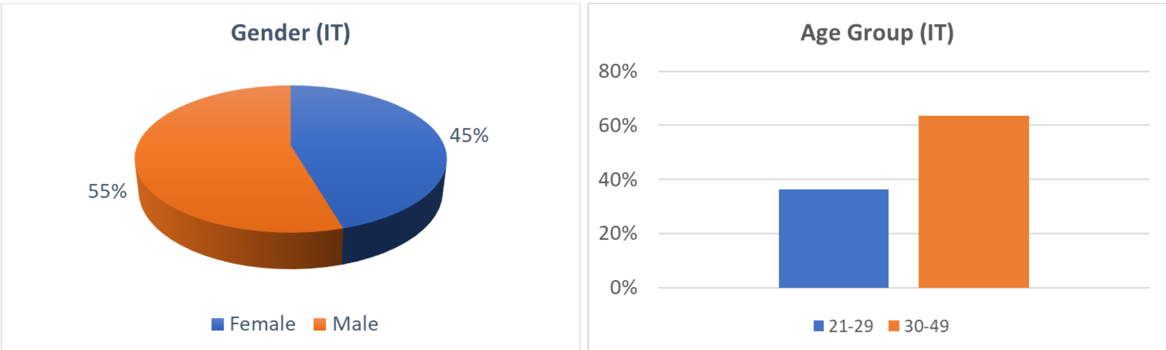
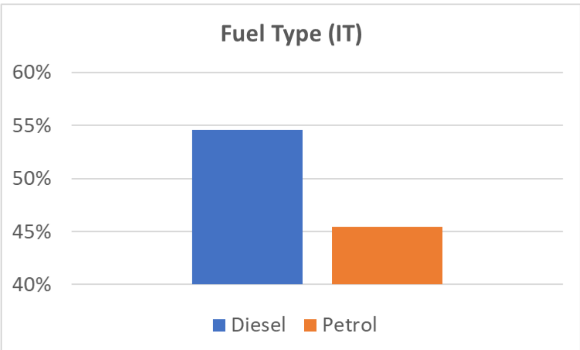


Figure 12: Gender and age distribution of the Italian drivers' sample



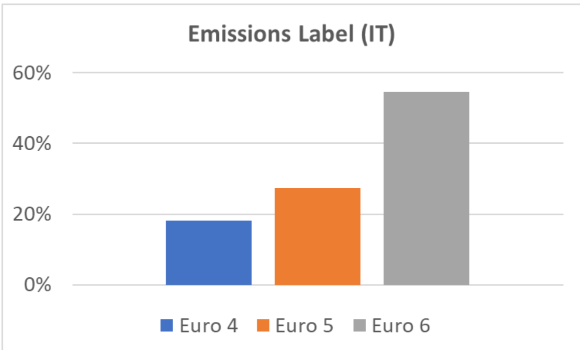


Figure 13: Fuel type and Euro Standards distribution of the Italian vehicles' sample

4.3.3 Finland (Helsinki)

The Helsinki region is the largest urbanised area in the country. The region is located in the south of Finland, on the coast of the Gulf of Finland, part of the Baltic Sea. Due to the urban nature of the region, public transport in Helsinki is very popular. However, the nearby municipalities of Espoo, Vantaa and Kauniainen have a more suburban structure, and car use is more common. Due to relatively good road infrastructure and traffic management, traffic is usually quite fluid, with the exception of some arterial streets becoming congested during a few hours in the morning and late afternoon.

Information about the participants and their vehicles

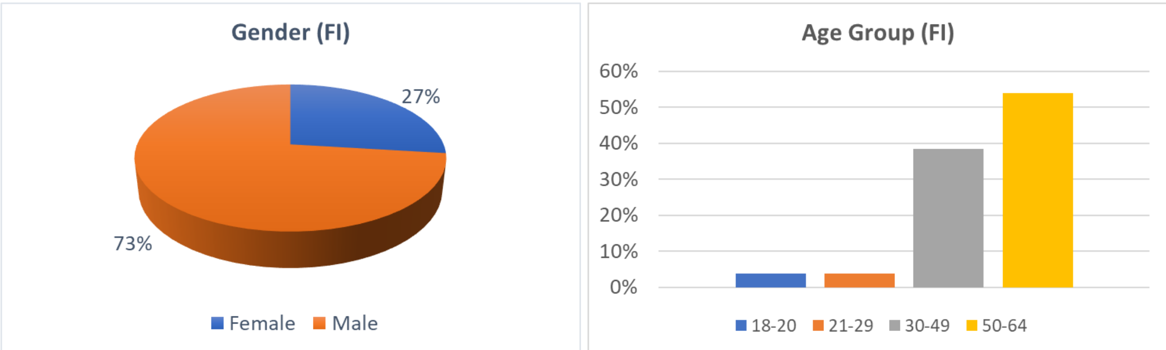


Figure 14: Gender and age distribution of the Finish drivers' sample

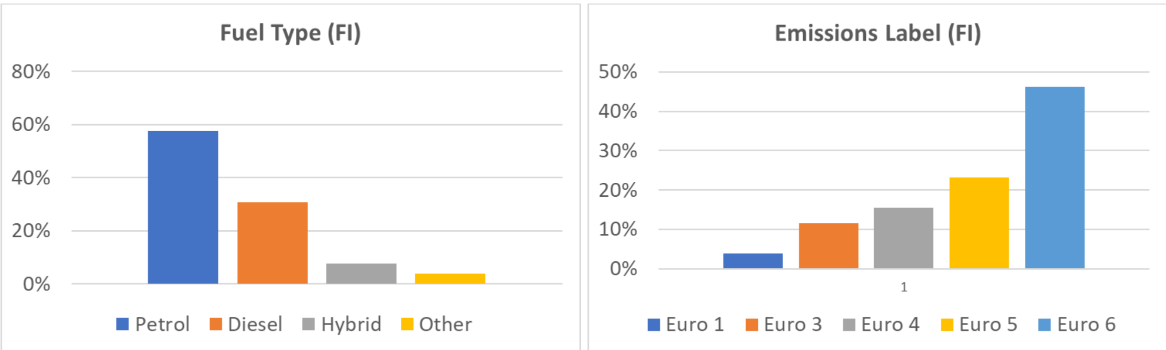


Figure 15: Fuel type and Euro Standards distribution of the Finish vehicles' sample

4.3.4 Turkey (Istanbul)

Istanbul has a population of approximately 14.8 million. Approximately 480 000 vehicles per day cross the Bosporus (Strait of Istanbul) via the 3 bridges and 35 000 vehicles via the submerged Eurasia Tunnel, which opened in 2016. Traffic volumes are increasing and leading to congestion on both main and side roads. Suburban sprawl is taking place, while most of the city's facilities (trip attractors) remain in the centre, thus leading to increased travel time, congestion and air pollution. The contribution of transport to carbon emissions in Istanbul is 28%. The city's objective is to decrease these emissions by 30% by 2030.

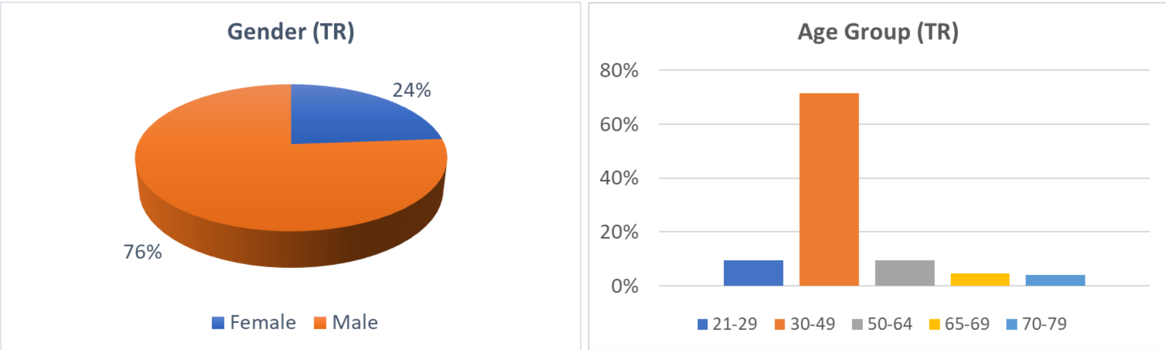


Figure 16: Gender and age distribution of the Turkish drivers' sample

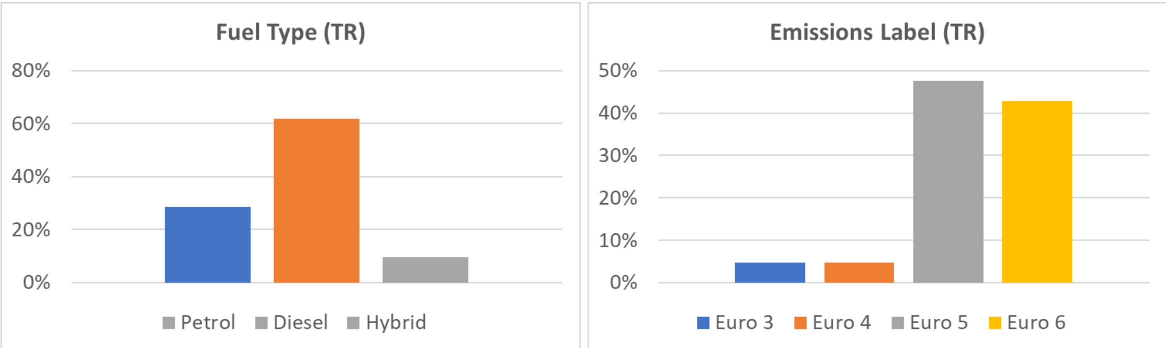


Figure 17: Fuel type and Euro Standards distribution of the Turkish vehicles' sample

4.3.5 UK (Leeds)

Leeds has become the largest legal and financial centre outside London and also the UK's third-largest manufacturing centre with around 1800 firms and 39000 employees. Leeds' transport system is dominated by cars with 4.18 billion vehicle miles (6.7 billion vehicle-km) travelled on roads in Leeds in 2018. It is currently the ninth most congested UK city, with congestion costing £1057 per driver. One street in Leeds has been measured as the most polluted outside London. As part of plans to tackle inner-city air pollution, Leeds introduced a Clean Air Zone in 2020.

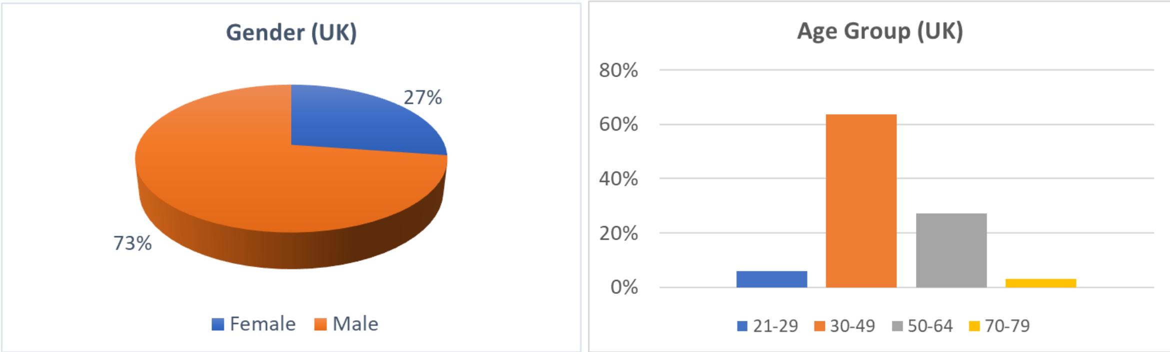


Figure 18: Gender and age distribution of the UK drivers' sample

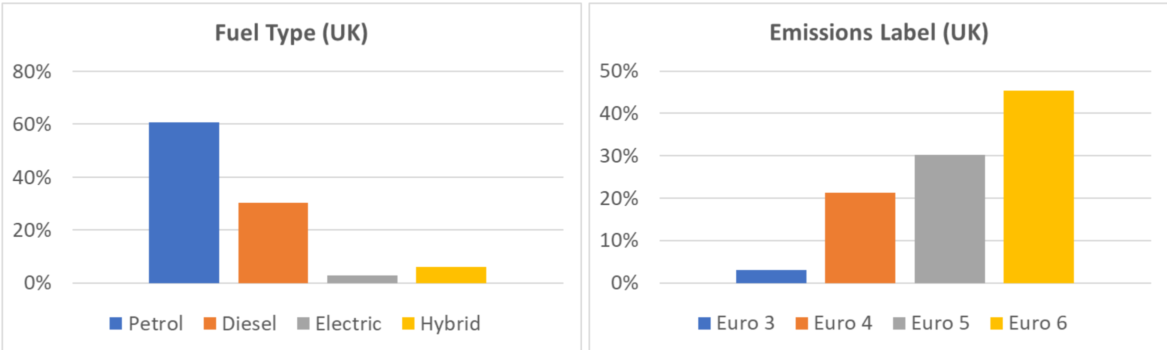


Figure 19: Fuel type and Euro Standards distribution of the UK vehicles' sample

4.3.6 Luxembourg (Luxembourg)

The Luxembourg region experiences very specific mobility patterns on a daily basis, with traffic between neighbouring countries (France, Belgium and Germany) creating daily traffic jams and causing ripple effects. According to EU data, about 200 000 people come into the country each working day from abroad. Congestion times are among the highest in Europe, with each driver spending on average 30 hours in traffic jams every year.

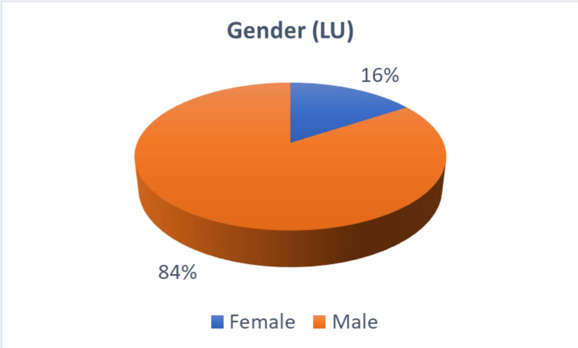


Figure 20: Gender distribution of the Luxembourg drivers' sample

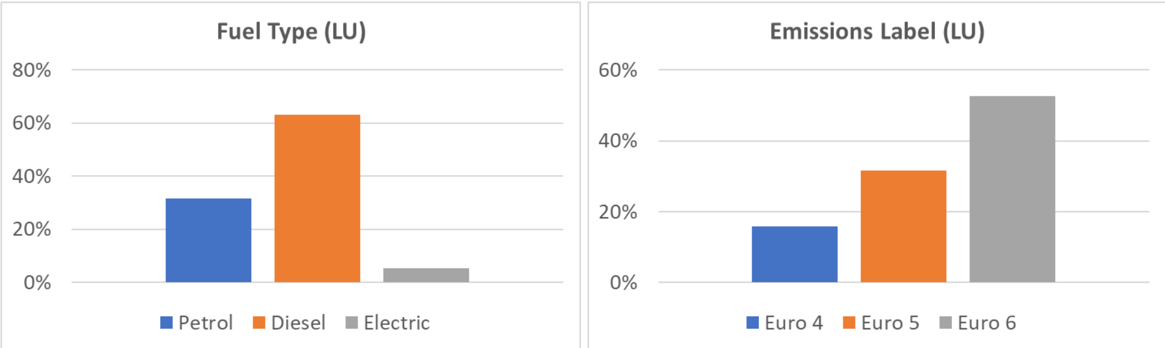


Figure 21: Fuel type and Euro Standards distribution of the Luxembourg vehicles' sample

4.3.7 Greece (Thessaloniki)

The Thessaloniki Metropolitan Area serves as an important transportation hub for Greece and south-eastern Europe, notably through the Port of Thessaloniki. In total, more than 750 000 vehicles are in circulation in the wider area of Thessaloniki, with most of them moving in or through the city on a daily basis. Thessaloniki's air pollution is a known problem and characterized by high concentrations of airborne particulate matter (PM) of carbonaceous particles and photochemical smog.

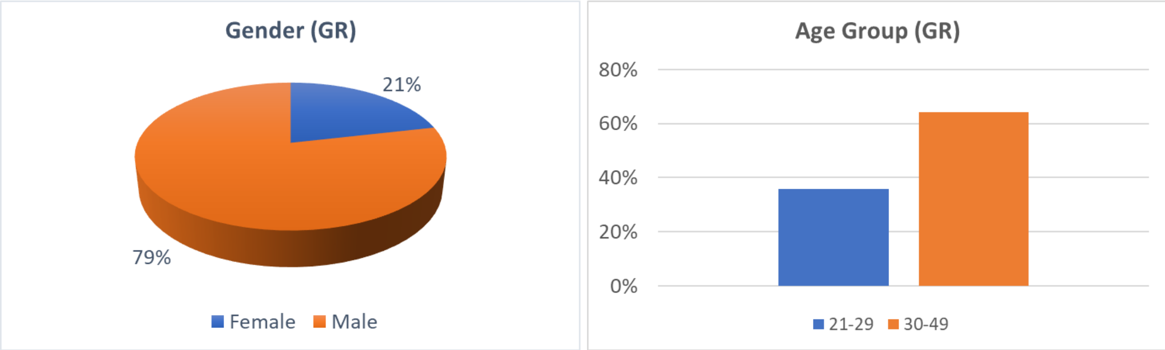


Figure 22: Gender and age distribution of the Greek drivers' sample

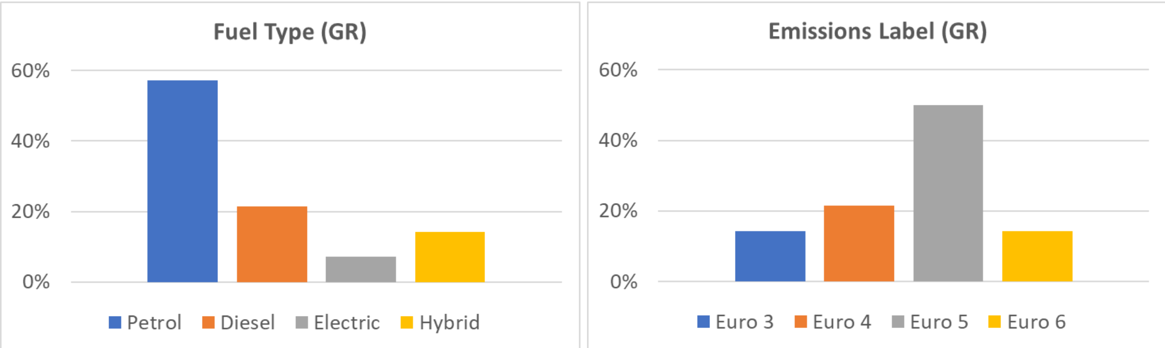


Figure 23: Fuel type and Euro Standards distribution of the Greek vehicles' sample

4.3.8 China (Nanjing)

Nanjing is the capital of Jiangsu province, with an area of 6596 square kilometres and a population of over 9 million. With the rapid growth of urban economies, the intensive use of vehicles in this heavily industrialised city poses the challenge of excessive emissions from urban road traffic. To mitigate road traffic emissions, Nanjing City established the Center for Motor Vehicle Pollution Monitoring and Management in 2007, aimed at preventing and controlling air pollution emitted from over 2.2 million vehicles. This centre is equipped with five sets of remote sensing monitoring equipment, in cooperation with the public security department, to carry out random road tests.

Southeast University was the trial leader in China. The university is a leader in research and development of low-emission transport, playing an important role in greening road transport in the country, and has a long history of research in vehicle emission solutions. Nanjing Sample Technology, a co-partner in the trials, is a high-tech company focusing on intelligent transportation, modern logistics and health services.

In Nanjing, an OBD remote online monitoring system for heavy-duty diesel vehicles is available, which stores data from drivers of vehicles registered on the platform. In order to obtain real driving data for analysis, instead of recruiting private car drivers as previously planned, the Chinese partner contacted logistics companies registered on the platform and recruited HDV drivers. After screening the drivers, 20 drivers (all men) were recruited to participate in the trial based on the completeness and balance of the data. A baseline questionnaire was distributed to these 20 drivers prior to the low-emissions training. During the training, the Chinese partner organized a face-to-face training session where the drivers were introduced to the low-emissions driving guidelines, provided with some leaflets of low-emissions driving tips, and watched a heavy-duty vehicle training video. An on-site discussion was conducted at the end to ensure a deep understanding of the low-emission training. After the training, a post-training questionnaire was distributed to them to collect their feedback.

All vehicles were diesel engine of Euro 5 equivalent standards. 50 % of the vehicles had a maximum weight of 16.4 t and the remaining 50% of 20 t.

4.4 Problems encountered during the baseline phase and contingency actions

In large scale trials, it is common to phase several issues, mainly on technical aspects. MODALES has experience the following issues and provided the necessary therapy actions:

- **Data transfer** and **connectivity** were not easy to manage from an end-user perspective. Mainly caused by the multiple countries' participation, with connectivity constraints, and asynchronous data transfer.

  Solution: more flexibility in the configuration of the mobile app.

- **OBD integration**. Not all PIDs are available. Moreover, it was difficult for the end-users to manager an additional device.

  Solution (not implemented but for future consideration): rely on car manufacturer data solutions.

- **Start** and **stop** of the mobile app. Users were forgetting to either start the app or even stop it on time.

  Solution: implementing an automatic start/stop option.

- Issues with the **graphical interface** on some phones. Difficult to manage all phones and OS.

  Solution: the App was compatible with the most recent graphical interfaces.

- Issues with the **Android version**. The MODALES app was built for smartphone with Android version 10 or newer. A number of users had to drop out because of owning older smartphones.

  Solution: the App was compatible with the most recent Android versions.

- Specific issues with **iOS**. Difficult to manage all phones and OS.

  Solution: no solution was available to cover all OS within a research project.

4.4.1 Additional issues encountered in Nanjing trial

There were a few issues using the MODALES app for the real-world trial in Nanjing. In China, most smartphones use Android (more than 70%) and require Google services to install apps. However, this service is blocked in China, so trial participants were unable to access the Google Play store to use the app.

Another issue concerns cross-border data transfer, regardless of whether the phone is an Android or IOS system. More specifically, the test data collected in Nanjing could not be sent to the project data server abroad, which is based at LIST in Luxembourg. On the other hand, LIST was concerned about the responsibility of receiving data from China.

4.5 Field testing of the MODALES app

In order to better understand the effect of the MODALES driving assistance tools and to quantify its impact on emissions reductions in real driving conditions, two field tests were conducted which were not initially planned in the DoA. One field test took place in Finland by VTT, focusing on PEMS measurements with and without the use of the App. The second one was done in Greece by CERTH with the aim to measure PM concentration of 0.3 to 10.0 µm diameter.

4.5.1 PEMS measurements at VTT

The goal of this study was to validate and demonstrate the potential gains obtained in tail-pipe emissions from using the MODALES application. The net effects were measured with a portable emissions measurement system (PEMS) in real-world conditions. For this purpose, a separate PEMS-testing campaign was organised for the Helsinki trials. A detailed description of the results is provided in the MODALES Deliverable D6.3 *"Real-world exhaust emission measurements from PEMS".*

Test driver pool

A set of seven volunteers from the Helsinki trial site were selected for this experiment. Most of the driving took place around the city of Espoo in where VTT is located, but due to its strong relation to the Helsinki region, it was referred as Helsinki. Each vehicle was operated by five drivers each. Because only seven test drivers volunteered for the experiment, three volunteers conducted tests with both vehicles. A central selection criterion for the volunteers was that the drivers were required to have sufficient time and mileage of baseline for the application to form suggestions of how to improve the user specific driving behaviour. Detailed information about the drivers are presented in Table 3.

Table 3: Break-down of the pool of test drivers

Driver ID	Gender	Age [years]	Driving experience [years]	Annual mileage
Helsinki 1	Male	58	40	> 20 000
Helsinki 2	Male	58	41	> 20 000
Helsinki 3	Male	64	46	> 20 000
Helsinki 6	Male	47	25	10 000 – 20 000
Helsinki 16	Male	40	22	10 000 – 20 000
Helsinki 26	Male	61	43	> 20 000
Helsinki 27	Male	33	15	10 000 – 20 000

Test protocol and test matrix

The experiments were divided into two different phases: recording the driving behaviour of the drivers' baseline behaviour and the change in behaviour with the MODALES application activated. Each driver was requested to drive the predefined MODALES PEMS route according to instructions given by the VTT MODALES project staff. The route was displayed for the drivers in a satellite navigation device, which guided the drivers throughout the complete trip. Additionally, a brief introduction of the vehicles and their attributes were given before the tests. The vehicles in question were mostly familiar to all test drivers because the same vehicles are freely available and used among VTT's staff for conducting regular business activities.

For the baseline tests, the drivers were told to drive the predefined trip two consecutive times. No instruction or training for low emission driving prior to the baseline tests were given for the drivers. The drivers were guided to record their driving with the MODALES application without the recommendations activated (Phase 1). When the baseline tests were completed, each driver would receive the MODALES training material and a short introduction on site for how to use and utilise the MODALES-application and its active and passive recommendations. When the training was completed, the drivers were asked to activate the recommendations (phase 2) on the MODALES application and to use the application in normal, everyday driving until the next phase of PEMS tests were conducted.

The second part of the study was aimed for recording the exact same route with the recommendations from the MODALES application activated. Before the start of the tests, the drivers were requested to analyse their history of passive recommendations from Phase 1. Additionally, the drivers were guided to follow the active recommendations displayed on their mobile phone during the PEMS tests whenever applicable. A general overview of the test matrix is shown in Table 4 and the different driver and vehicle combinations in Table 5.

Table 4: Test matrix for the driver, vehicle, and monitoring combinations

	Vehicle	Test configuration	No. Test drivers	No. test repetitions	Total tests
Test setup 1 (baseline)	Petrol	No driver aid applied; user driving "as usual"	5	2	10
Test setup 2 (w. MODALES app.)	Petrol	MODALES application in use	5	2	10
Test setup 3 (baseline)	Diesel	No driver aid applied; user driving "as usual"	5	2	10
Test setup 4 (w. MODALES app.)	Diesel	MODALES application in use	5	2	10

Table 5: Driver and vehicle matrix

Driver ID	Petrol	Diesel
Helsinki 1	x	x
Helsinki 2		x
Helsinki 3	x	
Helsinki 6		x
Helsinki 16	x	
Helsinki 26	x	x
Helsinki 27	x	x

Test vehicles

The test vehicles used in the experiments were VTT's in-house vehicles dedicated for internal purpose. The vehicles are generally familiar to most of the staff, including the test drivers because the vehicles are available for all VTT personnel if necessary. The reason for choosing these test vehicles for the tests was simple: the vehicles had previous history with PEMS-testing, which in turn was in favour for practical reasons (regarding configuring and installing the PEMS-device) and the drivers had previous understanding of the vehicle behaviour. Furthermore, the vehicles represent relatively well the typical vehicles present possessed by Finnish road users. Both vehicles were from the same brand and model. The first vehicle was equipped with a petrol engine combined with a 6-speed manual transmission. The latter vehicle was a diesel model equipped with an automatic 7-speed DSG transmission. The vehicles with the PEMS devices installed are illustrated in Figure 24 and Figure 25. A more detailed list of the vehicle configuration is presented in Table 6: The main specifications of the test vehicles.

Figure 24: Skoda Octavia Petrol (test vehicle #1) with the PEMS device installed

Figure 25: Skoda Octavia Diesel (test vehicle #2) with the PEMS device installed

Table 6: The main specifications of the test vehicles

Test vehicle #	1	2
Make	Skoda	Skoda
Model	Octavia	Octavia
Model year	2017	2019
Fuel type	Petrol	Diesel
Engine size [dm^3]	1.498	1.598
Induction	Turbo	Turbo
Power [kW]	110	85
Transmission type	Manual 6-speed	Automatic (DSG 7-speed)
Mass [kg]	1470	1556
Emission class	Euro 6C	Euro 6d_temp
EATS	TWC	EGR + DOC + SCR + DPF

Test route

The test route implemented for the experiments was a tailor-made route consisting of different driving conditions, such as urban, rural and motorway sections. The route started from VTT's vehicle laboratory, circulated around Espoo region, and returned to the starting point. The first and last section (ca. 4.5 km) were the same route but driven in opposite directions. This route is the same that was initially implemented in the work described in D3.1. The route chosen for this experiment is a relatively diverse yet representative for typical road usage, including several junctions, traffic lights and bus stops. It should be noted that all such road conditions together with the momentary traffic conditions may potentially affect the driving consistency between trips. The total length of the route was ca. 31 km, with an estimated average trip time (by the navigator) of ca. 45 - 50 minutes depending on traffic conditions. The speed limits over the route differed from 40/50 km/h for most of the streets to short sections of 20 km/h in the very beginning and at the end, with a few short sections (2.4 km in total) of 30 km/h. The rural route sections of some 2.8 km had speed limit of 60 km/h. The motorway section (2.5 km) had 100 km/h speed limit, and the dual carriageway type of ring-road section (3.5 km) had speed limit of 80 km/h. An illustrative map of the route including the corresponding sections speed limits are shown in Figure 26.

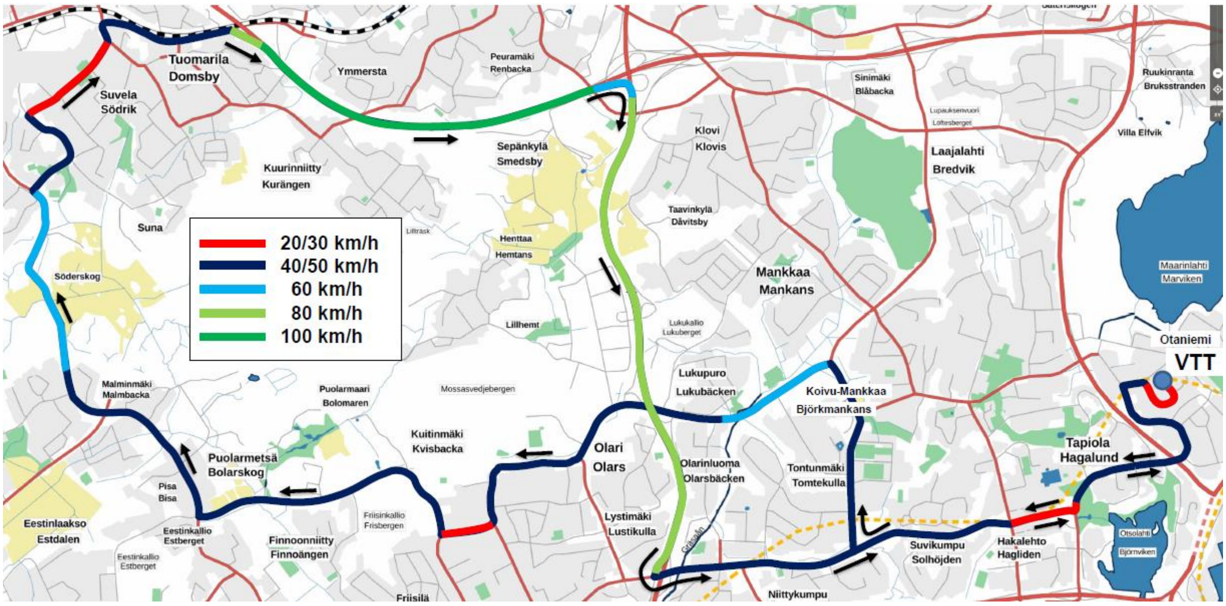


Figure 26: The preselected test route used for the PEMS tests

Test equipment and data collection

To record the essential data of each trip, a PEMS device (AVL M.O.V.E.) was installed in both test vehicles. The PEMS device can record the ambient conditions, exhaust emissions, driving parameters and GPS position. The post processing was performed using a dedicated PEMS data software (AVL Concerto). The output file contains both instantaneous (emissions/s) and cumulative (emissions/test, emissions/km) emissions values. Essential driving parameters were recorded by PEMS from vehicle OBD II port. The vehicles speed (km/h) was recorded by the PEMS device either based on the vehicle OBD-data or from the change in GPS position. From the vehicle speed data, concerto provides with additional information, such as acceleration (m/s^2) and v*a positive, or va pos (m^2/s^3), a parameter describing the (positive) vehicle acceleration in relation to current driving speed by multiplying the acceleration and the driving speed. However, the v*a positive does not account for deceleration, which in turn should be accounted for by other means. Main parameters recorded are listed following:

Parameters collected during the experiments

From ECU/OBD:

- Driving speed (km/h)
- Engine speed (rpm)
- Power (kW)
- Engine torque (Nm or %)
- Engine work (kWh)
- Coolant temperature (°C)

From PEMS:

- Exhaust emissions: CO, CO_2, NO, NO_2, O_2, PN (particulate number)
- Exhaust mass flow (kg/h)

- Exhaust temperature (°C)
- GPS position (long. lat. alt), vehicle speed (km/h) and distance travelled (km)

From MODALES application

- Passive recommendations

Simultaneously for each trip, the MODALES application was activated before the start of the test. The mobile MODALES application was not connected to the OBD-port, because the data collection would conflict with the PEMS recording. The mobile phones containing the MODALES application was positioned in the centre of the vehicle console, well within the line of sight of the driver but such that it would minimise the distraction of the overall driving view (Figure 27). For the baseline tests, MODALES app was left in Phase 1 mode such that no driving recommendation would be present during the driving event. For the second phase, the MODALES recommendations were activated, displaying the trip scoring from each test (Figure 28).

The net effect and gains obtained from using the MODALES application were analysed based on both momentary, total trip and average values of all data collected. For calculating the net results, the two consecutive tests for each driver/vehicle configuration were accounted for. If any OBD or vehicle related faults or abnormal behaviour occurred, the data of this output was discarded from the analysis. This includes discarding of trips with DPF-regeneration, which was expected to take place somewhat randomly yet repeatedly for the diesel vehicle.

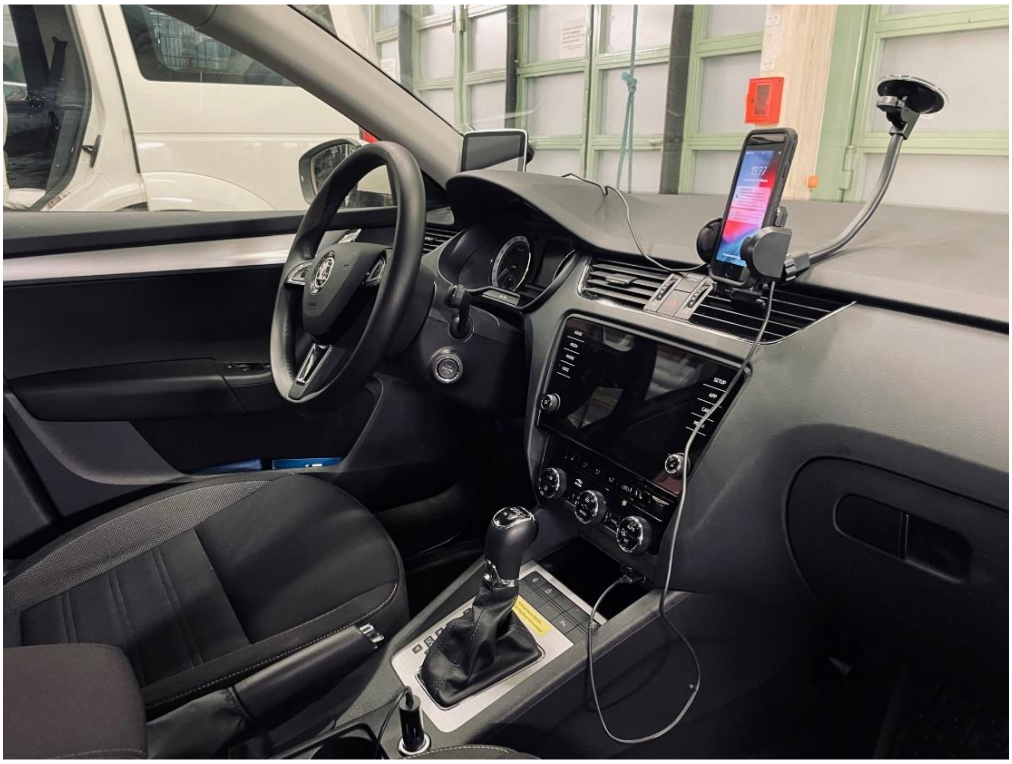


Figure 27: Mobile phone and the satellite navigation device positions in the vehicle cabin

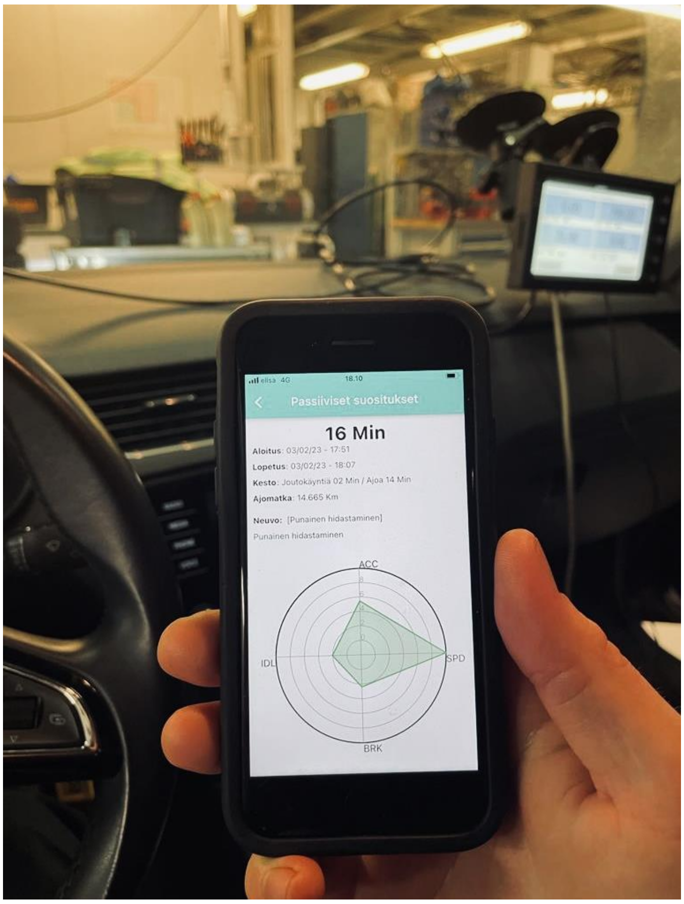


Figure 28: An example of passive recommendations for trip scoring

Validation and quality assurance

The validity and quality of each result was assured by implementing an integrated validation scheme provided by the PEMS supplier. This includes daily pre-check calibrations using standard gas mixtures with known concentrations, as well as post-checks. Possible analyser drifts were measured, and datasets were corrected according to the deviation between the pre- and post- tests. Additionally, momentary ambient conditions were recorded by the PEMS device, and the data was used to normalise the results. The tests were prepared and supervised and data post-processed by experienced professionals that regularly work with specifically this PEMS- device.

Execution of the PEMS-tests

The PEMS tests for this work were conducted in February 2023. February is typically one of the coldest months, temperatures below -20 °C being not uncommon. However, due to a milder winter, the average ambient temperatures were generally above or around 0 °C, thus conditions were seen suitable for PEMS testing. The lowest allowed ambient temperature (lower boundary condition) for the PEMS device is -10 °C, but extended conditions for Euro 6 vehicles reach down to -7 °C. All conducted tests fulfilled these boundary conditions but ranged between + 1.2 °C to + 7.7 °C for the petrol vehicle and between - 4.6 °C to + 4.3 °C for the diesel vehicle. The average trip temperatures are shown for the petrol vehicle in Table 7 and for the diesel vehicle in Table 8.

Table 7: Average trip temperature of PEMS test campaign with the Petrol vehicle

Petrol vehicle	Baseline		w. MODALES app	
Driver ID	Date	Average ambient temperature [°C]	Date	Average ambient temperature [°C]
Helsinki 1	9.2.2023	3.0	14.2.2023	5.0
Helsinki 3	13.2.2023	7.1	14.2.2023	3.7
Helsinki 16	10.2.2023	2.2	15.2.2023	2.0
Helsinki 26	10.2.2023	1.9	15.2.2023	1.2
Helsinki 27	9.2.2023	2.9	13.2.2023	7.7

Table 8: Average trip temperature of PEMS test campaign with the Petrol vehicle

Diesel vehicle	Baseline		w. MODALES app	
Driver ID	Date	Average ambient temperature [°C]	Date	Average ambient temperature [°C]
Helsinki 1	21.2.2023	-4.6	1.3.2023	2.7
Helsinki 2	24.2.2023	-1.4	28.2.2023	2.7
Helsinki 6	23.2.2023	-1.7	28.2.2023	4.3
Helsinki 26	23.2.2023	-2.4	24.2.2023	-0.1
Helsinki 27	27.2.2023	2.0	1.3.2023	5.6

4.5.2 PM brake measurements at CERTH

This dedicated study aimed to measure brake particle concentrations and size distributions from two test vehicles under real-world driving and braking conditions with and without using the MODALES app. Moreover, the in-cabin sound was measured during the two scenarios.

A detailed reference to the results is provided in the MODALES Deliverable D6.3 *"Real-world exhaust emission measurements from PEMS".*

Test design

On-road measurements were conducted to capture brake particles, using a custom apparatus for sampling. The sampling probe for the brake particles was positioned about 20 cm from the top of the left wheel centre and with an offset of about 5 cm to the front of the wheel centre (Figure 30), in order to reduce the potential sampling of particles coming from the wheel-road friction. The device for the sound measurement was placed in between the two front row seats at about half meter from the vehicle foot board.

Isokinetic sampling probe with a 10 mm inner diameter was utilized. Particle losses and aspiration efficiency were not calculated, because the aim of the study was not to provide accurate numbers of

PM concentration, but to investigate the emission reduction of brake emissions due to the MODALES tools.

It's also important to note that the collected particles may contain contributions from other emission sources, and chemical speciation analysis and source apportionment would be required to estimate their relative proportions accurately.

The sampling route was one km length, located in Thermi, Thessaloniki Greece (Figure 29). It is a restricted area of very low vehicle traffic. This place has been chosen because the road conditions would remain relatively constant throughout the measurements. The 1 km, flat terrain, route has been repeated 5 times, thus the total distance covered each time was 5 kms. The tests have been conducted in the morning of a weekend (07.30 am – 10.30 am), in order to minimise the air contamination from the surrounding traffic. There was a resting period of about 15 minutes each time to allow brake cooling. The weather conditions while testing were constant, dry and shiny. Ambient temperature and relative humidity during the sampling sessions averaged 13 °C and 85 %, respectively. The altitude of the testing ground is 380 m from the sea level.

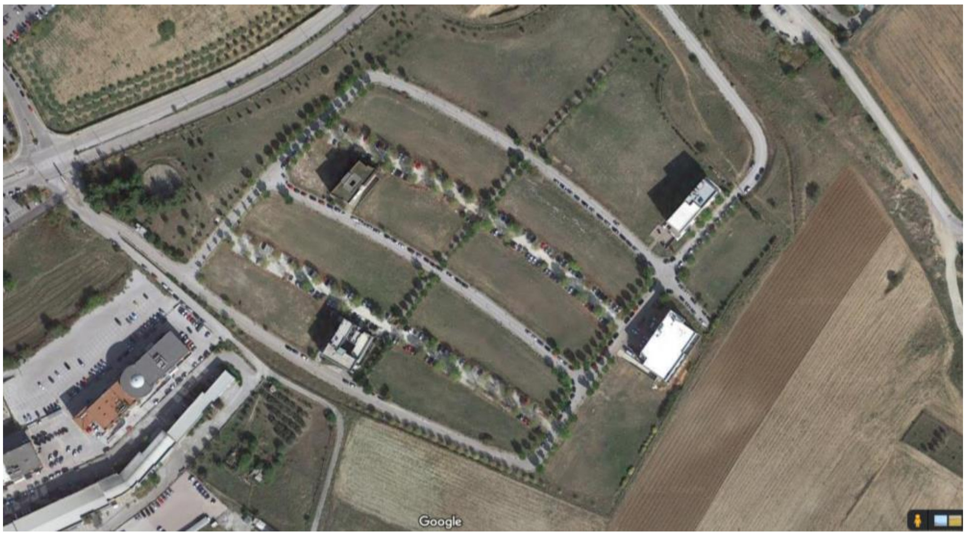


Figure 29: Top view of the test location in Thessaloniki, Greece

The measurements took place as follows:

- Background measurements while driving with a low speed (approx. 30 km/h to avoid any acronymic disturbances). The inlet probe was placed close to the left low side of the windshield where the air speed is relatively low in comparison with other locations at the front of the vehicle (Figure 30).
- Measurements with free-style driving for 5 kms. The measurements were done with the app deactivated and activated.
- Background measurement with the same configuration after the brake PM measurements, in order to have the background particle concentration before and after the tests.

Figure 30: Inlet probe location during background measurements (left) and inlet probe placement for the brake particle counting (right)

Tools

Two vehicles were used in the on-road sampling:

- a FIAT, diesel engine, Euro 5 technology, with 124 000 km, with the brake pads and discs replaced about 20 000 km earlier
- a BMW, BEV, with 5 300 km, with the brake pads and discs to be the original ones

The compound of the brake pads was ceramic, known for their stable thermal performance and lower particulate matter emissions compared to other brake types. The tire pressure was set according to the manufacturers' specifications. The brake pads and callipers were cleaned before the tests by blowing pressurised area.

The instrumentation used for measurements was a TSI 3330 Optical Particle Counter (calibrated in UK, in April 2023), classifying the particles into the following bins (μm): 0.30-0.35, 0.36-0.40, 0.41-0.45, 0.46-0.50, 0.51-0.55, 0.56-0.60, 0.61-0.65, 0.66-0.70, 0.71-0.75, 0.76-0.80, 0.81-0.85, 0.86-1.05, 1.06-2.50, and 2.51-9.99. Data logged at a 1-second interval. Velocity, GPS coordinates and vehicle parameters were recorded using the OBD-Link MX+ dongle and a Samsung smart phone.

The sound level in the interior of the cabin was measured with a Metrel FonS device. Sound values of LAeq, LAFmax, LAFmin, LApeak, L01, L05, L10, L50, L90, L95, and L99 have been logged at every 2-seconds interval.

The driver in both vehicles was a participant from the Greek trial site pool. Due to time limitations and the fact that conditions should remain approximately the same (weekend, hour of testing, weather conditions, etc), it was not possible to involve more drivers from the Greek trials.

Data analysis

The three files of data created by the smartphone, the TSI OPS and the Metrel sound meter were synchronised at a second level and a common file was produced with unique id the time stamp. Microsoft Excel 2016 and SPSS version 25 were used to perform the statistical analysis. All figures were generated with the SPSS software.

5 Assessments on user acceptance and impact on driving performance

Three surveys were conducted among the MODALES trial participants. The first was the driver selection survey (see Annex 8), which was administered individually by each participating project partner (site leader) to collect basic information such as vehicle type, age group, gender, driving experience and typical driving intensity (annual mileage, main trip purposes). These allowed the volunteer drivers to be selected, and this data provides context to the data analysis which is reported in Deliverable D6.3.

The second survey followed the viewing of the training video by each participant and their move to Phase 2 of the trial. This focused on their understanding and acceptance of the video, the extent to which they learnt new low-emission driving skills and any other feedback. This is reported below.

The final survey, after the end of Phase 2 of the trials, was on the use of the MODALES app and the extent to which drivers felt their driving style and behaviour had changed as a result of the MODALES training video and the MODALES app advice and feedback. This survey is briefly described below, but because it only closed as this deliverable was being finalised, the results are reported in D6.4: Impact Assessment report.

5.1 The training video user acceptance survey

5.1.1 Approach and response rate

This survey was developed and administered in early 2023, using the EU's EUSurvey tool[1]. This enabled a professional interface, officially branding it as part of an EU-supported activity, but also with the MODALES branding. It also allows easy creation of several versions in different languages.

It took the form of a short questionnaire, mostly multiple-choice for ease of responding and of analysis, but also with some open free-text questions.

The questions focused on the MODALES training video, which participants were asked to view beforehand on YouTube via a dedicated link to the version of their own language. It asked them about the clarity (ease of understanding) of the video, the novelty/usefulness of information in the video (including the most and least useful aspects), the completeness of the video and the practical examples shown in the video. In cases of a negative rating, respondents were asked to suggest what could have been improved or if there was anything they considered to be missing or incomplete.

They were also asked whether they thought the duration of the video was appropriate and how they rated their knowledge on low-emission driving before and after watching the video. This last point is important because drivers all start from different levels, and the videos were aimed at an elementary to intermediate level of knowledge. Thus, it would be expected that a driver who already had a very good knowledge or appreciation of eco-driving (eco-driving training programmes for professional drivers last a whole day and more aspects are covered), emissions and advanced driving techniques would probably not learn much new from such a video.

[1] https://ec.europa.eu/eusurvey

The questionnaire was made available on EUSurvey in the languages of the trial sites, i.e. English, Finnish, French, Spanish, Italian, Greek and Turkish. A separate Chinese version was circulated by the local partner by email to the drivers in Nanjing.

A total of 82 responses were received, with the breakdown by site shown in Figure 31 below.

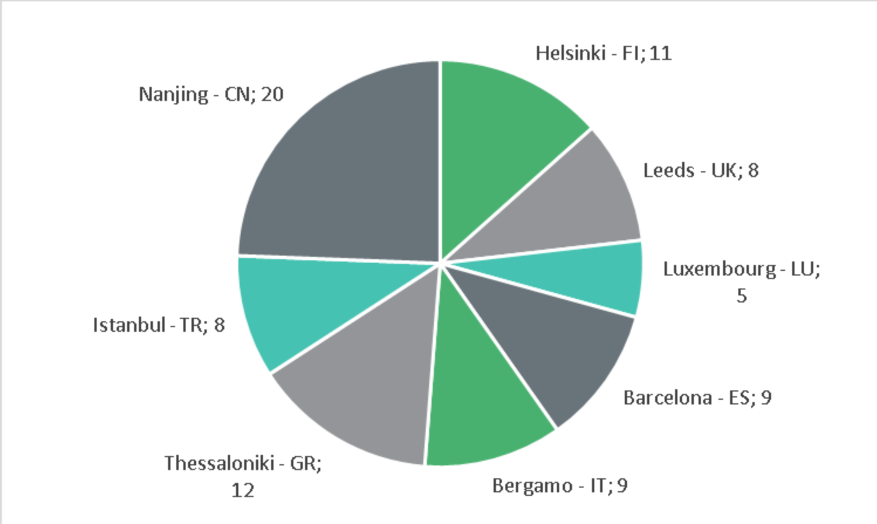


Figure 31: Responses to driver questionnaire on training video, by trial site

84% of respondents were male and 16% were female. Of the 51 who gave their age group, 34 (two-thirds) were in the category of 30 to 49 years old, 7 were under 30 years old and 10 were over 50 years old (with only one of these being over 65).

5.1.2 Results

Clarity

All but one of the respondents found the training video to be either **clear or very clear** (with approximately 85% saying very clear: score 5 out of 5) – see Figure 32.

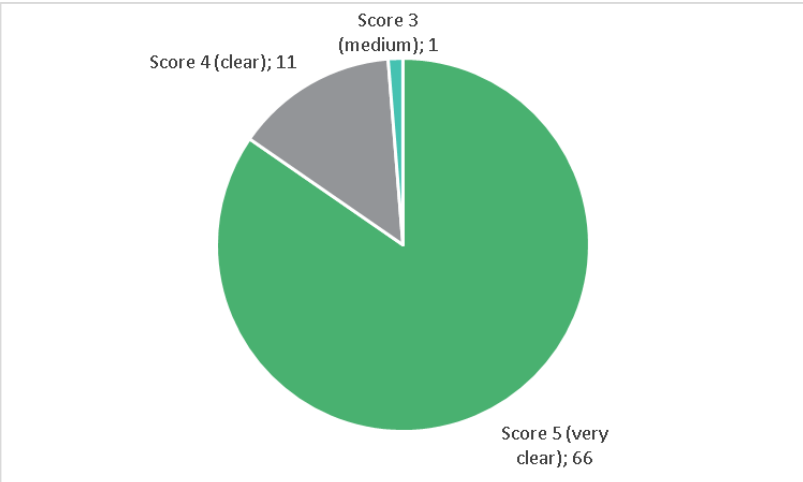


Figure 32: Driver questionnaire on training video: Rating of clarity of the video

Comments on the clarity included a suggestion for more details about car maintenance, including more specific instructions with respect to reducing tyre and exhaust emissions, and having it available with a soundtrack in more languages (rather than just subtitled: this was done for budgetary reasons).

Usefulness

Regarding the usefulness of the video, **89%** of respondents found it **useful or very useful** (score 4 or 5 on a scale up to 5). Four respondents gave a low score (1 or 2 on a scale up to 5) – see Figure 33. This illustrates that a single video might not be appropriate for all levels of drivers, with differing baseline knowledge. The need to keep the instructions simple and non-technical can make the video rather too simple or superficial to drivers who already have a good knowledge of eco-driving practice.

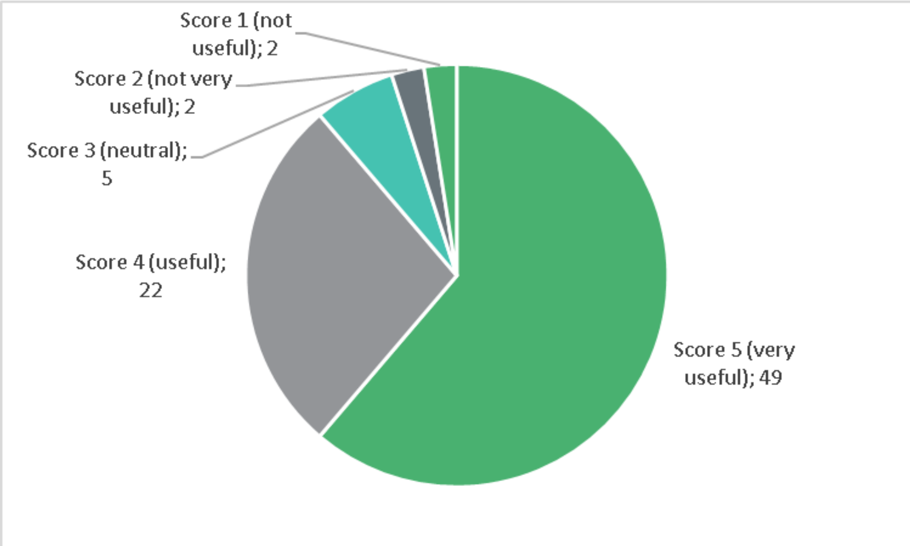


Figure 33: Driver questionnaire on training video: Rating of usefulness of the video

Several comments were made on the **most useful elements**, with some commenting that all the elements were useful. Aspects remarked on were the usefulness of recommendations related to brake and tyre wear emissions, in particular tyre pressure and oil change. Things that affect economical driving and the importance of maintenance were mentioned, as well as avoiding idling and the fact that there is no need to warm up newer vehicles when starting a trip were mentioned. Advice to think about the route to take was considered useful, for example avoiding congestion, taking motorways in preference to urban roads even if it is longer, and to take into account the quality of the road surface (roughness) when choosing between two similar routes that they are familiar with. The effects of behaviour on tyres especially were considered novel and useful by several people, as most previously only considered fuel use and exhaust emissions in terms of eco/low-emission driving.

One comment was that advice could be complemented with illustrative data to increase awareness and also a more directed approach to specific driving habits and the additional environmental and economic costs of them. Sub-dividing different driving behaviour aspects and explaining them scientifically in terms of different emission types (exhaust, brakes, tyres) was also mentioned. For the commercial vehicle videos, the advice to schedule tasks appropriately and to avoid unnecessary loads in the vehicle were considered useful.

Regarding the information people found **least useful**, aspects mentioned include the introduction of general principles, using navigation aids and selecting less hilly roads (depending on where the driver lives), maintenance recommendations and avoiding engine tuning. One user said that the part related to driving itself was too short. One said some of the things mentioned, such as minimising unnecessary short car journeys, checking tyre pressure, avoiding unnecessary heavy loads and avoiding harsh acceleration, were not useful because it is already obvious. A driver from Finland said the advice to minimise the use of air conditioning and heating was not useful, as in the Nordic winter the heating is not there for nothing, also air conditioning must be used even in winter to remove moisture and so that the device does not freeze due to lack of use.

Other respondents however said that all the tips were useful, or even if they were already known then the video is a useful reminder.

Completeness

The vast majority (77 out of 79 respondents) gave a score of 4 or 5 on a scale of 1 to 5, indicating that they considered the video to be **mostly or fully complete**, with 61% of users giving the full score (see Figure 34). There was only one respondent in each case giving a low score of 2 (with the comment that the information was very general, not specific) or a neutral score of 3 (commenting that he was expecting more information about the optimal engine load during acceleration, optimal speed and engine braking).

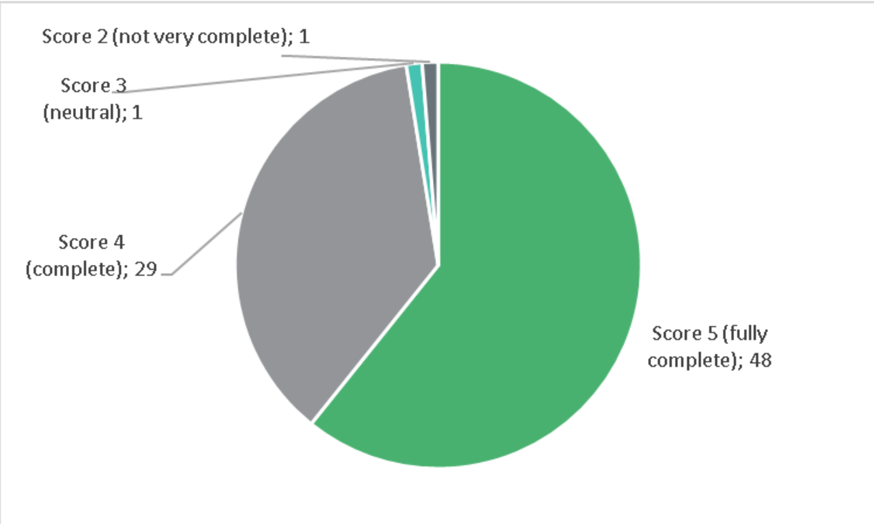


Figure 34: Driver questionnaire on training video: Rating of completeness of the video

Comments made on completeness include that there should also be driving advice for automatic transmissions, hybrids and electric cars. Another respondent missed a clear summary of things that must be taken into account in low-emission driving and one said that there could have been more explanation on the maintenance items that can reduce emissions. The effect of seasonal or weather conditions on low-emission driving was missing.

Practical examples

Most people gave a good score (4 or 5 on a scale of 1 to 5, see Figure 35) for practical examples given in the video: 71 out of 75 who answered this question, with 51 of them (68%) giving a full score of 5. Three people gave a neutral score, one of whom commented that the introductory section is about 1 minute and 30 seconds long, which feels on the long side. Only one person gave a score of 2 out of 5, commenting that there was little real information, it was at a very basic level and not always intended for the right audience (advice on the type of journey: responsibility of mapping companies; road conditions: from the road operator or local authority; and vehicle maintenance log: from the car dealer or garage).

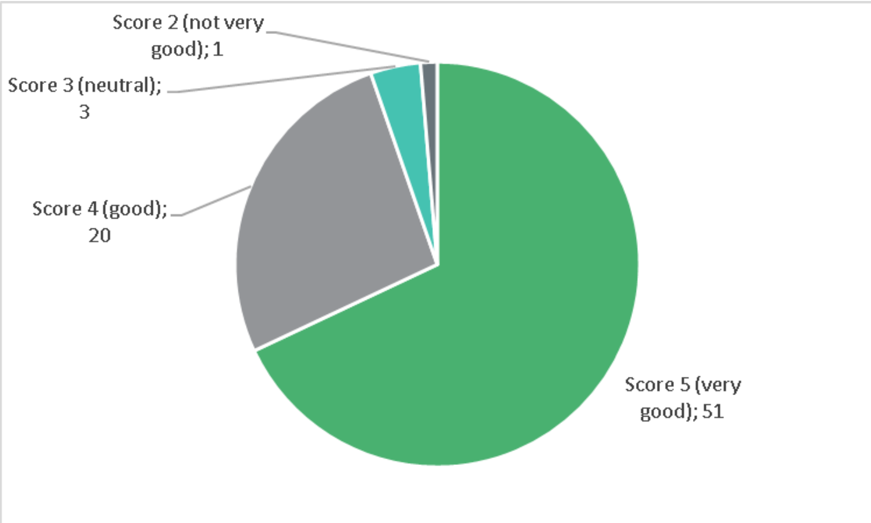


Figure 35: Driver questionnaire on training video: Rating of practical examples in the video

Regarding comments on this aspect, one person said an animation would be better, another said there should be more content, or more detailed videos with different models of vehicles, or in different climatic conditions. One said the video was too slow-paced and another said it is easy to lose patience watching it.

Another user wrote that the advice about maintenance of the car by an expert is a bit controversial, because with a second-hand car it is more likely to develop problems. It could be that the repair of the vehicle might cost more than the value of the car thus making it not a viable choice, so a driver in a tight financial situation is likely to keep using their car despite problems.

Video duration

Most respondents (56 out of 82 responses, or 68%) considered the video length to be appropriate, and 25 of them said it was too long. Only one said it was too short (see Figure 36).

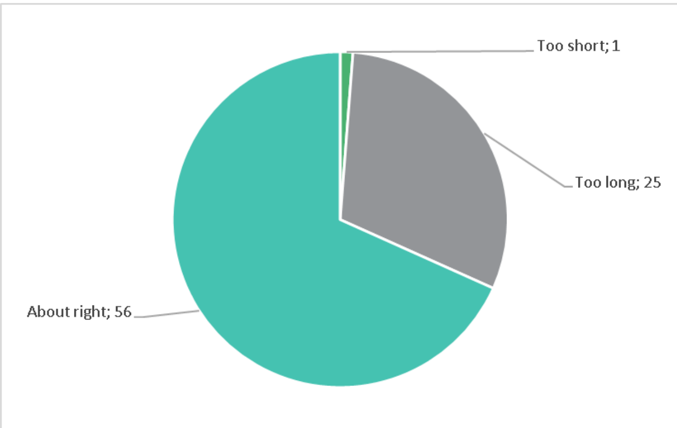


Figure 36: Driver questionnaire on training video: Opinions on video duration

Low emission driving knowledge before and after video

Most drivers rated their knowledge of low-emission driving as good (54%) or average (31%) prior to watching the video. Afterwards, most rated themselves as good (50%) or very good to excellent (39%) – see Figure 37.

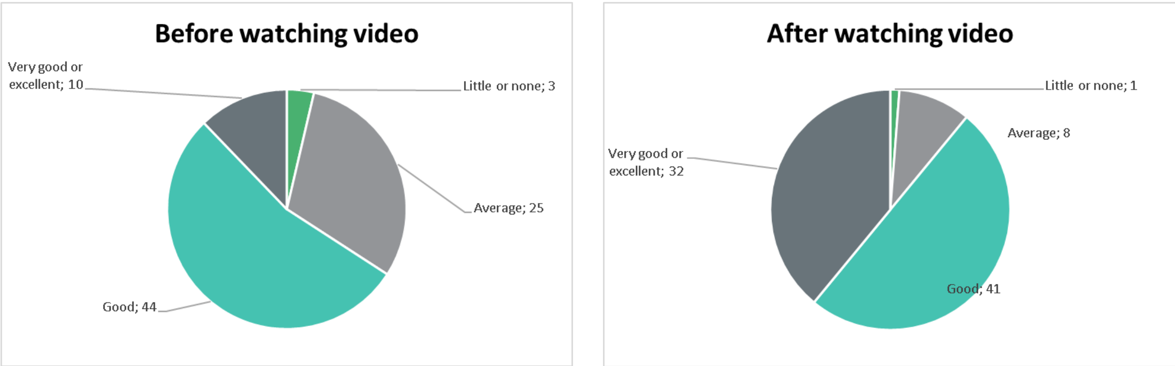


Figure 37: Driver questionnaire on training video: Knowledge of low-emission driving behaviour before and after video

35 of the 82 respondents did not report any change in their knowledge between before and after watching the videos. 35 considered that they had moved up one level following the video (for example from “average” to “good”, or from “good” to “very good/excellent”). Seven people considered that they had moved up two levels (from “little/none” to “good”, or from “average” to “very good/excellent”).

On the other hand, five users considered that their knowledge had gone down (for example from “good” to “average”). This might be because they misunderstood the question, or possibly because they over-estimated their knowledge before the video, and after watching it they realised there were more factors affecting driving emissions than they thought, so they downgraded their self-assessment of their knowledge.

5.2 Impact on driving performance survey

The final questionnaire to the volunteer drivers focused on their use of the low-emission driving app and the advice/tips/feedback given by it. Again, using EUSurvey, for consistency with the one above, this online questionnaire was available in different languages.

For two types of poor (high emitting) driving behaviour, it asked whether the user carried out this behaviour before taking the training and whether they now carry on with the same behaviour, they have modified (improved) a little, or have improved a lot (avoiding almost always this kind of poor behaviour). Alternatively, they already avoided poor behaviour and continue to do so after the training and using the app. The situations were:

- Speeding up when the engine is cold;
- Rapid accelerations, which might lead to a need for sudden braking.

The questionnaire asked how regularly the driver used the app during the trial period (most or all trips, around half of trips, or only a few). For occasions when the driver did not use the app, they were asked why not (e.g. in a hurry, only a short trip, did not like the app or did not find it useful, had technical/connection problems with the app).

The questionnaire included questions on how the user reacted to real-time on-trip feedback from the app (simple colour changes), and also how they reacted to the post-trip feedback.

Finally, this questionnaire recognised that some drivers had experienced difficulties such as getting the app to connect with the dongle, getting the app to send data, etc., and also reminded them that MODALES is a research project and not a commercial product. However, if this project led to a better performing and more stable version of this app being available, and available for free, it asked whether they would use it. Any other suggestions for improvements of the MODALES app were proposed by the respondents.

This final questionnaire was answered by a total of 69 users, covering all the European trial sites (Helsinki, Leeds, Luxembourg, Barcelona, Bergamo, Thessaloniki and Istanbul). It was not distributed to participants in China, as they were unable to use the app due to legal difficulties between China and the EU.

The analysis of results is presented in MODALES D6.4 – Impact Assessment Report.

6 Conclusions

This deliverable outlines the testing and evaluation procedures conducted to assess the functionality and impact of the MODALES driving assistance tools. The evaluation involved trial ramp-ups and real-world pilots, aiming to measure driver acceptance and performance. Measurable demonstrations were carried out to achieve the validation of the complete system in real test facilities using practical platforms, such as the MODALES app. The assessment of the technical performance, acceptance, and usefulness of the MODALES app for different user groups has been achieved via dedicated surveys that took place during different periods of the trials.

The total number of participants, 170 including the Chinese sites, can be considered quite satisfactory taking into account the COVID restrictions and its effects to driver willingness to participate in lengthy vehicle trials, different priorities and changes in people's driving habits. The majority of drivers, over 70%, were men. The objective was to achieve an equal distribution of both men and women, but this goal was not realized in the end. This was primarily due to the fact that the individuals who committed to participate and drive long distances within a short period of time (Phase 2) were predominantly men. Regarding the age groups, the 30-49 age group was the most represented. However, the consortium made efforts to include young drivers (18-29) to study the impact of the project solutions on the younger generation. The primary focus regarding the Euro emissions label was on vehicles with Euro 3-5 technology. Approximately 53% of the participating vehicles belonged to these categories. Nevertheless, a significant number of vehicles was of Euro 6 technology.

COVID pandemic has unfortunately affected the length of the two phases too. There was a significant shortening of Phase 1 and 2 in time than the initial 6 + 6 months planned. The consortium has decided to compensate the potential lack in in-depth knowledge from the shorter trials by conducting real-world tests with PEMS and brake particles' measurements that provided more accurate and reliable data about the effectiveness of the MODALES solutions. The results of the tests have been reported in D6.3.

After the ending of Phase 1 and the training of the drivers before the start of Phase 2, the participants had to answer a dedicated survey about the video usefulness. Overall, the feedback on the training videos was very positive and they are a useful resource that can and will be disseminated more widely even after the end of the project.

We have to consider that the videos in this project were developed following a change of approach due to COVID-19 travel restrictions when it was clear that face-to-face training was not possible (and it was not known at what point such restrictions would be lifted). So, while three videos were developed: for car, LDV/taxi and HDV drivers, there were not separate versions according to the baseline level of knowledge/expertise of the driver, or tailored to specific countries or environments (except for translations/soundtrack and subtitles in all the languages spoken at the trial site regions).

Regarding comments about making advice more technical or complementing the tips with data and examples, this would have made the videos much longer and more technically complex, thus reducing the attention most people would give them. However, it is a valid point for possible future training videos that could offer different levels of advice from elementary to expert drivers.

In a situation where low-emission driver training videos are more widely used, it would be advisable to not only tailor videos to different levels of drivers, but also by country or European region – not just for language use, but also characteristics, for example driving requirements in Nordic countries, especially in winter (as mentioned by some respondents in Finland), differ substantially from those elsewhere in Europe, so low-emission driving advice should be adapted accordingly.

It would also be useful for future use to have training videos tailored to automatic transmissions, hybrid and EVs, as mentioned by one respondent. This was not done in MODALES as the focus of the project is on conventional petrol and diesel vehicles. However, the feedback from the trainees can help improve training programmes including different categories of drivers, areas, vehicles and other aspects.

7 References

The following references have been consulted to support the writing of this deliverable:

1. MODALES D1.3: Data Management Plan. Report, November 2019 (Confidential report)
2. MODALES D5.3: Low-emission driving assistance tools (support document). Report, December 2022 (Public report)
3. MODALES D5.5: Training courses manual for low-emission driving. Report, November 2021 (Confidential report)
4. MODALES D6.1: Evaluation Plan. Report, September 2022 (Confidential report)
5. MODALES D6.3: Trial Data Integration and Analysis. Report, June 2023 (Public report)
6. MODALES D6.4: Impact Assessment. Report, June 2023 (Public report)

8 Annex

This Annex contains seven sub-sections that account to different documents created for the ramp-up and trial phases, as well as for recording the user experience during and after the trial period. Hereby a summary of the documents included in this Annex:

- **Driver pre-information** that used during the **ramp-up**. This is an example by Luxembourg that provides information to the potential participants about the project and explains the reasons of being part of the drivers group.
- **Driver information and consent form** that used during the **ramp-up.** This is again an example from Luxembourg with similar information about the project as the previous document but with more detailed information about the practicalities of the trial and the collected data management.
- **Invitation to fleet operators**. In order to have as many as possible professional drivers in the trial MODALES drafted and handed out this document to fleet operators.
- **Baseline questionnaire**. This questionnaire used for the selection of the participants and it is the example aimed for private vehicle users. With this document, the consortium collected data about the drivers and vehicle basic characteristics.
- **Driver FAQ and data protection**. This document intended to answer any potential questions the participants might have, also based on the feedback received during the ramp-up.
- **User acceptance survey**. After watching the training video, the participants asked to fill in this survey. The survey specifically aimed to assess their comprehension and acceptance of the video, the level of knowledge they gained from it, and any additional feedback they had.
- **User final questionnaire**. Following the completion of Phase 2 of the trials, the final survey was conducted to evaluate the usage of the app and assess the degree to which drivers perceived changes in their driving style and behaviour as a result of the training video and the advice and feedback provided through the app.

8.1 Driver pre-information, ramp-up (example of Luxembourg)

Be part of the testing of our low-emission driving app

Do you live in the Grand Duchy of Luxembourg or in a nearby border area of France, Belgium or Germany regularly drive a car to or within Luxembourg?

Luxembourg Institute of Science and Technology (LIST) is looking for volunteers to test a new low-emission driving app as part of the research project "MODALES"

Adapting driver behaviour
for lower emissions

Just drive your car as normal, for your ordinary everyday purposes, while using our device and get driving style feedback. Your data will be kept strictly confidential.

What is this about?

The European research project MODALES is developing an app to help drivers reduce their vehicle emissions. It is aimed at older vehicles, 5 or more years old.

Part of the development is to test and demonstrate the app with drivers in different parts of Europe. One of the test locations is Luxembourg. The demonstration will involve private motorists driving their own car as well as professional drivers (taxis, vans, heavy vehicles).

This information is for the pre-trial pilot (ramp-up) stage only, which concerns private car drivers. It is to test our procedures over a short time (1 month) before full trials and to help calibrate and improve the first version of the app. The full trials will take place later this year with about 50 drivers per city and they will last much longer, also involving a training session and a more mature version of the app. You will not be involved with these full trials.

We are looking for volunteer drivers for a period of one month, starting in late-March or early-April 2021, who are willing to have a device fitted to their car (it will not modify the functioning of the vehicle) and to use the MODALES app on their Smartphone. We will occasionally ask for feedback via questionnaires.

The purpose is to test the low-emission driving app in a variety of different situations (countries, road types, vehicle types) with a variety of different drivers (age groups, gender, driving style, level of driving experience).

Drivers will be asked about their experience using the app and we will also collect data on driving styles and test the functioning of the app.

What is MODALES?

MODALES is a 3-year European Union funded project aimed at reducing air pollution from all types of road vehicles by encouraging adoption of low-emission driving behaviour and good maintenance practices. This includes reducing emissions not only from the vehicle exhaust (for petrol and diesel vehicles) but also particle emissions from brakes and tyres. Reducing such emissions helps improve air quality, especially in urban areas, as well as reducing wear and tear on vehicle components as well as reduced fuel use, so saving the driver money.

The project is a partnership covering 9 countries: Belgium, Finland, France, Greece, Italy, Luxembourg, Spain, Turkey and the United Kingdom. The project runs from September 2019 to August 2022.

MODALES proposes a user-centric approach by researching, developing and testing a number of innovative and complementary solutions. These include a smartphone app which has been developed (and is being further improved) to help drivers reduce their emissions.

Further information about MODALES (in English only), its activities, the partners, and recent news, is available at https://modales-project.eu

How do I participate?

We will provide you with small device called an OBD dongle which is plugged into the OBD connector in your car. OBD stands for On-Board Diagnostics and the connector allows data on the functioning of the engine and other vehicle systems to be collected from the vehicle's on-board computer. This will collect information on driving style such as speed, gear use, brake use, etc., but it will not affect the electronics or operation of your car in any way. You will also be asked to download the MODALES app on your smartphone. You will be asked to download the first version of the MODALES app and drive normally for a month to allow it to collect driving and GPS (positioning) data. No specific routes/itineraries or driving styles are needed, just your normal car trips whether for work or personal/leisure reasons, both short local trips and longer distance trips. The OBD dongle will collect information from the car's on-board computer and with this we can calculate your driving style and estimate the emissions from your car.

Your phone should be in a hands-free holder so that it is visible while you drive, without requiring you to look away from the road ahead. We can provide a holder if you need one.

Do not let the app distract you from your normal driving. This first version of the app will not provide any advice, it just collects data. The data will only be used to test the app and its performance.

What happens to my data? How is privacy respected?

The project team will then analyse any changes in your driving behaviour from the baseline period (without the app) to the period when you use the app. We will also provide you with a summary of this analysis. The objective is to analyse how different drivers behaviour changes due to the app. **It is not to evaluate you as a driver.**

The data collected will include driving elements such as speed and gear selection, as well as your location so that we know what kinds of roads you are driving on (urban streets, major roads or motorways, congested roads, going uphill, etc.). **This data will only be used for the MODALES trial to evaluate the app. It will not be shared with any authority or anyone else outside this project, unless in exceptional circumstances as required by law (for example as evidence in case of a collision, if required by police or court of law: this is a legal obligation).**

Your local partner for Luxembourg, LIST, will use your contact data (name, email, telephone number) only to contact you about these trials and these personal details will not be linked to your driving data. **Driving data for each volunteer will be treated in an anonymous way**, using a unique number for each driver, which does not allow any individual to be identified. Only the age group, gender, driving experience (novice, mid, experienced) and the city/region will be linked to your driving data.

Drivers and the MODALES local partner will **sign an agreement** which details what data will be collected, how it will be used, how we will protect your privacy, what we will ask you to do, and how to contact us in case of questions or problems.

Unfortunately, we cannot pay any of the trial participants. However, it will require very little time from you and involve no expenses.

To participate in the trial, we would need you to:

1) Be over 18 years of age and have a full (car, B) driving licence.
2) Own or have regular access to a car which you regularly drive (it doesn't matter if the car is also driven by other people, such as members of your household, or if you have more than one car).
3) Own a smartphone (with Bluetooth and Wi-Fi connection).
4) Sign an agreement detailing what data will be collected, how it will be used, and explaining your rights.
5) Download an app to analyse your driving behaviour.
6) Use this app every time you drive during the trial period, to monitor your driving routines. This involves ensuring your Smartphone is switched on and Bluetooth enabled when you are driving.
7) Answer a small number of questionnaires (in addition to this one) during the analysis period, including one before you start to use the app.
8) Inform us if you use the app in another car to the one which you normally drive (for example a rented vehicle or one belonging to your employer).

If you agree to the above in principle, please proceed with the selection questionnaire which is being sent to you as a separate document.

Filling the questionnaire only registers your interest and eligibility. It does not commit you to anything.

What happens next?

We will reply to you within one week, based on your questionnaire answers.

If you are selected, we will contact you to explain the next steps and send you the privacy/consent form. If you agree to continue, you should sign this.

Thank you for your interest!

For more information or any questions, please contact Sébastien Faye at LIST, tel.: +33 6 01 19 51 01 (mobile) / +352 275 888 4909 (work), email sebastien.faye@list.lu

8.2 Driver information and consent form, ramp-up (example of Luxembourg)

modales

Adapting driver behaviour
for lower emissions

MODALES On-road trials: Driver information and consent form (pilot ramp-up phase in Luxembourg)

This document describes the purpose of the on-road trials in the MODALES project.

As a participant, it informs you what is expected, how the data will be used, and your rights.

We ask that participants who agree to this trial sign the form together with their local MODALES partner, the Luxembourg Institute of Science and Technology (hereafter "LIST"), which organises the trial in Luxembourg.

Version 0.5 (Luxembourg, English), Date: 30/03/2021.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 815189.

Information about the MODALES pilot and Frequently Asked Questions (FAQ)

1. About the MODALES study

The project's name is **MODALES**. This is an acronym (in English) for "**Mod**ify **D**river behaviour to **A**dapt for **L**ower **E**mission**s**".

The project's website (in English) is https://modales-project.eu

The project is coordinated by ERTICO in Brussels - https://ertico.com

The local partner responsible for the Luxembourg pilot site is the Luxembourg Institute of Science and Technology (LIST), https://www.list.lu

The full list of partners in MODALES can be seen here: https://modales-project.eu/about

The full list of pilot sites in MODALES can be seen here: https://modales-project.eu/pilot-sites

MODALES is a 3-year European Union funded project aimed at reducing air pollution from all types of road vehicles by encouraging adoption of low-emission driving behaviour and good maintenance practices. This includes reducing emissions not only from the vehicle exhaust (for petrol and diesel vehicles) but also particle emissions from brakes and tyres. Reducing such emissions helps improve air quality, especially in urban areas, as well as reducing wear and tear on vehicle components as well as reduced fuel use, so saving the driver money.

MODALES proposes a user-centric approach by researching, developing and testing a number of innovative and complementary solutions. These include a smartphone app which has been developed (and is being further improved) to help drivers reduce their emissions. This will be accompanied by a short online training session.

2. Participation in the MODALES demonstrations

The MODALES app and training will be tested by drivers in 8 pilot sites in Europe. The trials will involve private motorists driving their own car as well as professional drivers (taxis, vans, heavy vehicles). The purpose is to test the low-emission driving app over a long period (several months) in a variety of different situations (countries, road types, vehicle types) with a variety of different drivers (age groups, gender, driving style, level of driving experience). Volunteer drivers will be asked about their experience using the app as well as the associated short training session, and we will also collect data on driving styles using the app compared with before.

The part in which you are invited to participate is much shorter: it is the pilot (ramp-up) phase of the demonstrations, which will last only one month. The purpose is to test the recruitment procedure, the use of the app when driving, and get feedback via questionnaires that could help us improve the app or our process and identify any problems before the main trials start.

You will download a first version of the MODALES app on your smartphone.

We will provide you with device called an OBD dongle, which is plugged into the OBD connector in your car. OBD stands for On-Board Diagnostics and the connector allows data on the functioning of the engine and other vehicle systems to be collected from the vehicle's on-board computer. This will collect information on driving style such as speed, gear use, brake use, etc., but it will not affect the electronics or operation of your car in any way.

You will be asked to drive normally for a period of 1 month with the OBD dongle and smartphone connected each time you drive your car. No specific routes/itineraries or driving styles are needed, just your normal car trips whether for work or personal/leisure reasons, both short local trips and longer distance trips. The app will collect information on your driving as well as GPS location data, so that we can analyse how well it works.

At this first pilot stage, the app will not provide advice or feedback on your driving, and we will not assess your driving. It is only to test the functionality of the app, to help calibrate it and improve it, as well as to test our on-road trial procedures.

3. My participation

You have been selected to take part on the basis of your answers to the selection questionnaire.

The pilot ramp-up will include only a small number of internal staff from MODALES partners LIST (Luxembourg) and ACASA-RACC (Barcelona).

Your participation is voluntary, and you are free to withdraw your participation at any time, without explanation.

4. What will happen if I take part?

During this data collection campaign, the user will be asked to use a mobile application for low-emission driving (DALED, provisional name). In the present study, this app will only be used to collect preliminary data and train models recommend attitudes to adopt or to avoid. Each time users pick up their car, and if possible, they will be asked to open the mobile application and start the data collection. In case of problems, the people indicated at the bottom of this form can be contacted directly by email.

All this data collection will contribute to the calibration and the further development of DALED, so that this tool assist users throughout their journeys, providing recommendations as they travel, and in ways that won't interfere with their driving. The app is developed natively for Android and iOS.

Instructions for using the app are the following:

1. **Phone setup:** Phones should, if possible, be fixed in the car using a "car phone holder" so that you can have a comfortable view of the phone's interface, as well as for the proper recording of data.
2. **Downloading and installing:** The application is available at the following URL. Please download the file and install it.
3. **Opening the application for the first time:** When opened the first time, the application will require you to approve various authorizations. Afterward, you will have to fill in a form with your information. Please insert the code you received during the training in the "User ID" field.
4. **Button bar:** The main screen of the application shows a button bar at the bottom to access the "Journey" section (🚘) and the "Settings" section (⚙).
5. **Journey:** In the Journey section, press the green play button to start the data collection. A red stop button will replace the green play button. Press the red stop button to end the data collection. The journey section also shows the OBD Dongle and Vehicle status bars. Press the gear button on each status bar to configure the corresponding features. Please note that some of the settings might be blocked during a journey.

6. **Configuring the OBD Dongle (optional):** If you have an OBD Dongle, you need to configure it first, as follows:
   a) Before starting, make sure that your phone has Bluetooth turned on.
   b) To connect to the OBD Dongle for the first time, you need to "pair" the dongle to the phone. You can do the pairing on the phone's Bluetooth menu or inside our application in the OBD Dongle setting screen. The OBD Dongle needs to be in discovery mode (e.g., on the OBDLink MX+, you can find a small button, keep it pressed until the blue light starts to blink).
   c) In the application, you can press the "Scan" button to search for the OBD Dongle, and when it appears on the screen, press the (+) to do the pairing.
   d) After pairing, you can press the (▶) to connect to the OBD Dongle for the first time. The application will attempt a connection to the last used OBD Dongle every time you start a journey (if Bluetooth is enabled).
   e) We recommend starting a journey after the vehicle ignition is on to avoid errors.
7. **Configuring the vehicle (optional):** The "Garage" section shows all the vehicles you have registered in the application. You can edit (✎), select (▶) and delete (🗑) each vehicle, or create new vehicles (+). The application always needs one vehicle selected, and you cannot delete the selected vehicle. The application begins with a selected vehicle called "default vehicle" with empty details that you can complete. While creating or editing a vehicle, the application shows a form with all the vehicle details. When you connect an OBD Dongle, the application will try to obtain the Vehicle Identification Number (VIN), and if possible, will try to select a vehicle containing the VIN or will create a new vehicle including the VIN.
8. **Configuring other parameters (optional):** If you want to change other aspects of the application, please check the "Settings" section (⚙).
9. **Reporting an issue (optional):** In case of problems, please contact the project team.

This procedure will be carried by the participants, to be recruited by email internally by LIST. This procedure is to be done (ideally) for each trip, and during a total duration of 2 weeks. The researchers in charge of following the procedure are the following: S. Faye (main contact point: sebastien.faye@list.lu), R. Camino and U. Roth (LIST).

5. How will my data be used?

How will my data be collected?	Your personal data will be collected via two different channels: 1. The questionnaire you are asked to complete and send back to LIST; 2. The MODALES app and the OBD dongle, that will collect data in the course of your driving activities.
How will my data be stored?	The personal data collected via the questionnaire will be stored separately from the driving data, that are collect via the app and the OBD dongle. This will avoid any reidentification of the dataset related to your driving activity. The personal data collected via the questionnaire will be saved on a server located at LIST's premises, that will only be accessible to the LIST research team and will not be shared with any of the research partners. The driving data collected via the app and the OBD dongle will be stored on a separate server at LIST's premises; in this case, a secured access to this data will be given to the MODALES research partners.

How long will my data be stored for?	All the data we collect about you (both personal and driving data) will be permanently deleted on 31/12/2021 at the latest.
What measures are in place to protect the security and confidentiality of my data?	All datasets collected through the mobile application will be stored in secured server at LIST, accessible only by the project partners and LIST. LIST's server will provide the following services: authentication, session management and data management (create, read, update or remove aggregated information from trips, vehicles, and the user profile). This server will also periodically send the database to a backup server. Secure access (SSL certificate) will be used. LIST's Data Protection Officer (DPO) ensured compliance of the mobile application with the General Data Protection Regulation (GDPR). Alongside with the support of LIST's DPO and Security team, the project team will implement data protection and security by design and apply all basic security principles regarding the encryption of communications, storage, and what follows.
Will my data be anonymised?	Yes, your data will be anonymised. As explained above, the data collected via the questionnaire will be stored in a separate folder with limited access, in order to avoid any connection between the two datasets. In addition to this, we will link each dataset containing your driving data with a unique and anonymous identifier. This will allow us to retrieve your data (for example, if we receive a request from you), without the need to link them back to your name, surname and contact details.
How will my data be used?	Your data will be solely used for the purpose of the project, which is to study low-emission driving behaviour.
Who will have access to my data?	Personal data: local partner only (LIST) GPS data: local partner and LIST Driving data: all MODALES partners (anonymised)
Will my data be archived for use in other research projects in the future?	No, the data collected in this ramp-up phase will be deleted on 31/12/2021 at the latest.
How will my data be destroyed?	All the data will be destroyed, be it from LIST/the project server's database, backups. Local copies made by individual partners of the consortium will also be removed.

<u>Transferring data outside the EU</u>

Please be informed that we will not transfer any personal data outside the European Union.

6. Expenses

MODALES is unable to provide payment for participation in this trial.

We do not expect you to incur any expenses. The driving you will do is simply the normal trips you would make anyway. No particular extra driving or fixed conditions (routes, times) are requested.

If you do not already have a Smartphone holder in your car, we can supply one.

7. Are there any risks in taking part?

When taking part to the project, we ask you to fully concentrate on the driving, without letting the app distracting you.

In addition to this, LIST will provide you with OBD dongles, that have been granted the following certification in the European Union: CE (ETSI EN 300 328 V1.8.1 (2012-06), E-mark ECE R10, EN 60950-1.

LIST will not be held responsible for any accident or damage caused by inattentive or careless driving nor for any misuse of the ODB dongles.

8. Are there any benefits in taking part?

The aim of this research project is to reduce emissions caused by car and to contribute to an overall improvement in air quality.

The data collected within the Project will not be used or processed for direct commercial purposes.

9. What will happen to the results of the study?

The results of the ramp-up phase will be used to calibrate the larger scale collection campaign that will be launched in the following months.

The driving data collected in the course of the Project will serve to develop advanced recommendation models and other general scientific purposes of the Project. The results may be published in scientific papers; however, please note that such publications will not involve nor contain any of your personal data.

10. What will happen if I want to stop taking part?

You can decide to withdraw your consent at any time, without explanation.

If you agree to this, we will process the results related to your participation up until the moment of withdrawal. However, you have the right to request the deletion of your personal data collected via the questionnaire or of the results and that no further use is made of them.

In case you want to have your driving data deleted, please be informed that you will have to provide us with your unique identifier, that LIST will provide you when you download the app. Without the unique identifier, it will not be possible for us to re-identify your driving data and, therefore, to perform such deletion.

11. What if I am unhappy or if there is a problem? Who can I contact?

If you are unhappy, or if there is a problem, please let us know by contacting your local partner: Sébastien Faye, sebastien.faye@list.lu at LIST, 5, Avenue des Hauts-Fourneaux, 4362 Esch-sur-Alzette, Grand-Duchy of Luxembourg.

If you remain unhappy, if you get no response from the above person, or if you have a complaint which you feel you cannot raise with the above person, then you should contact the MODALES Data Protection Officer, Dr Haibo Chen, University of Leeds, UK, h.chen@its.leeds.ac.uk . He will then raise the issue with the MODALES Ethics and Privacy Board.

For any concern or complaint, please provide details of the name of the project (MODALES), your city and country, and the details of the comment or complaint you wish to make.

Participant consent form

Version number & date:

Title of the research project: **MODALES**

Name of researcher: **LIST**

1. I confirm that I have read and have understood the above information for the above study. I have had the opportunity to consider the information, ask questions and have had these answered satisfactorily.
2. I understand that taking part in the study involves a collection of driving data performed via the MODALES app and the OBD dongle.
3. I understand that my participation is voluntary and that I am free to stop taking part and can withdraw from the study at any time without giving any reason and without my rights being affected. In addition, I understand that I am free to decline to answer any particular question, or questions.
4. I understand that I can ask for access to the information I provide, and I can request the destruction of that information if I wish at any time.
5. I understand that the information I provide will be held securely and in line with the EU data protection requirements until it is fully anonymised and then deposited in the MODALES project archive (without including my identity) for sharing and use by other authorised researchers to support other research in the future.
6. I understand that signed consent forms, data and questionnaires will be retained in databases operated by LIST (Esch sur Alzette, Luxembourg) and on secured servers, that will be accessible only to authorized personnel of LIST until 31/12/2021.
7. I agree that my anonymised data can be shared for research publication purposes (publication, reports, etc.).

I agree to take part in the above study, and subsequently to all the points mentioned above.

Participant name: Date:

Signature:

Name of person taking consent: Date:

Signature:

Principal Investigator LIST: **Sébastien Faye**
Luxembourg Institute of Science and Technology
5, avenue des Hauts-Fourneaux
L-4362, Esch-sur-Alzette
Grand-Duchy of Luxembourg

Tel: **+352 275 888 4909**
Email: sebastien.faye@list.lu

8.3 Invitation to fleet operators

INVITATION TO FLEET OPERATORS TO BE PART OF THE TESTING OF OUR LOW-EMISSION DRIVING APP

modales

Adapting driver behaviour
for lower emissions

MODALES is a European Union funded research project to help drivers of all kinds of road vehicles to reduce their emissions. We are developing a **Smartphone app for low-emission driving** and associated training, which will be tested in several countries during summer and autumn 2021.

We invite passenger and freight transport operators in Europe to join these on-road trials, in order to:

- Assess the driving style of your drivers with respect to emissions from the engine, brakes and tyres of your trucks, vans, buses, coaches or taxis
- Benefit from low-emission training and recommendations to your drivers
- Let your drivers provide feedback on our systems
- Learn from results of our on-road trials and incorporate best practice elements from MODALES into your own internal training and support systems
- Be recognised as a MODALES Associate Partner (acknowledgement in the project's online media and at events), showing that your company cares about reducing emissions.

What is this about?

The European research project MODALES is developing an app to help drivers reduce their vehicle emissions, as well as a short associated training session. The scope is:

- **Older vehicles, 5 or more years old, which run on conventional fuel (petrol or diesel)**. This is because new vehicles (also electric and other alternative fuelled vehicles) already have low emissions and the scope to further improve using a driving app is much smaller.
- **Cars, taxis, buses, coaches, vans, trucks and Non-Road Mobile Machinery** (NRMM, for example diggers). Not motorcycles or other light vehicles (due to difficulty in positioning a Smartphone app which can be used while driving).

Part of the development is to test and demonstrate the app with drivers in different parts of Europe. Proposed test sites are as follows:

- Barcelona, Spain
- Bergamo, Italy
- Bucharest, Romania
- Helsinki, Finland
- Istanbul, Turkey
- Leeds, UK
- Luxembourg
- Thessaloniki, Greece

However, interest from transport operators in other cities or countries will be considered wherever practical.

The MODALES partners are looking for volunteers to test the app and training over a period of a few months, while doing their normal driving activities (whether for personal or professional trips). No special extra trips will be required. This involves a baseline over around two months (driving normally with the app and a dongle fitted to the vehicle, to collect information only), then – following a short online training session – driving for two to three months using the app which will give low-emission driving advice, recommendations and feedback.

The project is recruiting private car drivers separately in the above eight cities, but we are also looking for drivers of commercial vehicles. So we are looking to partner with:

- Freight and logistics operators
- Delivery companies
- Bus and coach operators
- Taxi companies.

We would like your company to participate in the before and after trials of the app and training, with different drivers (where possible, from different age groups, genders and level of driving experience).

The app and training will be made available in the language of the country where the trial will take place. The local partners in the eight cities above will manage the trials and administer user questionnaires in the national language.

Personal data is not linked to driving data and personal privacy is respected at all times.

What is MODALES?

MODALES is a 3-year European Union funded project aimed at reducing air pollution from all types of road vehicles by encouraging adoption of low-emission driving behaviour and good maintenance practices. This includes reducing emissions not only from the vehicle exhaust (for petrol and diesel vehicles) but also particle emissions from brakes and tyres. Reducing such emissions helps improve air quality, especially in urban areas, as well as reducing wear and tear on vehicle components as well as reduced fuel use, so saving the driver money.

The project is a partnership covering nine countries: Belgium, Finland, France, Greece, Italy, Luxembourg, Spain, Turkey and the United Kingdom. The project runs from September 2019 to August 2022.

MODALES proposes a user-centric approach by researching, developing and testing a number of innovative and complementary solutions. These include a smartphone app which has been developed (and is being further improved) to help drivers reduce their emissions.

Further information about MODALES (in English only), its activities, the partners, and recent news, is available at https://modales-project.eu

How does my company participate?

Firstly, please get in contact with your local partner to discuss the number and types of vehicles you would be willing to use, the types of driving duties (urban, interurban, fixed routes such as bus lines or variable driving), and the number of drivers who are likely to participate. See the end of this document for your local contact points.

The MODALES project partners will select interested companies that help meet our criteria for a balanced number of different types of vehicles, and according to their physical location (availability of a local partner to liaise with, and whether the local or national language can be covered by the project team).

When agreed by the project partners, a Memorandum of Understanding will be proposed, agreed and signed between the MODALES consortium (represented by the local partner and the Coordinator: ERTICO) and your company. This will specify the aims and objectives, what is expected from both parties, the expected duration, data management and privacy, etc. There will be no payment in either direction.

Involved drivers will first complete a short selection questionnaire and sign a consent form, informing them of their rights and how the data will be collected, used and stored. These will be in your national language.

For the practical trials, we will provide an OBD dongle for each vehicle, which is plugged into the OBD connector in the vehicle. OBD stands for On-Board Diagnostics and the connector allows data on the functioning of the engine and other vehicle systems to be collected from the vehicle's on-board computer. This will collect information on driving style such as speed, gear use, brake use, etc., but it will not affect the electronics or operation of the vehicle. We will need to check what vehicle type(s) you use to ensure they are compatible.

Your drivers will also be asked to download the MODALES app on their smartphone. They will drive for approximately two months (time depending on total kilometres driven) with the app linked to the dongle by Bluetooth and in data collection mode only (baseline, with no driving advice or feedback). The driving will be your employees' regular driving duties as part of their normal work.

Drivers will complete a baseline questionnaire.

Drivers should not let the app distract from their normal driving. It should be in a hands-free holder.

From late August 2021 onwards, a short online training will be provided to your drivers. They will then download the updated version of the app which will provide driving advice and feedback. The advice will include real-time elements that may be switched on or off, depending on need (and to avoid excessive distraction).

Data collected by the app and OBD dongle will be transmitted to the MODALES project team anonymously. Only the local partner will know the identity of the drivers, and this will only be used to contact them and will not be linked to their driving data.

Drivers will also complete periodical questionnaires (maximum of four) on their experiences using the app, feedback on their attitudes and to what extent it has helped them drive differently.

What's in it for my company?

By signing a Memorandum of Understanding and agreeing to participate in our trials, your business will be an Associate Partner of the MODALES project. Although no payment is possible, we can provide:

- Training and driver support for your drivers
- Data on driving behaviour (before and after training and app) from your drivers
- Benefit from the results of our trials: what are the lessons learnt and quick wins to reduce emissions while driving?
- Promote safer, less polluting and more fuel-efficient driving among your employees.
- Recognition of your company's participation (logo, news article) on the MODALES website (http://modales-project.eu) and other media such as that of your local partner, the ERTICO Newsroom (news on Intelligent Transport Systems in Europe: https://erticonetwork.com), as well as in project presentations in online and physical events.

You will also be showing your company's green credentials by supporting this important European research activity.

My company already provides eco-driving support to its drivers. What's the difference?

Eco-driving focuses on reducing Carbon Dioxide (CO_2) emissions, and therefore promotes driving styles that reduce fuel use. Several previous research and development projects have focused on this topic and different apps, training and other support for eco-driving are commercially available.

MODALES goes beyond this by looking at how driving behaviour affects other types of emissions, notably those leading to pollution such as Particle Matter (PM) and Nitrogen Oxides (NO_X). This includes not only exhaust emissions but also particle emissions from brakes and tyres.

Many aspects of low-emission driving will be similar to eco-driving, but some will be different. One of the objectives of MODALES is to establish the difference and how training and an app can not only reduce fuel use and CO_2 emissions, but also pollutant emissions from all parts of the vehicle.

We recognise that the MODALES Smartphone app is the result of a research project and cannot therefore be directly compared to commercially available eco-driving applications. However, our app will be made available free to companies and other users with whom we sign an agreement, both during the test phase and after the project.

In case your company already uses an in-cab driving assistance application (such as an eco-driving or fleet management system), we can use the MODALES app just to collect driving information and not to advise the driver. This is to avoid driver information overload or conflicting advice. We do not wish to interfere with or override any system your drivers currently use. We can discuss possible options with transport operators that already use a driver support or monitoring system.

What happens to my drivers' data? How is privacy respected?

The project team will then analyse any changes in driving behaviour from the baseline period (without the app) to the period when you use the app. We can also provide a summary of this analysis for drivers who request it. The objective is to analyse how different drivers behaviour changes due to the app. **It is not to evaluate how good or bad someone is at driving.**

The data collected will include driving elements such as speed and gear selection. **This data will only be used for the MODALES trial to evaluate the app. It will not be shared with any authority or anyone else outside this project, unless in exceptional circumstances as required by law (for example as evidence in case of a collision, if required by police or court of law: this is a legal obligation).**

Your local partner will use your drivers' contact data (name, email, telephone number) only to contact them about these trials and these personal details will not be linked to their driving data. **Driving data for each participant will be treated in an anonymous way**, using a unique number for each driver, which does not allow any individual to be identified. Only the age group, gender, driving experience (novice, mid, experienced), vehicle type (car, bus, van, truck) and the city/region will be linked to their driving data.

Drivers and the MODALES local partner will **sign an agreement** which details what data will be collected, how it will be used, how we will protect your privacy, what we will ask you to do, and how to contact us in case of questions or problems.

Unfortunately we cannot pay any of the trial participants. However it will require very little time from them and involve no expenses. Minimal administration support from your company would be needed to select and recruit drivers.

How to get in touch

For more information and to express your interest, please contact one of the following partners:

Country		MODALES local partner	Contact person
If your company is a member of **IRU** (International Road Transport Union)	Anywhere in Europe	IRU	**Ted Zotos** ted.zotos@iru.org
If your company is ***not*** a member of IRU, please contact your local partner as follows:			
	Ελλάδα	CERTH CENTRE FOR RESEARCH & TECHNOLOGY HELLAS	**Dimitris Margaritis** dmarg@certh.gr
	España	RACC	**Joan Domingo** joan.domingo@racc.es
	Italia	brembo	**Matteo Federici** matteo_federici@brembo.it
	Luxembourg	LUXEMBOURG INSTITUTE OF SCIENCE AND TECHNOLOGY LIST	**Sébastien Faye** sebastien.faye@list.lu
	Suomi	VTT	**Juhani Laurikko** juhani.laurikko@vtt.fi
	Türkiye	OKAN ÜNİVERSİTESİ İSTANBUL	**Orhan Alankuş** orhan.alankus@okan.edu.tr
	United Kingdom	UNIVERSITY OF LEEDS	**Haibo Chen** h.chen@its.leeds.ac.uk
	Other countries in Europe	ERTICO	**Andrew Winder** a.winder@mail.ertico.com

8.4 Baseline questionnaire

Adapting driver behaviour for lower emissions

On-road Trials of low-emission driving app and training:

User Selection Questionnaire (for private car drivers)

Introduction

Thank you for considering taking part in the driving trials as part of the European project MODALES.

Please read the short description of the project and overview of the on-road trials, before completing this questionnaire.

This questionnaire will allow us to select the participants for these on-road tests. We aim to have a range of different drivers (gender, age group and level of driving experience) as well as different types of cars. Mostly for this trial, we aim for mid-age cars, around 5 to 15 years old.

Please answer the questionnaire honestly. Your responses will only be used to decide if you (and your car) can be part of the trial. Your answers will not be shared with anyone outside the small number of experts working on the MODALES project. Your contact details will only be accessible to the local partner (name of partner) in order to contact you, and will not be divulged to others (including not to other project partners).

We cannot select every candidate because we need a range of different profiles (person/driver type and car type/age). If you are accepted, we will respond to explain the next steps. If we cannot accept you, or if we accept you but you subsequently decline to participate, we will also delete all the data you have supplied.

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 815189.

Personal data

1.1: Your name:

Salutation Choose an item.

Family name: Family name

First name: First (given) name(s)

1.2: Contact details:

Email: @

Contact telephone number (mobile): Click here to enter text.

Contact telephone number (other): Click here to enter text. Is this number: Choose an item.

The above information will only be used by the local partner to contact you about this trial and it will not be linked to your personal and driving profiles or vehicle type (below).

Your personal and driving profiles and your vehicle characteristics will be shared among the MODALES project partners, but in an anonymous way (without your name or contact information).

Personal Profile

2.1: In which municipality (commune) do you live?

Place name Post code

2.2: What is your age group? 50-64 years

2.3: What is your gender? Click here to enter text.

Smartphone use

3.1: What kind of mobile phone (Smartphone) do you have and how old is it?

If you have more than one mobile phone, please give the details of the one you would intend to use with the MODALES app while driving.

Make: Click here to enter text.

Model: Click here to enter text.

Operating system (e.g. Android, iOS): Click here to enter text.

3.2: Do you ever connect your smartphone to your car? (for data such as navigation or making hands-free calls; not just for charging) Choose an item.

3.3: How often do you use Smartphone apps? Choose an item.

Driving profile

4.1: In which year and in which country did your pass your driving test?

Please answer for the first time you passed a car driving test. If you have passed another kind of test for example motorcycle or heavy vehicle, do not count this.

Year: Click here to enter text. Country: Click here to enter text.

If you have passed a car driving test more than once, for example in different country or if you needed to do a new test to get back a licence that was suspended, please add the year(s) and country of your later test(s): Click here to enter text.

4.2: Approximately how many kilometres do you drive in a typical year in your own car?

Choose an item.

You can estimate your annual driving distance, or the vehicle's odometer reading may be shown on your annual car test certificate.

If you drove much less than usual during 2020 due to Coronavirus (COVID-19) restrictions, please give an estimate for a previous year like 2019 or 2018.

4.3: Do you also regularly drive another vehicle as well as your own car?

☐Yes, another car belonging to me or someone in my household, for personal use

☐Yes, a motorcycle belonging to me or someone in my household, for personal use

☐Yes, another car, van or taxi, as part of my work

☐Yes, a heavy vehicle (truck or bus), as part of my work

☐No

4.4: How often do you drive for the following purposes?

Commuting (travelling to and from work or education) Choose an item.

Professional business (driving as part of your job, including going to meetings, etc.) Choose an item.

Personal business (such as shopping or other essential trips) Choose an item.

Leisure (including visiting, day or weekend trips, holidays) Choose an item.

Vehicle characteristics

5.1: What type of car do you have?

If you have more than one car, just give the one you use most, which should be the one that you will drive as part of this trial.

1) Make (for example: Ford, VW, Renault): Click here to enter text.
2) Model (for example: Fiesta, Golf, Clio): Click here to enter text.
3) Engine size: Click here to enter text.
4) Transmission type:
5) Fuel type: Choose an item.

5.2: In what year was the car first registered? Click here to enter text.

Please return this form by email to …

Thank you very much for your answers.

We will be in contact by email within one week.

Adapting driver behaviour for lower emissions

MODALES On-road trials: Frequently Asked Questions (FAQ), including data protection

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 815189.

About the project

What is MODALES?

MODALES is a European Union funded research and innovation project aimed at reducing air pollution from road vehicles. MODALES is an acronym (in English) for "**Mod**ify **D**river behaviour to **A**dapt for **L**ower **E**mission**s**".

The project lasts 3 years, from September 2019 to August 2022. It is carried out by 16 European partners including national research institutes, universities, associations and industry.

The project's website (in English) is https://modales-project.eu

What are the objectives of MODALES?

MODALES is researching and demonstrating several ways to reduce air pollution from all types of road vehicles by encouraging adoption of low-emission driving behaviour and good maintenance practices. This includes reducing emissions not only from the vehicle exhaust (for petrol and diesel vehicles) but also particle emissions from brakes and tyres. Reducing such emissions helps improve air quality, especially in urban areas, as well as reducing wear and tear on vehicle components as well as reduced fuel use, so saving the driver money.

MODALES is working on a user-centric approach by researching, developing and testing a number of innovative and complementary solutions. These include a smartphone app which has been developed (and is being further improved) to help drivers reduce their emissions. This will be accompanied by a short online training session.

Who is involved in MODALES?

The project is coordinated by ERTICO – ITS Europe (European Road Transport Telematics Implementation Coordination Organisation), Avenue Louise 326, B-1050 Brussels, Belgium - https://ertico.com.

In total, there are 16 full (EU-funded) partners in MODALES. In addition to the coordinator, ERTICO, the other 15 are:

- ACASA – Automobil Club Assistència /RACC Mobility Club, Barcelona, Spain
- Brembo S.p.A., Bergamo, Italy,
- Bridgestone Europe, Rome, Italy
- Cerema – Centre d'études et d'expertise sur les risques, l'environnement, la mobilité et l'aménagement, Toulouse, France,
- CERTH – Hellenic Institute of Transport, Thessaloniki, Greece
- Dynnoteq Ltd, Kington, Herefordshire, UK
- FIA – Fédération Internationale de l'Automobile, Paris, France
- IRU – International Road Transport Union, Geneva, Switzerland
- LIST – Luxembourg Institute of Science and Technology, Esch sur Alzette, Luxembourg
- Michelin, Clermont-Ferrand, France
- Okan University, Istanbul, Turkey,
- Proventia Oy, Oulu, Finland

- Spark Legal Network (EU) bvba, Brussels, Belgium
- University of Leeds, Leeds, UK
- VTT – Technical Research Centre of Finland, Espoo, Finland

In addition there are two self-funded partners in China: Southeast University and Nanjing Sample Technology. These partners will conduct similar on-road trials in China, but data sets from the European trials will not be shared with these partners. In particular, no personal data will be transferred to any entity outside Europe.

The full list of partners in MODALES can be seen here: https://modales-project.eu/about

About the on-road trials

What is the purpose of the MODALES on-road trials?

The MODALES app and training will be tested by drivers in at least eight trial sites (between 30 and 50 drivers per site). The trials will involve private motorists driving their own car as well as professional drivers (taxis, vans, heavy vehicles).

The purpose is to test the low-emission driving app over a period of a few months in a variety of different situations (countries, road types, vehicle types) with a variety of different drivers (age groups, gender, driving style, level of driving experience).

The full list of pilot sites in MODALES can be seen here: https://modales-project.eu/pilot-sites

Participants will drive for a period of one or two months using the MODALES app and OBD dongle (see FAQ items below) in data collection mode only, to measure their normal driving style. This is called the baseline. They will then have a short online training session and download an updated version of the app, which will provide on-trip and post-trip tips and feedback for reducing driving emissions.

Drivers will be asked about their experience using the app as well as the associated short training session, and we will also collect data on driving styles using the app compared with before.

What are the benefits and costs of taking part?

The aim of this research project is to reduce emissions caused by car and to contribute to an overall improvement in air quality.

Participants will benefit from a short online training session on low-emission driving and free use of the MODALES app. For drivers who do not have a Smartphone holder for their car, the project can provide one.

Participants will not have any expenses. They will simply drive for the normal trips that they would make anyway. No particular extra driving or fixed conditions (routes, times) are requested.

The only time required would be to:

- Read and agree to the consent form for the trials;
- Download and configure the MODALES app (instructions will be given);
- Plug the OBD dongle that the project will provide into the car (instructions will be given);
- Participate in the online training (expected maximum two sessions, less than half an hour);
- Answer periodic online questionnaires (four expected, maximum 10 minutes each).

MODALES is unable to provide payment for participation in this trial. However for some trial sites, a small incentive will be offered to participants who continue to the end of the trial period. The local partner for each trial site will provide details.

The data collected within the project will not be used or processed for direct commercial purposes.

What is the MODALES app?

The MODALES app is a Smartphone application (available in Android and iOS versions), developed by the project partner LIST (Luxembourg Institute of Science and Technology). It collects certain driving data from the smartphone sensors and from the vehicle's On-Board Diagnostics (OBD) which is the car's on-board computer, such as speed and acceleration. It also monitors these together with situational data such as the road type (urban, rural, motorway, flat, hilly, etc.). It monitors driving and provides suggestions and feedback in order to lower emissions.

The app is used on the driver's personal smartphone and should be fixed using a hands-free car phone holder, so that it can be seen comfortably without distracting the driver. This is also necessary for the app to correctly record driving data.

The app is a research prototype and not a commercial application. It is therefore different to other eco-driving and clean driving applications and software available on the market.

The app will be made available in the languages of the trial sites. Initially, these will be English, Finnish, French, Greek, Italian, Spanish and Turkish.

Instructions for downloading, configuring and using the app will be provided separately to trial participants.

What is an OBD dongle?

An OBD dongle is a connector to the On-Board Diagnostics of the vehicle. It is a small plug that MODALES will provide to trial participants, which they plug into the OBD connector in their car. It allows data on the functioning of the engine and other vehicle systems to be collected from the vehicle's on-board computer. This will collect information on driving style such as speed, gear use, brake use, etc., but it will not affect the electronics or operation of the car in any way.

Instructions for receiving, fitting and using the OBD dongle will be provided separately to trial participants.

Are there any risks in taking part?

When taking part to the project, we ask you to fully concentrate on the driving, without letting the app distracting you.

In addition to this, your local partner will provide you with OBD dongles that have been granted the following certification in the European Union: CE (ETSI EN 300 328 V1.8.1 (2012-06), E-mark ECE R10, EN 60950-1.

Neither the local partner nor the MODALES project can be held responsible for any accident or damage caused by inattentive or careless driving nor for any misuse of the OBD dongles.

What will happen to the results of the study?

The driving data collected in the course of the MODALES project will serve to develop advanced recommendation models and other general scientific purposes of the Project. The results may be published in scientific papers; however, please note that such publications will not involve nor contain any personal data of the participants.

Can participants stop taking part?

Participants can decide to withdraw their consent at any time, without explanation.

In such cases, the project will process the results related to their participation up until the moment of withdrawal.

Personal data of any participant withdrawing will also be deleted.

Data protection and use

Who is responsible for data in the MODALES trials?

ERTICO (MODALES Project Coordinator) is the Controller of this data processing and will have the overall responsibility for data management and determine the purposes and means of the collection and processing of personal data in the project.

The local partner responsible for each country trial site acts as Data Processor according to Art. 28 of GDPR (EU General Data Protection Regulations).

The local partners (Data Processors and also joint Data Controllers) for the trials involving car drivers are:

- Finland: VTT – Technical Research Centre of Finland
- Greece: CERTH/HIT – Centre for Research and Technology Hellas / Hellenic Institute of Transport
- Italy: Brembo S.p.A.
- Luxembourg: LIST – Luxembourg Institute of Science and Technology
- Spain: Automobil Club Assistència /RACC Mobility Club
- Turkey: Istanbul Okan University
- United Kingdom: University of Leeds.

In addition, different partners in Europe (see FAQ 3: Who is involved in MODALES?) will be involved in data analysis, but this analysis will not involve any personal or contact data that would allow an individual driver to be identified.

What personal data of drivers will be collected, who can access it and how will it be used?

The following personal data is asked in the selection questionnaire and **this will be held only by the local partner for the sole purpose of contacting the participant for the MODALES on-road trials**:

- Name (first, family)
- Email address
- Telephone number.

These details will not be divulged to any other MODALES partner, to any outside body, or used for any other purpose. After the end of the driver's participation (and by 31/12/2021 at the latest), these personal details will be permanently deleted.

Other details collected include:

- Municipality of residence (town or city only, not full address) and postcode
- Gender
- Age group (for example 30 to 49, 50 to 64), not precise age
- Level of driving experience (year driving test was passed)
- The make, model and age of car you drive.

These data will be used by different MODALES partners as part of the analysis, to assess the usage and feedback on the app and training by men and women of different age groups in different cities and using different types of cars.

The data that can be accessed by MODALES partners for the analysis would, for example, show that a certain participant is female, aged 50 to 64 years, lives in Luxembourg and drives a 7 year-old Volkswagen Golf. However it would not allow her to be identified as an individual.

What other data will be collected, how will it be collected, and who will have access to it?

Other data will be collected by online questionnaires and via the MODALES app and the OBD dongle that will collect driving data.

This data will be associated with a personal "Participant Code" in order to preserve privacy and anonymity.

Data collected by questionnaire will include participants' attitudes and habits regarding driving, as well as opinions and feedback on the MODALES app and training.

Data collected through the MODALES app will be:

- **Manual inputs from the user**: information about his/her vehicles, participant code, gender (optional), birthdate (optional), licence date (optional)
- Raw data from the smartphone's **accelerometer and gyroscope**. This data will be used to compute and acceleration profile.
- **Activity data**, automatically computed locally on the phone to detect if the user is in a vehicle or not.
- **Anonymised Wi-Fi and Bluetooth data** collected **passively** from the other devices. This will be used for research purpose in order to detect the presence of a traffic jam or situational variables.
- **GPS positioning data**, which includes latitude, longitude and speed of the user collected at a regular sampling rate during the data collection. This GPS data will be sent to a server hosted by LIST in Luxembourg. It will be decoded and translated into anonymised indicators, including but not limited to: weather (e.g., temperature, humidity), road traffic (e.g., average traffic speed) and characteristics (e.g., slope, type of road) at each of the collected GPS data point. Only these decoded and anonymised indicators will be stored. All the GPS positioning data will

be removed. An external service, managed by Motion-S in Luxembourg, will be used for this decoding. Motion-S is not storing and information of any kind about the user and his location.

- **Vehicle information**, which will be retrieved through the Vehicle Identification Number (VIN) of the car used by the participant. This VIN will be collected automatically (if an OBD dongle is used) or manually (user input). The process and the conditions will be the same than for the GPS data. An external web service, vindecoder.eu, will be used to translate the VIN into useful and anonymised indicators. These indicators include, but are not limited to: make of the car, manufacturer, type of engine, vehicle type, etc.
- **OBD data**, collected through the OBD dongle. Various variables are collected, and heavily depend on the type of vehicles. Most common variales include, for instance: revolution per minute, gas pedal position, fuel consumption, vehicle speed, NOx emission, gear position at a given time.

Driving data (not personal data) will be able to be accessed by European partners involved in the project (see FAQ 3: Who is involved in MODALES?)

What is the “Participant Code”

Each participant will receive a unique code comprising letters (representing the trial city where they are located) and a sequential number.

The participant will enter this code (and not their name or email) when configuring the MODALES app and when answering questionnaires. In this way, the MODALES partners who receive this information can link the questionnaire responses to the driving data coming from the app for each person, but they will not know the identity of the participant (only the city or region where they live).

Only the local partner who received the participant’s contact details (to communicate about the trials in this project only) will know which code is which individual person. The local partner will not share this personal information with any other partner or anybody else.

How will my data be stored?

The personal data collected via the initial selection questionnaire will be stored separately from the driving data (that are collected via the app and the OBD dongle) and subsequent questionnaires. This will avoid any immediate re-identification of the dataset related to your driving activity.

The personal data collected via the questionnaire will be saved on a server located at the local partner for the participant’s trial site only, and it will only be accessible to that partner for the purposes of contacting the participant. It will not be shared with any of the other research partners. The local partner will only forward the questionnaire replies to other MODALES partners with the Participant Code and not with any personal data (name, address, email or telephone number).

The driving data collected via the app and the OBD dongle will be stored on a separate server at the premises of MODALES partner: the Luxembourg Institute of Science and Technology (LIST), ITIS Department, 5 avenue des Hauts-Fourneaux, L-4362 Esch-sur-Alzette, Luxembourg. A secured access to this pseudonymised data (with Participant Code only and no personal or contact data) will be given to the MODALES research partners listed under FAQ 3: “Who is involved in MODALES?”

For how long will my data be stored?

All personal data we collect will be permanently deleted on 31/08/2022 at the latest. Driving data of participants will be stored after this date but it will be completely anonymised.

In case, after analysing the Drivers Selection questionnaire, a potential participant is not selected as a volunteer in this project, or if a participant decides to withdraw, their personal data (collected through the questionnaire) will be deleted within 30 days by the local partner for their trial site.

What measures are in place to protect the security and confidentiality of participants' data?

All datasets collected through the mobile application will be stored on a secured server at the Luxembourg Institute of Science and Technology (LIST), accessible only by the project partners. This server will provide the following services: create, update or remove aggregated information from trips, vehicles, and the user profile. The information only flows from the mobile device to the server (there are no read operations). This server will also periodically send the database to a backup server. Secure access (SSL certificate) will be used. LIST's Data Protection Officer (DPO) ensured compliance of the mobile application with the General Data Protection Regulation (GDPR).

Alongside with the support of LIST's DPO and Security team, the project team will implement data protection and security by design and apply all basic security principles regarding the encryption of communications, storage, and what follows.

Will participants' data be anonymised?

Participants' driving data and questionnaire responses will be anonymised on or before 31/08/2022, and personal data erased. Until such date, participants' data will be pseudonymised.

Participants' contact data (first name, family name, email, telephone, the association of the participant's name to the unique identifier "Participant Code") will be processed and stored only by name of local partner in a specific folder/server, with limited access, in order to avoid any connection between the two datasets.

The data collected via the questionnaire (without any personal or contact data and identified only with the Participant Code) will be available to the MODALES partners involved in the data analysis. We will link each dataset containing participants' driving data, collected thorough the app, only with the Participant Code. This will allow the project partners to retrieve participants' data (for example, if a request is received from a driver), without the need to link this back to the participant's name and contact details.

How will participants' data be used? Will it be transferred outside Europe?

Data from participating drivers will only used for the purpose of the MODALES project.

For participants in EU countries, no personal data will be transferred outside the European Union. In fact personal data will not be transferred outside the local partner for the trial site (city/region) concerned.

Non-personalised driving data (not identifying the driver) will be shared between the European project partners, which include partners from EU Member States, Switzerland, Turkey and the United Kingdom.

What will happen to participants' data after the end of the MODALES project?

Driving data may also be used after the end of the project, as open data but only after proper anonymization process. Personal details will not be stored or archived after the period of this trial.

All personal data collected by the local partner will be destroyed on or before 31/08/2022. All data collected through the MODALES app, be it from /the project server's database or backups, will be fully anonymized on or before 31/08/2022. Local copies made by individual partners of the consortium will also be removed.

What are participants' rights according to applicable data protection rules?

Participant drivers, as "Data Subjects", have the rights contemplated in the GDPR (EU General Data Protection Regulations, articles from 15-21) in respect of the processing of data contemplated thereto, including the right to:

- Obtain confirmation of the existence of personal data concerning him/her and to gain access to them (right of access);
- Obtain the updating, modification and/or rectification of its personal data (right of rectification);
- Obtain erasure, or to set limits to processing, of personal data whose processing is unlawful, including those that are no longer necessary in relation to the purposes for which they were collected or otherwise processed (right to be forgotten and right to the restriction of processing);
- Object to processing (right to object);
- Withdraw previously given consent, if any, without prejudice to the lawfulness of processing based on that consent;
- Receive a copy in electronic form of the data concerning him or her which have been provided to a controller in the framework of an agreement and to have such data transmitted to another controller (right to data portability).

For the exercise of the rights above and in case of further requests for information regarding the present privacy notice, the participant driver can contact:

- the MODALES Data Protection Officer (DPO) by sending an email to Dr Haibo Chen, University of Leeds, UK, email: h.chen@its.leeds.ac.uk ,
- or by a registered letter to the legal address of the Controller (ERTICO, Avenue Louise 326, B-1050 Brussels, Belgium), to the attention of MODALES Project Coordinator.

Participant drivers (Data Subjects) may also lodge a complaint with the Supervisory Authority in case of infringement of regulations concerning the protection of personal data.

Who should participants contact if they are unhappy or if there is a problem?

Participants who have a question, problem or concern should first contact their local partner whose name, address, email and telephone number are in the participant consent form.

In case of no response or an unsatisfactory response from that partner, or in case of a complaint that the participant feels cannot be raised with that partner, they should contact the MODALES Data Protection Officer (DPO), Dr Haibo Chen, University of Leeds, UK, h.chen@its.leeds.ac.uk . He will then raise the issue with the MODALES Ethics and Privacy Board.

Any concern or complaint should include the name of the project (MODALES), your city and country, and the details of the comment or complaint.

8.6 User acceptance survey

Note that this questionnaire was made available in English, French, Spanish, Italian, Finnish, Greek, Turkish and Chinese.

☑ Save a backup on your local computer (disable if you are using a public/shared computer)

MODALES Training Video: Participant questionnaire

Disclaimer
The European Commission is not responsible for the content of questionnaires created using the EUSurvey service - it remains the sole responsibility of the form creator and manager. The use of EUSurvey service does not imply a recommendation or endorsement, by the European Commission, of the views expressed within them.

Adapting driver behaviour for lower emissions

This short questionnaire will help us to assess the training video produced by MODALES for low-emission driving.
Please watch the video before responding to these questions. The link to the video on YouTube is given to you by your local partner (trial site leader) in the covering email.

Please enter your participant ID.
This should be communicated to you by your local partner (trial site leader) in the covering email.

1) Please give a rating for the CLARITY (ease of understanding) of the video.
Use the slider to score from 1 (the most negative) to 5 (the most positive), with 3 being neutral.
Move the slider or accept the initial position.

Very poor | Very good

3

1 | 5

1a) If you gave a negative rating, please specify which aspects were unclear.

2) Please give a rating for the USEFULNESS of information in the video.

Use the slider to score from 1 (the most negative) to 5 (the most positive), with 3 being neutral.

Move the slider or accept the initial position.

Not at all useful | Very useful

3

1 | 5

2a) Which elements (if any) were most useful?

2b) Which elements (if any) were least useful?

3) Please give a rating for the COMPLETENESS of information in the video.

Use the slider to score from 1 (the most negative) to 5 (the most positive), with 3 being neutral.

Move the slider or accept the initial position.

Not at all complete | Very complete

3

1 | 5

3a) If you gave a negative rating, could you specify what aspect was missing or incomplete?
Was there something else you expected to see or learn?

4) Please give a rating for the PRACTICAL EXAMPLES in the video.

Use the slider to score from 1 (the most negative) to 5 (the most positive), with 3 being neutral.

Move the slider or accept the initial position.

Very poor | Very good

3

1 | 5

4a) Please give any comments or suggestions, especially if you gave a negative rating.

5) Do you think the duration of the video is:

- ◯ Too short?
- ◯ About right?
- ◯ Too long?

6) How would you rate your knowledge of low-emission driving BEFORE watching the video?

- ◯ Little or none
- ◯ Average
- ◯ Good
- ◯ Very good or excellent

7) How would you rate your knowledge of low-emission driving AFTER watching the video?

- ◯ Little or none
- ◯ Average
- ◯ Good
- ◯ Very good or excellent

End of Survey

Submit

8.7 User final questionnaire

Note that this questionnaire was made available in English, French, Spanish, Italian and Turkish.

☑ Save a backup on your local computer (disable if you are using a public/shared computer)

MODALES - Final questionnaire for participants

Disclaimer
The European Commission is not responsible for the content of questionnaires created using the EUSurvey service - it remains the sole responsibility of the form creator and manager. The use of EUSurvey service does not imply a recommendation or endorsement, by the European Commission, of the views expressed within them.

Adapting driver behaviour for lower emissions

Thank you for participating in the trials of the MODALES Low -Emission Driving App.
This short questionnaire is the final one in this project. It will help us to assess the effects of the app and driving tips.
The questionnaire is anonymous, but we ask your age group, gender, the country in which you participated in the trials, and the type of vehicle you mainly drove for the trials.

About you

In which country did you participate in the MODALES trials?

- ◯ Finland
- ◯ Greece
- ◯ Italy
- ◯ Luxembourg
- ◯ Spain
- ◯ Turkey
- ◯ United Kingdom

What is your age group?

- ◯ Under 21 years
- ◯ 21-29 years
- ◯ 30-49 years
- ◯ 50-64 years
- ◯ 65-74 years
- ◯ 75 years or older

Are you...?

- ◯ A man
- ◯ A woman
- ◯ No answer / other

What kind of vehicle did you mostly drive in the MODALES trials?

- ◯ Car (petrol/gasoline)
- ◯ Car (diesel)
- ◯ Car (electric or hybrid)
- ◯ Taxi or light commercial vehicle (van, light pickup truck, minibus) (petrol/gasoline)
- ◯ Taxi or light commercial vehicle (van, light pickup truck, minibus) (diesel)
- ◯ Taxi or light commercial vehicle (van, light pickup truck, minibus) (electric or hybrid)
- ◯ Heavy vehicle (lorry/truck)
- ◯ Heavy vehicle (bus/coach)
- ◯ Other

If "Other" to the question above, please specify vehicle type, make and model:

Evaluation

For the next two questions about types of driving behaviour, please select the response that is closest to your situation (after using the MODALES app, compared to before).

1. Regarding speeding up when the engine is cold:

- ◯ Before using the MODALES app, I already avoided strong acceleration or high speeds with a cold engine, and I still do so now (**no change**)
- ◯ Before using the MODALES app, I **used to accelerate or drive fast** with a cold engine but do so **less often now**, following the advice
- ◯ Before using the MODALES app, I **used to accelerate or drive fast** with a cold engine but try to **avoid doing this at all now**, following the advice
- ◯ **I still accelerate or drive fast** with a cold engine, as before (**no change**)

2. Regarding rapid accelerations, which might lead to a need for sudden braking:
   - ◯ Before using the MODALES app, I already paid attention to traffic situations to avoid unnecessary rapid or sudden acceleration, and **I still do so now** (**no change**)
   - ◯ Before using the MODALES app, I did not consider the traffic situations so I sometimes rapidly accelerated, only to have to brake very shortly afterwards. But now, following the advice, **I accelerate less in these situations**
   - ◯ Before using the MODALES app, I did not consider the traffic situations so I sometimes rapidly accelerated, only to have to brake very shortly afterwards. But now, following the advice, **I try to avoid this completely**
   - ◯ **I still rarely pay attention to traffic situations** which might allow me to avoid unnecessary rapid or sudden acceleration (**no change**)

The next two questions are about when you used the app and when you did not use it.

3. Regarding when you used the MODALES app:
   - ◯ I used the app **every time or most times** I drove during the trial period
   - ◯ I used the app on **around half** of my driving trips during the trial period
   - ◯ I used the app on **only a few** of my driving trips during the trial period

4. On occasions when you did **not** use the MODALES app, what were the main reasons?
*Choose the most important ones, with a maximum of **three** reasons.*
   - ☐ I forgot to open the app
   - ☐ I was in a hurry to leave
   - ☐ I was only driving a short distance
   - ☐ The app malfunctioned / was not working (for example closing, not connecting with the dongle, or not sending data)
   - ☐ The app distracted me from driving
   - ☐ The information and feedback given by the app was not useful
   - ☐ I did not have a suitable holder for my smartphone
   - ☐ I did not want to use data on my phone

The next two questions are on the feedback/advice from the app

5. Regarding the **real-time on-trip feedback** from the app (simple colour changes), how did you usually **react** in cases of the colour changing from green to yellow, orange or red?
   - ◯ Reduced acceleration or drove more slowly in **most or all** cases
   - ◯ Reduced acceleration or drove more slowly in **some** cases
   - ◯ **No reaction or change** in driving style
   - ◯ Other reaction

If "Other reaction" to Question 5 above, please describe:

6. Regarding the **post-trip feedback** from the app (advice), how did you usually **react** in cases where the app gave you tips for improvement?

- ◯ Adapted according to the recommendations in **most or all** cases
- ◯ Adapted according to the recommendations in **some** cases
- ◯ **No reaction or change** in driving style
- ◯ Other reaction

If "Other reaction" to Question 6 above, please describe:

7. We recognise that some drivers experienced difficulties such as getting the app to connect with the dongle, getting the app to send data, etc. MODALES is a research project and not a commercial product.
However, if this project led to a better performing and more stable version of this app being available, and available for free, would you:

- ◯ Install and use it with the dongle on **most or all journeys**
- ◯ Install and use it with the dongle on **some occasions** (like on long journeys)
- ◯ I would only use it **without the dongle**, even if that resulted in less accurate or less reliable feedback
- ◯ I would only use it if such as system was **integrated into the dashboard of the vehicle** and not on my phone
- ◯ I would **not be interested** in using such an application, even if it was integrated into the vehicle and worked perfectly

8. Finally, if you have any suggestions for improvements to the MODALES app, please enter them here

Submit

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Adapting driver behaviour
for lower emissions

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