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PAsCAL

Enhance driver behaviour & Public Acceptance
of Connected & Autonomous vehicles

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D6.1 – Pilot handbook for pilot managers

Version 1.0

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D6.1 – Pilot handbook for pilot managers

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0.7	23 Feb 21	Addition of missing sources and bibliography, completion of KPI considerations. Addition of references and adoption of comments made by partners
1.0	18 Mar 21	Final formatting of the document. Addition of data protection policy and requirements.

List of acronyms	
Acronym	**Meaning**
AV	Autonomous Vehicles
CAV	Connected and Autonomous Vehicles
ERTRAC	European Road Transport Research Advisory Council
FAIR	Findable, Accessible, Interoperable and Reusable
FDG	Focus Discussion Groups
FOT	Field Operational Test
KPI	Key Performance Indicator
PAsCAL	Enhance driver behaviour and Public Acceptance of Connected and Autonomous vehicLes
UX	User Experience
WP	Work Package

Legal Disclaimer

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This deliverable is a draft document subject to revision until formal approval by the European Commission.

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Table of contents

Table of figures

List of Tables

Executive summary

The PAsCAL project aims to address all the issues and concerns that may delay the wide market uptake of Connected and Autonomous Vehicles (CAV) and to enhance the general public's acceptance of these vehicles. At the same time, the project also studies questions relating to the role of humans within the system, with special attention to vulnerable users, ranging from real-time driving control to long-term training needs for jobs. In order to facilitate the research process, the consortium partners will collect user-related data, as well as capture the public opinions and acceptance via a variety of channels.

Five different real-world pilots will be carried out to validate the project's findings. A common set of specifications and requirements is necessary for the correct execution of these pilots and to ensure that the information collected is homogeneous and in line with the project's objectives. This document describes the methodology devised to that end. Special attention to ethics issues and the needs of persons with disabilities and mobility constraints will be given in each pilot design.

The common pilot design will ensure that all pilots will be feasible, reliable, and will provide the necessary data to achieve the project's objectives. Also, common issues need to be easily comparable across all pilots. To ensure a correct pilot execution, a common workplan has been designed, based on the pilot specifications. This common workplan must be used as a general guideline but will need to be adapted for each pilot's needs.

This manual follows the general guidelines and recommendations proposed by the FESTA methodology, adapting it to the specific needs of PAsCAL's type of research and objectives.

Qualitative and quantitative data from the pilots needs to be collected and made available so they are accessible to the involved partners. A common data protection policy has been drafted and will be used across all pilots to ensure that the data collection process complies with European law and policies. Deliverable D2.2 describes relevant guidelines, standards and principles that shall be followed by the consortium partners during the project as FAIR (Findable, Accessible, Interoperable and Reusable) and compliant.

1   Introduction

The PAsCAL project aims to address all issues and concerns that may delay the wide market uptake of Connected and Autonomous Vehicles (CAV) and to enhance the general public's acceptance of these vehicles. At the same time, the project also studies the questions relating to the role of humans within the system, with special attention to vulnerable users, ranging from real-time driving control to long-term training needs for jobs. In order to facilitate the research process, the consortium partners will collect user-related data, as well as the public opinions and acceptance via a variety of channels. The results will be used to design the Guide2Autonomy (G2A), providing a rich set of recommendations, tools, and insights for a variety of stakeholder groups. The G2A will be presented and assessed with relevant stakeholders.

Five different real-world pilots will be carried out to validate the project's findings. A common set of specifications and requirements is necessary for the correct execution of these pilots and to ensure that the information collected is homogeneous and in line with the project's objectives. This document describes the Methodology devised to that end.

1.1   Purpose and organisation of the document

This document details the methodology for addressing the requirements and specifications for the five real-world pilots to be carried out in PAsCAL.

- **Section 1** serves as an introduction to this handbook;
- **Section 2** describes the document's objectives and includes an overview of the pilots;
- **Section 3** details the methodology that needs to be followed. It describes the types of research, and based on this, the common methods and specifications to be followed;
- **Section 4** addresses potential legal, ethical, or privacy-related issues;
- **Section 5** describes the data collection methods and requirements to comply with the project objectives;
- **Section 6** provides a common work plan and a check list for the pilots' execution;
- **Section 7** briefly defines the type of evaluation that will be applied to the pilots.

1.2   Intended audience of this document

The main audience for this document is the consortium members of the PAsCAL project, specifically partners responsible for pilot design and implementation. This manual can also serve as a guideline to other researchers in the field of autonomous vehicles, in particular to those involving tester's behaviours and acceptance.

2　Overview of the PAsCAL pilots

2.1　Objectives

Within the PAsCAL project, all the research work packages - from WP3 to WP8 - need a high degree of interaction and feedback information, both during planning and execution. The PAsCAL pilots must de designed to provide validation of the previous WPs findings, in particular WP4 and WP5. Therefore, they must also be aligned with WP3. At the same time intermediate results of the pilots will also feedback to those WPs.

Including the ethics and data protection handbooks from WP2, and in compliance with the data analysis and impact assessment plans defined in WP7, the pilot results and data collected will be directly transferred to WP7 for evaluation. Tester responses and observed behaviours will be analysed in task 7.3.

2.2　Pilots summary

2.2.1　High-capacity autonomous bus operations

This pilot will study the use of automated high-capacity autonomous buses from the perspective of the passengers, the driver and the other road users sharing the street with the bus. The considered passengers are comprised of a diverse group, including those with special needs for (human) support. The pilot will run in collaboration with a bus manufacturer (Volvo) and public transport operators in Luxembourg and Sweden. A high-capacity (12 metre) prototype autonomous bus will be used.

2.2.2　Autonomous driving training

In this pilot the training conducted in WP5 will be assessed through the use of a L3+ CAV in the "protected" and equipped environment at the Lainate safe driving centre (Italy). 70 drivers will test the most critical situations and the solutions previously identified. Moreover, the pilot will assess if there is difference in acceptance of CAVs between a simulated and a real situation.

2.2.3 SMEV - Smart Emergency Response

In this pilot the functioning of emergency vehicles will be investigated by using SMEV, an ITS Cooperative System which provides free corridors and routes for emergency vehicles at any time during missions by clearing junctions from disruptive traffic and reorganising traffic dynamics surrounding the route in real time. Both reactions from road users, who will be confronted with these vehicles, and the drivers of these emergency vehicles will be studied.

2.2.4 Shared connected transport

Roadmaps on automation (such as the one published by ERTRAC[1]) put quite some emphasis on shared mobility. However, still little is known about the attitudes towards future sharing schemes. This pilot will study attitudes and perception of "drivers" and passengers toward different kinds of shared connected vehicles including small- and medium-size passenger cars, sport vehicles, vans, electric vehicles and vehicles with autonomous features. This study will allow operators of shared fleets to optimally design and operate fleets of shared vehicles and design well-suited incentive mechanisms to increase public acceptance and improve attitudes towards different kinds of shared vehicles.

2.2.5 Experience of vulnerable travellers with connected transport environment

The last pilot focuses on the acceptance and behaviour of vulnerable travellers, such as the elderly, pregnant women, disabled, with sensory impairments, travellers with heavy luggage, and parents with a baby stroller when travelling with CAVs. A digital platform will be used, which advises specifically vulnerable travellers in real-time on the best routes to take, removes non-accessible routes and transfers, and alerts them of possible obstacles which may be encountered. This platform has already been extensively tested in Madrid, Spain, but in this pilot the new challenges of a more connected transport environment will be addressed and the potential of CAV vehicles for a more inclusive public transportation network, can be assessed. Furthermore, Focus Discussion Groups (FDGs) shall be prepared specifically for people with sensory impairments.

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[1] https://www.ertrac.org/uploads/documentsearch/id57/ERTRAC-CAD-Roadmap-2019.pdf

3 Methodology

3.1 Common design

Field Operational Tests (FOTs) have been introduced as a standard evaluation method for proving systems and functions in the scope of transport and mobility. FOTs have proven to be valuable as an instrument to verify and validate Research & Development projects.

FOTs are large-scale user tests where a large number of participants are recruited to try out a system (or a function). During these tests, questionnaires, measurements, and observations are gathered to identify how the system may potentially change the participants' driving and travelling behaviour.

A common FOT methodology has to ensure that a systematic and scientific approach is adopted during the FOTs. The FESTA handbook[2] published by the FOT-Net consortia proposes a generic FOT implementation plan (FOTIP) to serve as a checklist for planning and running FOTs.

The generic FOTIP proposed is non-exhaustive and FESTA recommends defining the requirements and a list of tasks/subtasks on a case-by-case basis. This manual follows the general guidelines and recommendations proposed by the FESTA methodology, adapting it to the specific needs of PAsCAL's type of research and objectives.

PAsCAL pilots are intrinsically different to the generic FOTs described by FESTA in two key aspects:

1) PAsCAL will not focus its' pilots on testing a single system or function, but issues which are more exemplary and subjective.
2) Due to the nature of the research, there will not be a long period of data collection stemming from measurement equipment, since the main data will be collected at the end of the pilot in form of questionnaires and surveys. Also, activities related to analysis and dissemination will be carried out in other Work Packages (WPs) of this project. For this reason, the two last stages defined by FESTA, "Data collection" and "Completion" are merged.

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[2] https://connectedautomateddriving.eu/wp-content/uploads/2017/08/2017-01-31_FOT-NET_FESTA-Handbook.pdf

The FESTA handbook proposes a generic scheduling for the activities described for the generic FOTIP, divided in 4 stages:

i. Setup/design;
ii. Preparation;
iii. Data collection;
iv. Completion.

Most activities included in the first stage have already been completed, since the pilots' design, locations, aims, objectives and purpose have already been defined.

PAsCAL
Enhance driver behaviour & Public Acceptance
of Connected & Autonomous vehicles

Table 1 'Generic' FESTA guide to scheduling activities

Activity	Setup/design	Preparation	Data Collection	Completion
Convene teams and people	▒			
Define aims, objectives, research questions & hypotheses		▒		
Develop project management plan		▒		
Implement procedures and protocols for communicating with stakeholders		▒		
Design the study		▒		
Identify and resolve legal and ethical issues		▒	▒	
Select and obtain FOT test platforms (vehicles, mobile devices, roadside units, ….)		▒		
Select and obtain systems and functions to be evaluated	▒	▒		
Select and obtain data collection and transfer systems		▒		
Select and obtain support systems for FOT platforms		▒		
Equip FOT test platforms with all systems		▒		
Implement driver feedback and reporting systems		▒		
Select/implement relational database for storing FOT data		▒	▒	
Test all systems against functional requirements and performance specifications			▒	
Develop recruitment strategy and materials		▒		
Develop driver training and briefing materials		▒		
Pilot test FOT equipment, methods and procedures			▒	
Run the FOT			▒	▒
Analyse FOT data			▒	▒
Write minutes and reports	▒			▒
Disseminate the FOT findings				▒
Decommission the FOT				▒

The present handbook will cover the specific FESTA activities listed in the table below:

Table 2 FESTA activities covered

Activity	Setup/Design		Preparation		Data collection/ Completion	
Identify and resolve legal and ethical issues	■	■				
Select and obtain data collection systems		■				
Develop recruitment strategy and materials		■				
Run the FOT			■	■	■	■
Analyse FOT data					■	
Write minutes and reports	■	■	■	■	■	■

Table 3 FESTA activities covered (by section)

Activity	Section of this handbook
Identify and resolve legal and ethical issues	4
Select and obtain data collection systems	5

PAsCAL
Enhance driver behaviour & Public Acceptance
of Connected & Autonomous vehicles

Develop recruitment strategy and materials	3.7-3.8
Run the FOT	6
Analyse FOT data	7
Write minutes and reports	5

When performing large-scale FOTs, it is recommended to carry out restricted FOTs involving a lower number of participants in a controlled environment prior to launching the full FOT. The restricted FOT will serve as a test, to ensure that the FOT design demonstrates the expected results.
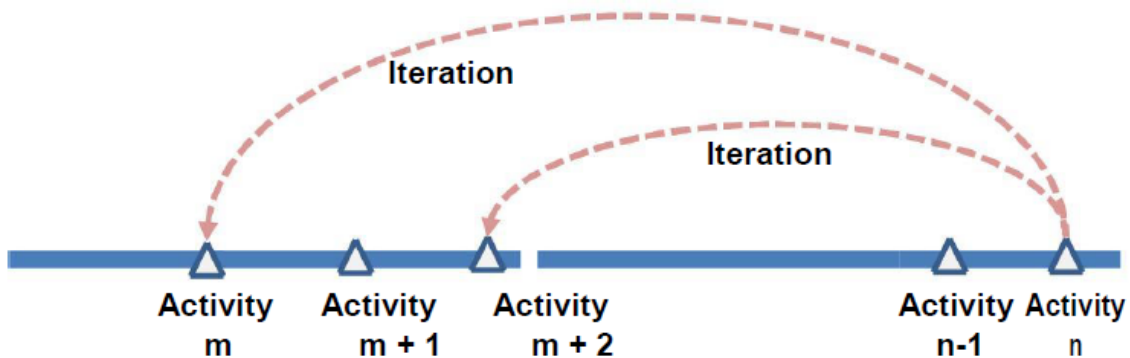
Figure 1 Iterative development process

It is recommended to check whether the surveys and questionnaires will eventually provide the required results. Different iterations, or waves may be needed to adjust either the questions, the means of data collection, or the pilot scenarios. At the same time, different waves of testers will be adopted, so partial results may be analysed, issues identified, and necessary changes applied to the FOT design.

3.2   Type of research

The project's objectives and the subject to be studied and analysed determine the type of research and methodology that needs to be applied. Different kinds of research can be defined, depending on the Application, Objectives and Type of Information that is required:
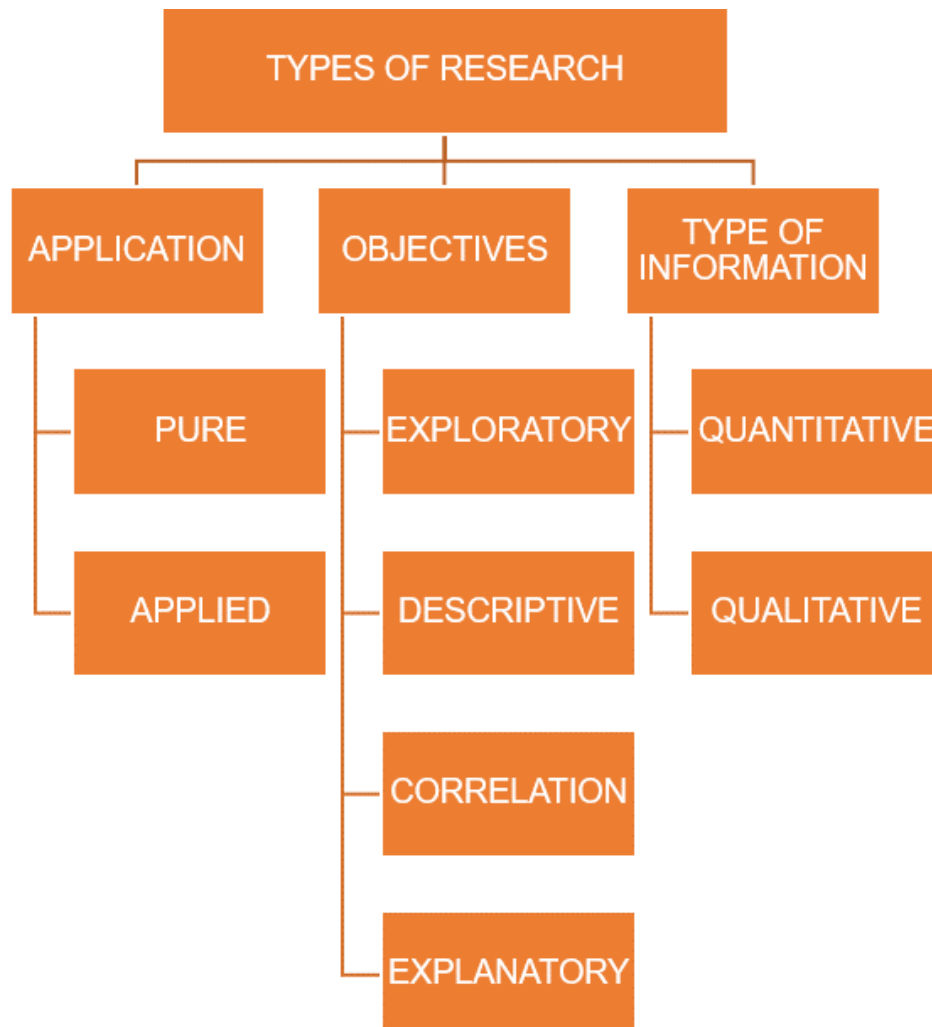
Figure 2 Types of Research

According to this structure, based on its application, objectives and type of information sought, the research carried out in PAsCAL needs to be applied, exploratory and mostly qualitative.

3.2.1   Applied

Applied research is designed to solve practical problems of the modern world, rather than to explore diffuse and novel subjects. In the case of PAsCAL, there is a part of pure research since user's behaviour and

acceptance of CAVs need to be studied and described. However, the final objective is to address the issues discovered and propose a series of guidelines and recommendations to enhance user's acceptance and accelerate the market uptake of CAVs.

Since applied research often works with real-world data, it can be difficult for researchers to maintain complete control over all variables. External variables can also exert a subtle influence that the experimenters may not even consider or recognise. This methodology will ensure that this risk is minimised.

3.2.2 Exploratory

Exploratory research investigates a problem that has not been studied or thoroughly investigated in the past. An exploratory type of research is usually conducted to gain a better understanding of the existing problem or to address a new problem. It is often referred to as grounded theory approach or interpretive research as it used to answer questions like what, why and how. There are several characteristics that are common to this type of research and that will also be present in PAsCAL:

- The research problem must be important and valuable.
- Exploratory research mostly deals with qualitative data.
- Exploratory research is highly interactive and open-ended in nature.
- The absence of relevant information from past research means the researcher will spend a lot of time studying materials in detail.
- Since there is no standard for carrying out exploratory research, it is usually flexible and scattered. Researchers often need to be creative and use new methods for testing and evaluation.
- Researchers cannot form a fixed conclusion based on exploratory research.

3.2.3 Qualitative

As previously described in the characteristics of exploratory research, this research will rely on mostly qualitative data, but also complementary quantitative data from pilots' observations:

- Qualitative data from user's answers to questionnaires.
- Quantitative data from pilots' observers' notes (dynamic verification) using a common Pilot Incident Form.

3.3 Research methods

PAsCAL pilots will use mostly primary research methods, which means the data is collected directly from the subject of research. The primary research methods that will be used in PAsCAL pilots are:

3.3.1 Questionnaires

Questionnaires are the main source of information from the pilots. This method allows gathering qualitative information from a sample of people, that can be analysed and used with the intention of generalising the results to a larger population.

Given the heterogeneous nature of each pilot, a specific questionnaire must be developed in each case, adapting the questions to each scenario and type of user. However, the questionnaires must follow a common structure so the results can be analysed and compared. Specifically, the order, labelling and phrasing of the questions and answers is homogenised to ensure comparability across all pilots. All questionnaires are fully accessible and available in local languages to ensure that any test subject is able to understand and complete the questionnaire without further assistance.

3.3.2 Observations

PAsCAL pilots are documented, and information will be obtained from the observation of user's behaviours and other external elements such as weather conditions, incidences, and any other relevant element that may affect the pilot or the testers' answers to the questionnaires.

Situational variables (weather, lightning conditions, location conditions, etc.) are essential and need to be documented, since it helps to identify important control factors that are needed when analysing the effects observed in the different pilots.

4 Legal, ethics and data privacy considerations

4.1 Legal considerations

A FOT project should therefore value its participants and treat their data and privacy with respect. When undertaking tests involving users, researcher may encounter a considerable number of legal and ethical issues. In particular, when tests are carried out in multiple countries, or involving cross-border activities, the different national and local regulations must be respected.

A prior risk assessment must be defined regarding tester's safety, security and accessibility. It is essential to ensure that testers are legally entitled to participate in the tests (i.e. have a valid driving license) and that they are eligible for insurance.

When recruiting testers, a legal arrangement must be formulated, in form of a "letter of agreement". Issues potentially relevant between the handling organisation and the test participant should be regulated and addressed in a contract to provide legal certainty on both sides (e.g. on obligations, liabilities, insurance issues, information on the logging of personal data requiring informed consent, which parties will use the data, data sharing after the project including the use of personal data). Any individual test participants will be informed of the project's data protection policy, which has been specified in WP 2 in the Deliverable D2.2.

4.2 Risk Assessment

The project requires a comprehensive risk assessment plan and will need to be able to demonstrate subsequently that the identified hazards have been properly managed. Each pilot manager must identify potential risks and provide a satisfactory solution. Potential risks and issues include:

- Safety,
- Vehicle approval for on-road use/homologation,
- Insurance,
- Legal liability and responsibilities,
- Issues with video data collection,
- Accessibility issues.

4.3   **Privacy and data protection**

The PAsCAL consortium partners are fully obliged to abide to the EU General Data Protection Regulation. Apart from this legislation, the consortium partners regard privacy and data protection as a fundamental principle and hence apply a strict policy on this matter. They have a strong focus on data protection and sharing and will produce a specific Data Protection Handbook (D2.3), which will be combined with the Ethics handbook (D2.1) to produce the European Data and Ethics handbook (D2.5) in the field of autonomous driving, vehicles and usages of humans and data.

With respect to video (and also audio) recordings, testers should give prior consent to being recorded. In this case, it is important that personnel handling and analysing the data are given appropriate education on personal integrity issues.

4.4   **Vulnerable users**

Autonomous vehicles are particularly interesting for people with mobility constraints or disabilities, which usually find it difficult, if not impossible, to drive a car. For this reason, PAsCAL pays special attention to vulnerable user groups, and promotes their participation in the pilots. The pilot design and implementation must meet the needs of these groups, specially:

For blind and partially sighted persons:

- Written and digital documents must be accessible and usable for blind and partially sighted persons (e.g. in Braille, large print or screen reader-friendly);
- Assistance must be available during practical parts of pilots or Focus Discussion Groups (FDGs).

For deaf persons:

- Translation into sign language.

For physically disabled persons:

- Ramp, pram park and fixation for wheelchair;
- Attachment for crutches.

For persons with learning difficulties:

- Documents and explanations in easy language.

5   Data collection

Qualitative and quantitative data from the pilots needs to be collected and made available so they are accessible to all of the involved partners. Deliverable D2.2 describes the relevant guidelines, standards and principles to be followed by the consortium partners during the project as FAIR (Findable, Accessible, Interoperable and Reusable).

The data collected will be processed and analysed, and the findings will be used to inform the public and private decision makers in designing, deploying and regulating CAV-related services.

For each pilot, the data generated and collected will be described including

- Data ID,
- Description,
- Type and format.

The tables with the proposed data description for each pilot are displayed below. Pilot managers should specify and fine-tune them according to the needs of each specific pilot.

Table 4 Data description for "High-capacity autonomous bus operations" pilot

Data	Description	Type & Format
ToolID	This is the tool used in the pilot.	A string of three letters to identify the tool. • APP: apps. • VID: videoing of interaction with HMIs and road users. • INT: interviews.
CountryID	This is the country in which the training takes place.	A string of two letters to identify the country. • LU: Luxembourg. • SE: Sweden.

ScenarioID	The scenario identifier for the pilot.	The possible values will be defined when the final version of the pilot is available. • Integer.
TestID	This is the test ID.	The number of the pilot wave. • Integer.
UserID	A unique user identifier.	A string of six digits, starting at 000001 and ending at 999999, depending upon the order of arrival of each participant.
StartTime	The timestamp (both date and time) of the start of the pilot session.	String in ISO 8601 format. • (JJJJ-MM-TT hh:mm:ss).
StopTime	The timestamp (both date and time) of the end of the pilot session.	String in ISO 8601 format. • (JJJJ-MM-TT hh:mm:ss).
Feedback	Questionnaire ID used in the pilot.	Integer for multiple choice or scaling questions. • 1,2,3, depending on the order of the choice selected. • String (free text) for open questions.

Table 5 Data description for "Autonomous driving training" pilot

Data	Description	Type & Format
ToolID	This is the tool used in the pilot.	A string of three letters to identify the tool. • APP: apps. • VID: videoing of interaction with HMIs and road users. • INT: interviews.
CountryID	This is the country in which the training takes place.	A string of two letters to identify the country. • IT: Italy. • LU: Luxembourg. • UK: United Kingdom.
ScenarioID	The scenario identifier for the training.	The possible values will be defined when the final version of the pilot is available. • Integer.
TestID	This is the test ID.	The number of the pilot wave. • Integer.
UserID	A unique user identifier.	A string of six digits, starting at 000001 and ending at 999999, depending upon the order of arrival of each participant.
StartTime	The timestamp (both date and time) of the start of the training session.	String in ISO 8601 format. • (JJJJ-MM-TT hh:mm:ss).
StopTime	The timestamp (both date and time) of the end of the training session.	String in ISO 8601 format. • (JJJJ-MM-TT hh:mm:ss).

Feedback	Questionnaire ID used in the pilot.	Integer for multiple choice or scaling questions. • 1,2,3, depending on the order of the choice selected. • String (free text) for open questions.

Table 6 Data description for "SMEV – Smart Emergency Response" pilot

Data	Description	Type & Format
ToolID	This is the tool used in the pilot.	A string of three letters to identify the tool. • APP: apps. • VID: videoing of interaction with HMIs and road users. • INT: interviews.
CityID	This is the city where the pilot takes place.	A string of two letters. • RM: Madrid. • FO: Frankfurt an der Oder.
TestID	This is the test ID.	The number of the pilot wave. • Integer.
StartTime	The timestamp (both date and time) of the start of the test session.	String in ISO 8601 format. • (JJJJ-MM-TT hh:mm:ss).
StopTime	The timestamp (both date and time) of the end of the test session.	String in ISO 8601 format. • (JJJJ-MM-TT hh:mm:ss).
User Category	Classifying each user according to their	A string of two letters. • ED: emergency drivers.

	mode of transportation.	• CD: civilian drivers. • PE: pedestrians. • CY: cyclists.
Feedback	Questionnaire ID used in the pilot.	Integer for multiple choice or scaling questions. • 1,2,3, depending on the order of the choice selected. • String (free text) for open questions.

Table 7 Data description for "Shared Connected Transport" pilot

Data	Description	Type & Format
ToolID	This is the tool used in the pilot.	A string of three letters to identify the tool. • APP: apps. • VID: videoing of interaction with HMIs and road users. • INT: interviews.
CityID	This is the city where the pilot takes place.	A string of two letters. • LU: Luxemburg
VehicleID	This is the vehicle ID.	A string of three digits. • Digit one for vehicle size: small-size passenger cars (1), medium-size passenger cars (2), sport vehicles (3), vans (4). • Digit two for fuel type: combustion (1), electric (2), hybrid[3] (3).

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[3] This option was not included in the current version of D2.2 and has been added in this document.

		• Digit three for autonomous features: highway platooning (1), automatic valet parking (2), urban driving (3).
TestID	This is the test ID.	The number of the pilot wave. • Integer.
DayID	This is the ID of the day a test is carried out.	The possible values will be defined when the final version of the tests is available. • Integer.
StartTime	The timestamp (both date and time) of the start of the test session.	String in ISO 8601 format. • (JJJJ-MM-TT hh:mm:ss).
StopTime	The timestamp (both date and time) of the end of the test session.	String in ISO 8601 format. • (JJJJ-MM-TT hh:mm:ss).
UserID	A unique user ID.	A string of six digits, starting at 000001 and ending at 999999, depending upon the order of arrival of each participant.
Feedback	Questionnaire ID used in the pilot.	Integer for multiple choice or scaling questions. • 1,2,3, depending on the order of the choice selected. • String (free text) for open questions.

Table 8 Data description for "Experience of vulnerable travellers with connected transport environment" pilot

Data	Description	Type & Format

ToolID	This is the tool used in the pilot.	A string of three letters to identify the tool. • APP: apps. • VID: videoing of interaction with HMIs and road users. • INT: interviews.
CityID	This is the city where the pilot takes place.	A string of two letters. • RM: Madrid.
ScenarioID	The scenario identifier for the pilot.	The possible values will be defined when the final version of the pilot is available. • Integer.
UserID	A unique user ID.	A string of six digits, starting at 000001 and ending at 999999, depending upon the order of arrival of each participant.
TripID	This is a unique ID of the scenario followed by the participants.	The possible values will be defined when the final version of the pilot is available. • Integer.
StartTime	The timestamp (both date and time) of the start of the test session.	A string in ISO 8601 format. • (JJJJ-MM-TT hh:mm:ss).
StopTime	The timestamp (both date and time) of the end of the test session.	A string in ISO 8601 format. • (JJJJ-MM-TT hh:mm:ss).
Route	This is the route used by the traveller.	A string consisting of three pairs of two letter. • Origin (PP: Principe Pio). • Destination (GY: Goya).

		• Stopovers/changes (OP: Opera).
TripDuration	This is the duration of the trip.	A string in ISO 8601 format. • (JJJJ-MM-TT hh:mm:ss).
TripDistance	This is the trip distance in metres.	A float of up to five digits. • 2400.
TripCost	This is the trip cost in cents.	A float of up to four digits. • 210.
Feedback	Questionnaire ID used in the pilot.	Integer for multiple choice or scaling questions. • 1,2,3, depending on the order of the choice selected. • String (free text) for open questions.

5.1   Questionnaires

Questionnaires are the main data source of the PAsCAL pilots. As previously described, they provide qualitative data from tester's responses. The questionnaires need to provide information that can be used to achieve the project's objective.

Each questionnaire will be divided into two main parts: a "**background questionnaire**", including relevant questions about the tester (age, gender, previous experience with CAVs, literacy level, etc.), and a "**technical questionnaire**" which will include questions concerning the pilot itself. Technical questions must be aligned with the acceptance Key Performance Indicators (KPIs) described in Deliverable 7.2 of WP7, and each question must be attributed one of the KPIs to label and identify the exact benefit of the question. The indicators are categorised into five thematic focus areas with subsequent topics, which serve as labels for each pilot:

1) *Indicators of acceptance by end users*

a) Willingness to pay;

b) Willingness to adopt;

c) Willingness to let others use;

d) Changed mobility behaviour;

e) Perceived risk;

f) Perceived ease of use;

g) Perceived quality of travel;

h) Perceived usefulness;

i) Attitudes and human factors.

2) *Indicators of acceptance by road co-users*

a) Perceived risk;

b) Attitudes and willingness to accept;

c) Data collection.

3) *Indicators of acceptance by vulnerable user groups*

a) Availability of the solution;

b) Adequacy of the solution;

c) Accessibility;

d) Affordability;

e) Social inclusion;

f) Human dignity and ethics.

4) *Indicators of acceptance by other stakeholders*

a) Local authorities: willingness to pay/invest in CAV technology;

b) Local authorities: willingness to pay/invest in new or adapted infrastructures;

c) Local authorities, Businesses and Producers: willingness to pay employee use;

d) Businesses and Producers: willingness to pay/invest and to adopt to increase efficiency;

e) Businesses and Producers: willingness to pay/invest for business opportunities.

5) *Indicators of society level acceptance*

a) Mobility and transport network;

b) Safety and security at societal level;

c) Socio-economic impacts;

d) Quality of life;

e) Public awareness;

f) Public acceptance.

These indicators have been designed to gather information about potential issues, advantages and shortcomings that may affect CAVs acceptance by the general public. This information will be provided by the research carried out in WP3.

The relatively high complexity of the technology being tested (CAVs) may cause technical questions to be difficult to understand for testers, leading to incorrect answers. It is strongly recommended to simplify the terminology as much as possible and write each question in plain language, minimising misunderstandings and avoid tester's frustration.

Following FESTA recommendations, questionnaires should be kept short to avoid that testers become "bored" or annoyed, which would lead to low quality answers. A maximum of 30-40 questions, including background and technical questions, is recommended. The questions must evidently be formulated in a clear and unambiguous way, they must be specific, not too complicated, and formulated in simple terms that can be understood by the interviewee. Hypothetical questions should be avoided.

PAsCAL pilots will include on-site assistants for blind and partially sighted participants, when necessary. In any case, questionnaires should be accessible for this type of vulnerable users. For instance, radio buttons as multiple-choice grids (i.e., matrices) and drop-down menus are not accessible [4]. Furthermore, the questionnaires shall be translated into several different local languages by a professional translator.

The consortia will use Qualtrics[5], a powerful survey software that offers numerous functionalities both as an online survey platform and as a field survey tool. It is accessible with mobile devices, apps, websites, chatbots and other platforms. It also provides automated analysis, real-time reporting, and advanced logic. In addition, professional translations to

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[4] More advice is available at: https://help.alchemer.com/help/how-to-build-accessible-surveys
[5] https://www.qualtrics.com

local languages will become available to secure testers understand the questions posed fully.

The FESTA handbook recommends that qualitative data should be considered as "sensor" data within the scope of the FOT methodology. Data from surveys and questionnaires should therefore be handled accordingly and stored in an electronic format. The following related information should be included:

- Data and time (hh:mm) of test start;
- Data and time (hh:mm) of test end;
- Subject ID code;
- If present, reference to objective data (file name, location, etc.).

5.2 Video recording

Video recordings are considered very important data sources for analysing driver's behaviour and reactions, as well as monitoring the pilots. For this purpose, video should include both the interior (driver/passenger monitoring) and exterior (surroundings and other road users), when possible. The recording angle must be chosen carefully, so the tester's reaction can be clearly seen and analysed. For videos not involving the physical testing of the pilots, footage should be taken manually by following the testers through the pilot itinerary.

For documentation and dissemination purposes, footage of the pilot preparation, briefing and general views should be taken. To this purpose, it is important to add the exact timing in both video and the written report, so the different parts of the video can be identified. The necessary means for video recording must be defined for each pilot/scenario and tested, including number of cameras needed, coverage angle, video quality and storage.

5.3 Pilot observation

It is advised to include observers that can provide additional information about the testers, vehicles and external conditions of the pilots. This data will be collected mostly manually and should be included annexed to each questionnaire. For example, different weather conditions may produce altered perceptions and produce dissimilar answers from testers.

Incidences such as delays, malfunctioning, accidents, external interference, etc, must also be described in detail in the Pilot Incident

Form[6]. This information may be relevant to understand differences in results between pilots. Including the exact time of such incidences is important, in particular when also videos are being recorded, so the exact moment and actions can be identified.

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[6] Example form: https://forms.gle/1sMYjCU4bfisUEsUA

6 Running the pilots

6.1 Testers

In order to achieve the project's objectives, testers must be chosen in order to provide information that is representative for each population group, profession or specific public, depending on the pilot requirements. Of course, testers must be real persons, external to the project and willing to participate and give true answers.

To this purpose, independent testers must be engaged for each pilot. If necessary, a small compensation should be offered to motivate or encourage their participation in the tests. It is important to contemplate that testers may have motives to participate, such as getting a better grade in a course if they are college students, which may affect their behaviour and answers.

The following information should be collected in the questionnaires (background) that will provide relevant data for the results analysis.

- Age, gender, social economic variables, and permanent or temporary driver impairments;
- Driving experience, in particular with CAVs;
- Other relevant information for the pilot.

The appropriate number of testers for each pilot depends on a number of choices that have to be chosen depending on the pilot's conditions and available time.

6.2 Definition of pilot specifications

The pilot implementation will be based on a common set of specifications so that all pilots will be feasible, reliable, and will provide the necessary data to achieve the project's objectives. Also, common issues should be easy to compare across pilots. For this reason, the following elements need to be defined and described in each pilot´s design:

- **Scope and purpose**: In order to correctly design and implement a pilot, it is necessary to clearly define the scientific obejctives and which data needs to be collected to reach them. As described in section 2.1, PAsCAL pilots are intended to validate the research carried out in WP3, WP4 and WP5. At the same time, the data collected from them must be analysed in WP7. In particular, Impact Indicators described in

deliverable 7.2 must be used as guideline to define what must be explored by the pilots.

- **Scenarios**: Different tests and subtests need to be defined to cover all the aspects previously defined.
- **Assumptions**: Given the nature of PAsCAL's research, the pilots results must be open-ended. Although assumptions are often necessary for the research progress, any previous assumptions need to be tested carefully to avoid biased results. In the case of exploratory research, it is common to overlook important information, based on assumptions. This risk should be minimised.
- **Questionnaires**: The questionnaires must be aligned with previous elements and should be customised for each pilot and the type of tester. It is recommended to make the questionnaires short, and simple to understand for any tester user independently of their literacy level. Each questionnaire needs to include 2 types of questions:
    1. *Background questions*: they will provide information about the tester, such as age, education level, experience with CAVs, gender, or any other relevant element that may be important for understanding the pilot's results.
    2. *Technical questions*: testers will give their opinion and express their experiences during the pilots. These questions must be formulated so the answers will provide the necessary information to fulfil the purpose of the test. Technical questions should explore the KPIs addressed in PAsCAL's Deliverable 7.2.
- **Tester considerations**: For each pilot, it is necessary to define how many testers need to be engaged, how they will be recruited, how they will access the pilots, what material they need for the pilots, and eventual needs during the pilots' duration, such as water, food, access to toilets and eventual protection against rain, cold or sun.
- **Location and equipment needed**: In order to set up the different scenarios and conduct the tests, the necessary equipment need to be defined. This includes all the material from identification badges for testers to vehicles. At the same time the best suitable location for the different scenarios needs to be selected. It is important to ensure that both the location and material will be available on the day of the pilot execution.
- **Scheduling:** The day and time of each pilot, as well as the estimated duration must be defined. It is important to take in consideration the possible weather conditions as well as daylight hours or other

circumstances (holidays, strikes, etc.), that may affect the pilot execution.

- **Staff**: The necessary number of staff and volunteers must be also estimated. The staff may include a presenter, a moderator, several observers, etc., according to the needs of each scenario. Adequate assistance for blind and partially sighted testers must also be provided.
- **Pilot documentation**: For each scenario, other than the questionnaires, different qualitative and quantitative data needs to be collected during pilot execution. For instance: start and end time, weather conditions, possible incidences, how many users took one direction or another, etc. This data must be identified, and the necessary means to collect this data must be assured.
- **Test moderation**: For each scenario, it is also necessary to define any tester guidance during pilots. For instance, what is going to be explained to the testers, or kept secret; if help will be provided to testers, or the reaction of testers will be observed without external help. Etc.
- **Accessibility**: The pilots design should meet the needs of persons
    - with total or partial visual impairment;
    - with hearing difficulties or deafness;
    - using a wheelchair;
    - with intellectual disability;
    - of small size (children, persons with microsomia);
    - carrying luggage;
    - with a baby stroller or a buggy;
    - using crutches;
    - using a walking frame.
- **Data collection from users**: It is important to define how the answers to the questionnaires will be collected: oral or written interview, individually or in focus groups, etc.
- **Contribution to dissemination**: Finally, each pilot description must contain a section explaining the materials it provides and contributes for dissemination and communication purposes, such as video footage, interviews, pictures, etc., which have been specifically created for this purpose. A collaboration with WP9 activities shall be strengthened, to ensure that there is promotion of the project and its results and a common cross-fertilisation calendar is created.

6.3 Common pilot workplan

To ensure a correct pilot execution, a common workplan is proposed, based on the pilot specifications described above. This common workplan defines the timing and duration of all activities that should be carried out during the pilot's execution. It serves as a general guideline to schedule the pilot execution and will be adapted for each pilot's needs. When the pilots are arranged in waves, the workplan should contain when these waves are happening as well as the activities involved in each one.

The different activities, which need to be included and reported on each wave are:

- Team briefing and instruction before the start of the pilot;
- Material preparation (preparation and verification of the vehicles, and any equipment such as wheelchairs or crutches);
- Accessibility verification (verification of possible obstacles or external people that may be present at the pilot location and subsequently their removal where possible);
- Tester briefing (inform users of the purpose, length, and progress of the pilot, give instructions on the operation of the pilot's service as well as any test material needed);
- Pilot process monitoring and documentation (pictures, videos, notes, collected metrics and data);
- Survey/user interviews (collect answers to the questionnaires).
- Preparation of the collected data and documentation for the analysis;

Table 9 Common pilot workplan

Month	M20	M21	M22	M23	M24	M25	M26	M27	M28
2021	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Task	T1.1		T1.2			T1.3			T1.4
Pilot preparation	■								
First wave		■							
Second wave					■				
Third wave								■	
Wave result verification			■			■			■

Table 10 Common wave workplan

|	Day	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Wave setup																
Team briefing																
Material preparation																
Location verification																
Wave ready																
Wave execution																
Briefing with testers																
Tests																
Monitoring and Documentation																
Surveys/Interviews																
Wave completed																

The different steps included in the pilot workplan must be described and defined in detail and their progress and viability must be reported on for each pilot definition, implementation and evaluation report in order to identify the planned and the actual progression of each step.

7 PILOT EVALUATION

7.1 Heuristic evaluation

User answers to the questionnaires (qualitative data) and pilot documentation (quantitative data) need to be analysed, taking into consideration the project's framework and objectives.

Exploratory research allows for the researcher to be creative in order to gain the most amount of insight on a subject. In particular, it is necessary to define an evaluation method that can provide the best results in this case.

Given the similarity of these pilot studies with usability test pilots used to validate user interfaces and understand user-machine interactions, a similar evaluation will be used. Jakob Nielsen and Rolf Molich published the landmark article "Improving a Human-Computer Dialogue". It contained a set of principles—or heuristics—which industry specialists soon began to adopt to assess interfaces in human-computer interaction. A heuristic is a fast and practical way to solve problems or make decisions.

In user experience (UX) design, professional evaluators use heuristic evaluation to systematically determine a design's/product's usability. A similar evaluation can be used to understand the user's acceptance of CAVs. In general, heuristic evaluation is difficult for a single individual to do because one person will never be able to find all issues and identify all risks. Therefore, it is necessary to involve multiple evaluators in any heuristic evaluation.

The evaluation uses several general principles called "heuristics" because they are broad rules of thumb and not specific rules. Based on Impact indicators identified and described in D7.2, some general principles of user's behaviour and acceptance of CAVs will be chosen for each pilot. Heuristic evaluation does not provide a systematic way to create conclusions or solutions to problems. However, because heuristic evaluation aims at explaining each observed behaviour compared with general principles, it will be useful to generate guidelines and recommendations.

7.2 Reporting results

The pilots' results need to be collected and reported so they can be brought together with results of previous Work Packages (WP3-WP4-WP5) and carry out a detailed impact assessment in Work Package 7. The results will be collected and described in deliverable D6.3 **Pilot Implementation and Evaluation Report** that must include a detailed description of each pilot specifications described in section 6.2. and the pilot workplan followed, as suggested in section 6.3 as well as the findings and evaluation described in section 7.1.

The pilots' results will be crucial to meet the KPIs designed in WP 7 and provide guidelines for defining impact areas and best course of actions.

In particular, tasks 7.3 "Integrated data analysis" will conclude the level of acceptance of CAVs based on the project results and survey responses from the pilots.

The analysis will show results for different user categories:

- Age group;
- Gender;
- Willingness to pay;
- Mobility need.

Pilot related conditions should also be reported by the pilot staff by means of a form. This form will collect information related to the following topics:

- Date, time and duration;
- Weather conditions (if applicable);
- Number of tester users in that wave;
- Incidents related to the pilot (if any);
- Incidents unrelated to the pilot (if any);
- Additional comments.

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