SHared automation Operating models for Worldwide adoption

SHOW

Grant Agreement Number: 875530

D1.1: Ecosystem actors needs, wants & priorities & user experience exploration tools

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Legal Disclaimer

Executive Summary

This document, standing for *D1.1: Ecosystem actors' needs, wants & priorities & user experience exploration tools* consists part of WP1, which aims to depict and analyse the real and perceived needs of the SHOW ecosystem and to integrate then in the priority UCs that will be applied in the demonstrations across all project sites.

The definition of the full ecosystem of the project around automated urban mobility is being described within this report, for which a two-fold approach is being followed, (a) in terms of actors and (b) in terms of mapping actors to each of the project's pilot sites. Moreover, the common SHOW terminology that has been developed through a collaborative process is presented, as agreed by the project's partners, which is going to be further updated and aligned with international terms.

In addition, this report includes the identification of the prioritised needs, wants and expectations of the AV users, per relevant stakeholder group, achieved by the realisation of a desktop research focusing specifically on AV user and stakeholder acceptance, while its outcomes will be complemented by a number of on-line surveys and interviews that will be realised in each of projects' Mega and Satellite sites before and during the Pilots and are being described in detail here.

Deliverable D1.1 also describes and highlights the operating module and mechanisms that are developed and applied in the project in order to accommodate user opinion discovery regarding the envisioned shared, connected, electrified fleets of AV in coordinated Public Transport (PT), Demand Responsive Transport (DRT), Mobility-as-a-Service (MaaS) and Logistics-as-a-Service (LaaS) operational chains in SHOW pilots (A1.2).

The continuous monitoring of user acceptance criteria in the test sites serves to predict the future market success of the innovative approaches. All the technical developments will be directly linked to the prospective customers and other potential stakeholders of the mobility services. The use of social media data to analyse user acceptance will be a new strategy used in this context.

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Abbreviation List

Abbreviation	Definition
AR	Augmented Reality
AaaS	Automation as a Service
AI	Artificial Intelligence
AGT	Automated Guided Transport
AGV	Automated Guided Vehicles
ARTS	Automated Road Transport Systems
AV	Autonomous Vehicle
AVP	Automated Valet Parking
B2B	Business to Business
B2C	Business to Consumer
BERT	Bidirectional Encoder Representations from Transformers
BRT	Bus Rapid Transit
C-ITS	Cooperative Intelligent Transportation System
CAV	Connected and Autonomous Vehicle
CCAM	Cooperative, Connected & Automated Mobility
CCAV	Cooperative Connected Automated Vehicle
CRISP-DM	Cross Industry Standard Process for Data Mining
DRT	Demand Responsive Transport
FMS	Fleet Management System
GDPR	General Data Protection Regulation
I2V	Infrastructure to Vehicle
IoT	Internet of Things
IT	Information Technology
ITS	Intelligent Transportation System
LaaS	Logistics-as-a-Service
LDA	Latent Dirichlet Allocation
LoS	Letter of Support
LSTM	Long Short-Term Memory
MaaS	Mobility-as-a-Service
MoU	Memorandum of Understanding
NER	Named Entity Recognition
NLP	Natural Language Processing
NP	Nondeterministic Polynomial
OEM	Original Equipment Manufacturer
PPP	Public-Private Partnership
PRM	Person with reduced mobility
PT	Public Transport
QoS	Quality of Service
SAV	Shared Autonomous Vehicles
SME	Small or Medium Enterprise
SUMP	Sustainable Urban Mobility Plans
SULP	Sustainable Urban Logistics Plan
TAM	Technology Acceptance Model
TLA	Traffic Light Assist

Abbreviation	Definition
TMC	Traffic Management Centre
TRL	Technology Readiness Level
UC	Use Case
UI	User Interface
UTAUT	Unified Theory of Acceptance and Use of Technology
V2I	Vehicle to Infrastructure
VASes	Value Added Services
VEC	Vulnerable to Exclusion
VR	Virtual Reality
VRU	Vulnerable Road User
WP	Work Package

1. Introduction

1.1 Purpose and structure of the document

This document includes the definition of the ecosystem of automated urban mobility, the extended reference terminology for the full course of the project, and the specific methodology and mechanisms through which ecosystem needs, wants and priorities are captured in the project (through literature reviews and on-line surveys). The outcomes of the literature review first loop will be part of this document. Forty-three different sources were reviewed and analysed in a systematic manner until M6. In addition, the A1.2 operating module and mechanisms that are developed and applied in the project are described within this document in order to accommodate user opinion discovery in the social media regarding the envisioned shared, connected, electrified fleets of AVs in coordinated PT, DRT, MaaS and LaaS operational chains in SHOW pilots.

After an introduction (**chapter 1**), **chapter 2** (Methodological Approach) highlights the methodological aspects regarding the definition of the ecosystem, the definition of the terminology, the synthesis of the research outcomes and the different methods to assess needs and acceptance.

Chapter 3 presents the ecosystem according to 2 levels:

- A generic level defining the different stakeholders of the project,
- A specific level listing the stakeholders of each demonstration site (**Appendix I**).

Chapter 4 describes the followed approach to build the terminology definition, while the terminology itself is detailed in **Appendix II**.

Chapter 5 refers to the ecosystem needs, wants and priorities and comprises two subsections:

- A subsection describing the main inputs from the desktop research,
- A subsection reporting the approaches, objectives, key tools and engagement methods of the on-line and on-site surveys. First versions of the survey tools to be shared with the demonstration sites leaders are presented in **Appendix III**.

Chapter 6 describes the approach used to discover and collect the user opinion in social media. This chapter contains the link to the tool. The keywords used in Social Media mining and algorithms are presented in **Appendix IV**.

Finally, **chapter 7** concludes on the use of the knowledge produced in this Deliverable in the project, the next steps of the different activities and the internal interrelations to build during the next months.

1.2 Intended Audience

The main target group for this Deliverable is all the different partners and stakeholders of the project. It focuses on the importance to engage with all different stakeholders to get a concise and balanced view of their needs, wants and priorities; but also to arrive to a joint consensus representing all key stakeholders' views. Each demonstration site leader must ensure that he/she is aware of the deployment of the needs and acceptance on-site surveys and the different tools to be used.

1.3 Interrelations

The definition of ecosystem will feed the stakeholder forum of A15.2. The criteria of users' recruitment will be accommodated through the user engagement initiatives of A9.3. The user wants & needs exploration is accommodated throughout the demonstration phases of the project (WP11 & WP12). There is a strong liaison with the user acceptance to SP3 tools and user acceptance impact assessment. Indeed, this part of work is closely connected to A9.2 tools of AVL, A9.3 user engagement of EPF and A13.5 user acceptance of DLR and with the approval of the sites. A strong link is also expected with WP2, on the related economic aspects.

Figure 1 details the inter-relation between SHOW components.

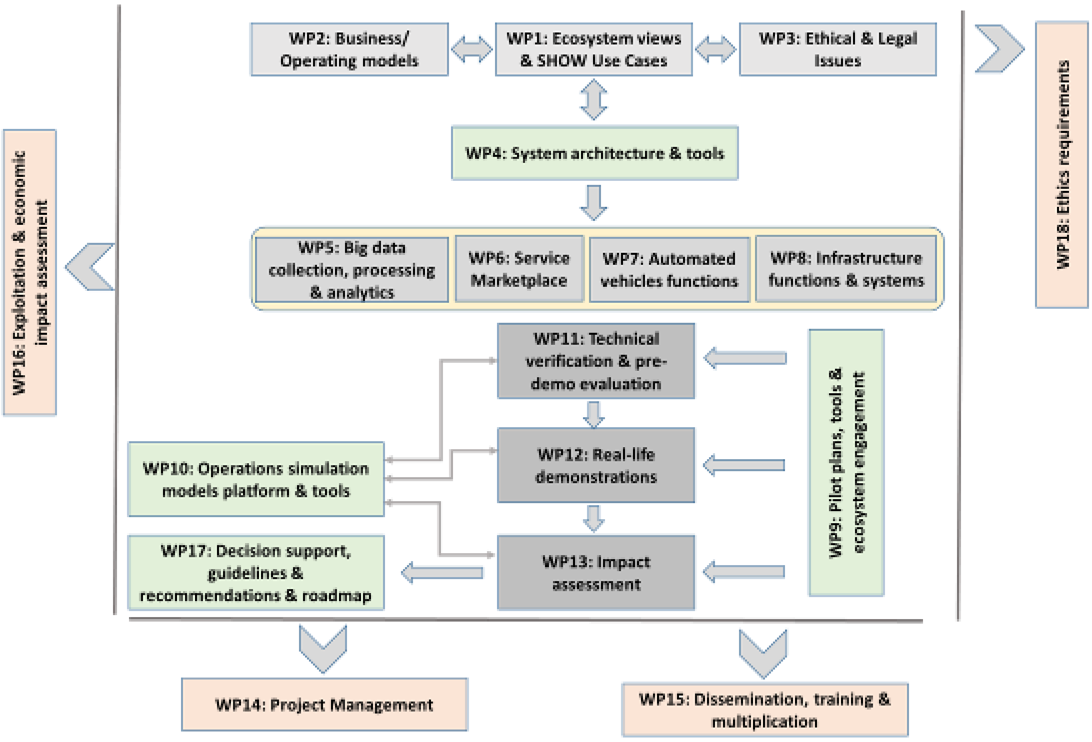

Figure 1: Graphical presentation and inter-relation of SHOW components.

2. Methodological Approach

2.1 Overall approach at a glance

WP1 aims at highlighting the real and perceived needs of the SHOW ecosystem and transforming them to priority UCs to be applied in the demonstrations across all project sites.

WP1: “Ecosystem view and SHOW Use Cases” consists of 3 elements (see Figure 2), corresponding to the WP activities, as shown in the following figure. The WP aims primarily at investigating and elaborating the shared Cooperative, Connected & Automated Mobility (CCAM) involved stakeholders’ needs and priorities in an iterative manner throughout the whole course of the project. For that purpose, it provides specific tools and mechanisms (e.g., survey tools, social media based or not, checklists, etc.).

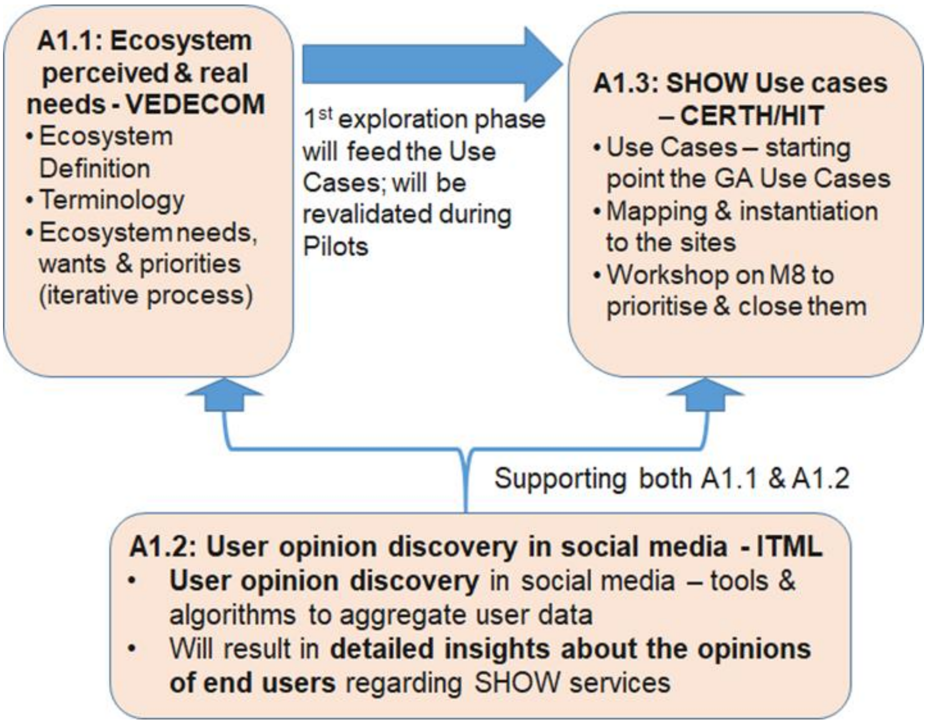

Figure 2: Approach for WP1.

One of the main outcomes of the work package is the SHOW Use Cases, resulting from A1.3 work, that constitute the reference point for the project. Starting from the existing Use Cases that are described on upper level in the Grant Agreement, WP1 participants in the first place and the whole Consortium in a second stage, will elaborate, specify and instantiate them.

As part of the main outcomes of this work package, the WP begins by working with the definition of the value chain ecosystem that is then instantiated for the SHOW Mega Sites and the formulation of the project terminology, exploiting and building on top of existing terminologies (i.e., the one emerging from Drive2theFuture). The ecosystem stakeholders’ wants, needs and priorities are investigated through a series of mechanisms, the most important of which being the desktop research conducted as of the beginning of the project and the massive user acceptance survey planned to take place iteratively in the context of the pre-demo and demo activities of the project.

Traditional and more innovative mechanisms are explored for the latest, as a big audience needs to be reached. Within A1.2: User opinion discovery in social media, the tools that support all exploration and dissemination activities of the project are developed and there it is explored whether they can support the user acceptance survey of A1.1. The WP closes with a Pan-European workshop, the first to be held in the project that will ratify the so far key project outcomes and seek for more feedback to stabilize them, namely the Use Cases, the business/operating models, regulatory aspects, etc.

Thus, Deliverable (D1.1) is at the reports on the work performed within A1.1 and A1.2 of the project and provides the key input needed towards the formulation of SHOW Use Cases.

Figure 3 presents the inter-relations between the different actions contained in this deliverable.

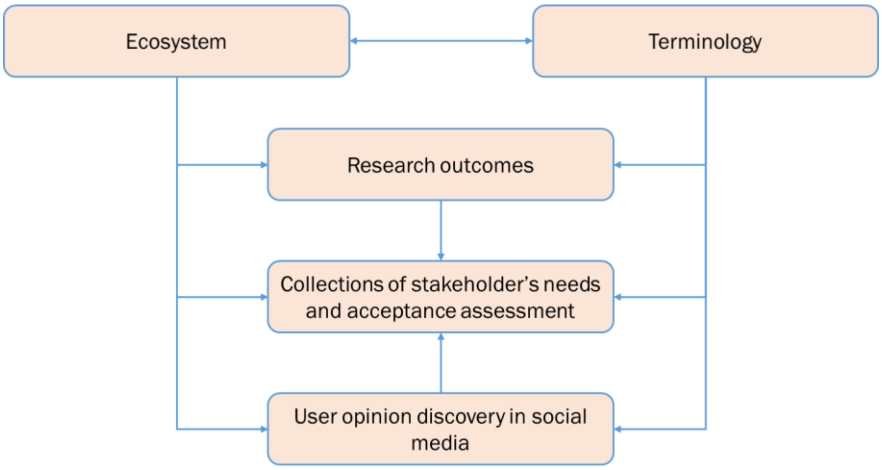

Figure 3: Inter-relations between the D1.1 actions.

2.2 Definition of ecosystem

The first objective of this Activity is to define the whole ecosystem of the project around automated urban mobility in order to identify the stakeholders who will be relevant to interview in our surveys. This ecosystem includes all the internal (i.e., SHOW partners) and external (e.g., municipalities, users) stakeholders to SHOW project.

The definition of the ecosystem follows a two-stage approach that includes:

- A generic description of the ecosystem;
- And an instantiated one for each site.

For the first step, a definition of the stakeholders' categories is being proposed, as listed below:

- Original Equipment Manufacturers (OEMs) and transport/mobility operators;
- Tier 1 suppliers, telecom operators, technology providers, Small or Medium Enterprises (SMEs);
- Research & academia;

- Passengers and other road users encompassing Vulnerable to Exclusion (VEC);
- Umbrella associations;
- Road operators, Authorities (Cities, Municipalities, Ministries) & policy makers.

To achieve this goal, we asked the demonstration site leaders to provide a description of their main activity and their contributions and added value to the project as well as the added value of the project for them (see section 2). For this purpose, an Excel file describing the shared Cooperative Connected Automated Vehicle (CCAV) ecosystem was developed in the project. This will feed the stakeholder forum of A15.2 to include a balanced representation of all recognised actors.

The second step will immediately follow the first step and will be conducted at the same time. In the second step, we proposed that the same individuals would complete a finer description with another Excel table which describes in more detail the identification of stakeholders for the different use cases proposed by each pilot site (see section 0 and Appendix I).

The crossing point of these two approaches allows us to quickly build the ecosystem definition of each pilot site according to its particularities.

2.3 Definition of terminology

The common SHOW terminology has been developed through a collaborative process in which all A1.1 participants were involved, as they were requested to provide additional inputs to the initial set of terms provided by the Drive2theFuture[1] project. All provided input was then processed to remove duplicates and terms that were not fully related to the work of SHOW. The first version of the SHOW Terminology is available in "Appendix II – Terminology" of this document. Further updates and alignment with international terms are expected during the life of the project, therefore an updated and final version of the SHOW Terminology will be included in D1.3 (M42).

All definitions have been analysed, with the use of the following categories/fields:

- Term;
- Group (Vehicle, User, Infrastructure, Operational, Other);
- Abbreviation (If applicable);
- Definition;
- Source.

Based on the Drive2theFuture, other sources considered, include input from: EC-funded projects (ARCADE, ENSEMBLE, HEADSTART, ENABLEs3, InterACT, PEGASUS, PROSPECT, SaferTec), DINSAE-91381, ERTRAC, IEC 61508, ISO 26262-1, ISO/IEC 27000, ISO/IEC 27032, PAS 11281, PAS 1885, SAE-J3016 and SAE-J3063.

The procedure for new terms will follow the following steps:

1. Verification and documentation of its source;
2. Check whether the term is a synonym of an existing one;

[1] http://www.drive2thefuture.eu/

3. Check whether the term is unambiguous and precise (see SAE-J3016, deprecated terms);
4. Addition of new term and completion of all fields for its analysis.

2.4 Synthesis of research outcomes

The main research objective is to come up with the identification of the needs and priorities per relevant stakeholder group, by the realisation of a desktop research focusing specifically on AV user and stakeholder acceptance, while its outcomes will be complemented by a number of on-line surveys that will be realised in each of SHOW Mega and Satellite sites in 2 phases, before and during the Pilots.

Shared and cooperative automation in Public Transport (PT) in urban context has been investigated and as much as possible has been associated to private vehicle transport, DRT and MaaS. Both passenger and freight transport are addressed. All the key findings will also feed the project Use Cases in order to ensure that they truly respond to the users' demand.

This goal is pursued through the review of a set of initiatives and studies incorporating pilot demonstrations and other field studies, as well as respective papers and reports relevant to the development, testing, evaluation and impact assessment of shared CCAV for passenger and freight transport in urban and peri-urban environments, aiming to depict the value chain requirements and prioritised needs, wants, and expectations of the users and other stakeholders.

Respective solutions will have to be integrated with conventional ones in the context of the current transport paradigm and under large scale holistic approaches, such as Sustainable Urban Mobility Plans (SUMPs) / Sustainable Urban Logistics Plan (SULPs), regarding MaaS and LaaS. They comprise autonomous driven, connected and electrified vehicles (SAE level 3, 4 or 5) together with their sub or peripheral systems and provided services, used to provide on demand, individualised door to door transportation services for passenger and cargo transport, inside urban and peri-urban areas. Those solutions are implemented, tested and assessed either within an isolated and protected environment or interrelated within the conventional transportation means. Initially, they are considered to be additional or of added value. However, it is expected that in due time, within the next couple of decades they will be at first integrated with the existing conventional ones and gradually replace them.

The key fields of the research were to identify the a) **objectives**, b) **focus and type of operation**, c) the **stakeholder categories**, d) **the type of environment and the vehicle type**, e) **the needs/wants/priorities per stakeholder category** and f) **the major outcome of** each analysed **literature source**. The target audience is the SHOW project ecosystem, which includes both public (e.g., authorities) and private (e.g., SMEs) actors, involved in the existing infrastructure and equipment, the established services and of course the transportation and telecommunication networks.

The desktop research was conducted with the use of a comprehensive spreadsheet/template for the collection of all the key information for each relevant source considered and analysed. A group of SHOW partners filled in the spreadsheet identifying a) findings of relevant projects they have participated in, b) papers and publications and c) available results of relevant reviews and questionnaires. The spreadsheet has been divided in columns, each one of which requesting different information. In particular, the first section of columns comprises of general information (e.g., source's title, year of publication, etc.). The second section is about its content, its focus, the types of stakeholders involved, the environment and conditions where AVs were tested in, the vehicle(s) type and the level of automation; the last section is about the needs/wants/priorities identified, stakeholders comments, the major outcome and additional information. In addition, the spreadsheet template has provided definitions of the different types of operations anticipated in the context of SHOW, the stakeholders' categories as well as the SHOW thematic areas that the Use Cases – and consequently this exploration phase – should address. Those thematic areas are listed below:

a. (Shared cooperative) Automation in Public Transport
b. (Shared cooperative) Automation of Private Vehicles (mainly for first/last mile connections)
c. (Shared cooperative) Automation and MaaS
d. (Shared cooperative) Automation and DRT
e. (Shared cooperative) Automation in freight transport

The structure of the desktop research results is based on the types of (shared cooperative) automation operation listed above. Each section describes an overview of the subject and then summarises the critical findings of the sources reviewed. The findings are presented in a table format, where **gaps**, **needs**, **wants** and **priorities** are listed per stakeholder type. More specifically, in each one of the tables for each operation type, the gaps per stakeholder group are identified and connected to their relevant needs. This information is also enhanced by the description of some additional stakeholders' wants of lower urgency and importance that however, complete the picture per stakeholder group. This information results to the definition of the priorities of the group and their prioritisation level, based on **3 priority levels** defined in the project: a) **essential**, referring to the needs/wants/priorities that are vital and have to be taken into account immediately by relevant technology providers, legislation, etc. b) **secondary**, referring to the needs/wants/priorities that are considered important and have to be taken into account at a secondary stage by relevant technology providers, legislation, etc. and c) **additional**, referring to the needs/wants/priorities that are good to have and have to be taken into account at some point by relevant technology providers, legislation, etc., once essential and secondary needs/wants/priorities have been satisfied. The Use Cases of the project, to be elaborated in D1.2, are expected to respond to them also following this order.

All relevant sources that were reviewed are displayed in the list of references at the end of the report.

2.4 Collection of stakeholder's needs and acceptance assessment

Overall approaches of stakeholder's needs and acceptance

The assessment of the users' needs and more generally stakeholders' needs is prompted by a great number of interests as shown by the scientific literature:

- A better quality of the final service thanks to a better adequacy to the expectations of the users (Damodaran, 1996);
- A more precise delimitation of the objectives of the project (Nielsen, 1993);
- A better targeting of solutions on the market (Cooper & Kleinschmidt, 2000);
- A positive effect on the use of the service/product designed in the short and medium term (Baroudi, Olson, & Ives, 1986);

- A general user satisfaction and higher level of perceived usefulness of the service/product (Foster & Franz, 1999).

Moreover, a lot of studies have shown that to collect, understand and integrate the stakeholders' needs and wants earlier in the experimental stages leads to a better acceptance of a service, a tool or a product. Technology or services acceptance refers to the subjective judgments that make the technological object attractive, usable, useful and even essential for users (Venkatesh et al., 2003). To address all these aspects fully, an acceptance study needs to identify the object, the user category and the context of use. Two complementary approaches exist: the ergonomic and the social approaches. The ergonomic approach defines an individual acceptance level based on the preferences and needs of individuals (e.g., practical acceptance). The social approach defines a collective acceptance (*vs* individual acceptance) and concerns values and beliefs that are shared.

Studying the acceptance of a new technology or service makes it possible to understand and predict the use behaviours associated with it. Acceptance is increasingly considered in the strategies of decision makers in order to "prevent" disputes and opposition, and to ensure successful deployment. Acceptance is a process that takes place on a temporal continuum in three steps (see Figure 4).

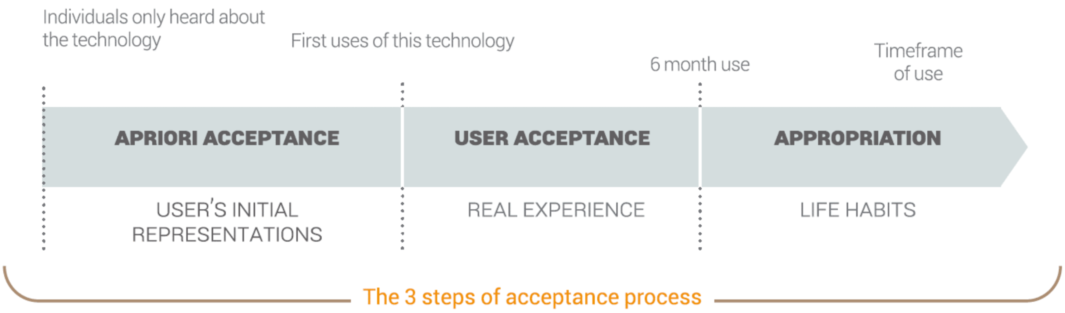

Figure 4: Acceptance process (representation proposed by VEDECOM).

The first step corresponds to the ***a priori* acceptance** (before the first use). *A priori* acceptance is the consequence of a comparison judgment between reality and its known alternatives, i.e., the possible benefits generated by the new technological device or the new service. The other two steps correspond to the **acceptation in use** of the technology (from the first uses to 6 months of use) and **appropriation** (established use in everyday life). The acceptation step takes place from the first uses to a real experience with the technology (Venkatesh et al., 2003). The step of actual appropriation of the technology characterises the step of adequacy between the user's real needs and the technology which becomes a real component of her/his identity.

Assessment of needs in the mobility service context

A frequent approach used in collecting needs consists in building experience or user journey maps (see for example Crosier & Handford, 2012, or Adlin & Jamesen Carr, 2006). Maps are precious tools to better understand and anticipate interactions between users and a specific product or service. They are often used to make projections in the future users' or stakeholders' minds.

The first stage consists in drawing the typical journey of a user. Then, on this basis, both qualitative and quantitative methods can be deployed to collect the different needs in each step.

Based on previous research projects (see for example, Coeugnet et al., 2018, EVAPS, ADEME Project), the inclusion of the 6 following main categories is planned (see Figure 5):

- **Information and signage** (e.g., display at bus stops, means of recognizing the correct vehicle, information after the journey about congestion or disruption...);
- **Service request** (e.g., reservation on an application, tickets, included in a subscription card, on demand or continuous with a timetable, service available all day and/or night…);
- **Identification & boarding** (e.g., validation, code, automatic doors, privacy…);
- **Service start** (e.g., automatic start or with a button press…);
- **On-board experience and activities** (e.g., speed and position of the vehicle, available connections, available space per person, infotainment, shared activities, control on the driving and/or on the vehicle, view of the cameras, safety …);
- **Descent** (e.g., automatic stop, doors opening, satisfaction assessment, feedback after the journey and support in the event of lost luggage and complaints …).

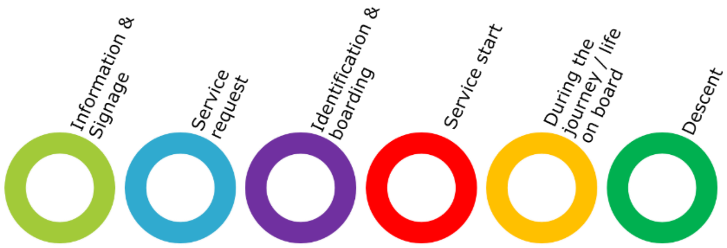

Figure 5: Categories of a user journey map adapted to an automated mobility service (Coeugnet et al., 2018).

The assessment of the ecosystem's needs will allow us to know how mobility services should be adapted to users' lifestyle and stakeholders' expectations, in order to improve their acceptance.

Assessment of user experience: the models of acceptance

To study the social dimension[2] of acceptance, several theoretical models can be used (e.g., the multi-level model on automated vehicle acceptance: MAVA, Nordhoff et al., 2019, the car technology acceptance model: CTAM, Osswald et al., 2012), but these models contain a lot of dimensions which do not always apply in our application domain (i.e., automated mobility offer and services).

To focus on common dimensions that can be applied to all the different SHOW Use Cases, we propose to use a general acceptance model. Many studies have been carried out and many theories and models were provided to explain acceptance, such as the Technology Acceptance Model (proposed in different versions, TAM 1, Davis et al., 1989; TAM 2, Venkatesh & Davis, 2000; TAM 3, Venkatesh & Bala, 2008) or the

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[2] *Dimension (or factor) in Psychology is defined as a variable of the behaviour, thought or perception which can be measured objectively or subjectively.*

The Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh, Morris, Davis & Davis, 2003). These two models come from the Theory of Planned Behavior (Ajzen, 1991) and was used in several studies.

The TAM relies on two essential dimensions to explain the behavioural intention, the perceived usefulness and the perceived ease of use (see Figure 6 for a presentation of the TAM 1). The first version of the TAM can be used as a validation tool to know the user needs and expectations. The core of the model contains three main variables[3] that are measured by means of psychometric scales composed of several items:

- **Perceived Ease of Use** – "the degree to which a person believes that using a particular system would enhance his or her […] performance." (Davis et al., 1989);
- **Perceived Usefulness** – "the degree to which a person believes that using a particular system would be free from effort." (Davis et al., 1989);
- **Behavioral Intention to Use** – this factor predicts the probability of using the technology. It is the concrete measurement of acceptance. It is influenced by the attitude, a psychological or mental predisposition towards a technology.

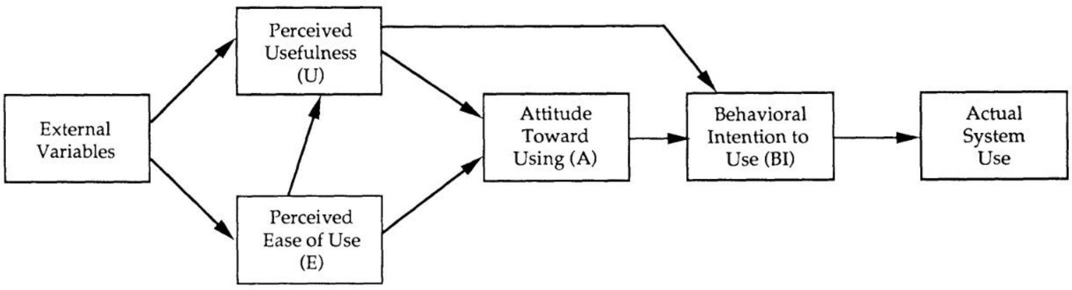

Figure 6: TAM 1 (Davis et al., 1989).

The Unified Theory of Acceptance and Use of Technology (UTAUT; Venkatesh, Morris, Davis & Davis, 2003), **aims to predict the use of a technological system based on:**

- The **performance expectancy –** It is the intensity by which a user believes that the use of a technology can improves his performance.
- The **effort expectancy –** It is the ease with which a user will be able to use the technology.
- **The social influence –** This dimension refers to the user's perception of what his close entourage would advise him (e.g., parents, friends, colleagues, children) about the use of technology (e.g., image, subjective standard).
- And the **facilitating conditions –** It is the user's perception of the existence of an organizational structure that could support the use of the technological system (Venkatesh, Morris, Davis & Davis, 2003).

Finally, the behavioral intention of an user is the model dependent variable. Intention is the motivation to perform the task, which determines the adoption of a volitional

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[3] *Attitude towards using has been quickly abandoned as a main variable because considered as inseparable from the concept of behavioral intention (Davis & Venkatesch, 1996).*

behavior (i.e., under the voluntary control of the individual). The UTAUT model allows a good prediction (i.e., explained variance of 70% of the behavioral intention of use; cf. Venkatesh, Morris, Davis & Davis, 2003) whatever the cultures and technologies of which one wishes to explain and predict use (Casey & Wilson-Evered, 2012).We propose to use the UTAUT model to assess a priori acceptance because it offers a better prediction of behavioral intention with technology than TAM or than the assessment of acceptance in use. Indeed, this model takes into account the social aspect of acceptability, which is essential and highly explanatory. However, the two approaches, TAM and UTAUT, are very close and it is also possible to consider the use of one cannot go without the other (Figure 7).

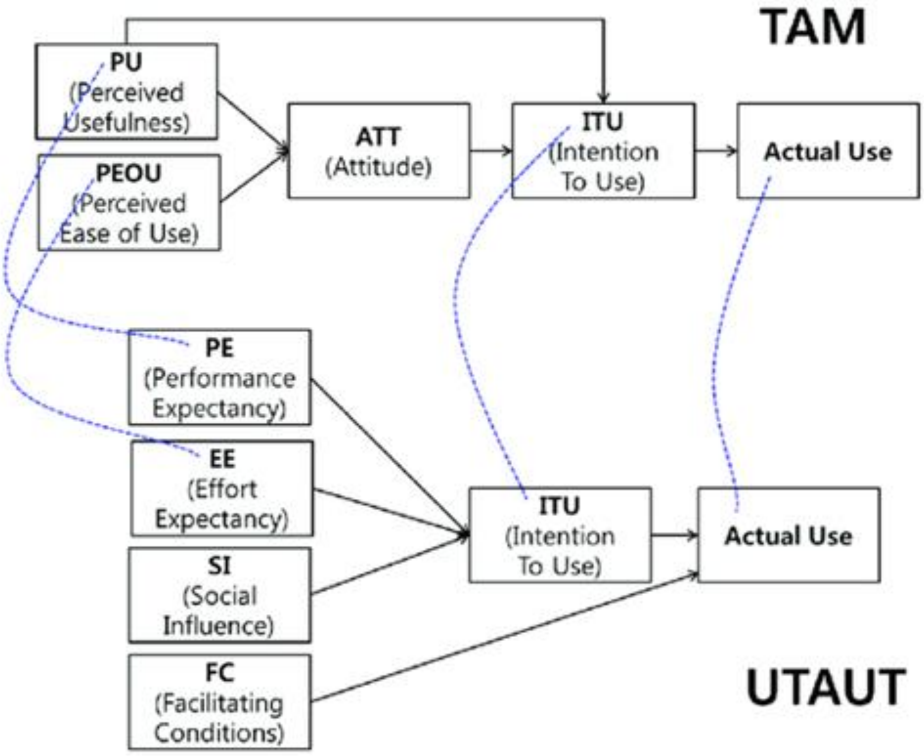

Figure 7: Comparison between UTAUT and TAM (Kim et al., 2015).

In another part, during the tests, to assess the acceptance in use, which has to be differentiated from the *a priori* acceptance, we propose to focus on a more practice-focused model, the Nielsen's model on system acceptability (Nielsen, 1993). This model allows us to precisely refine the dimensions of practical acceptance / acceptance in use (see Figure 8).

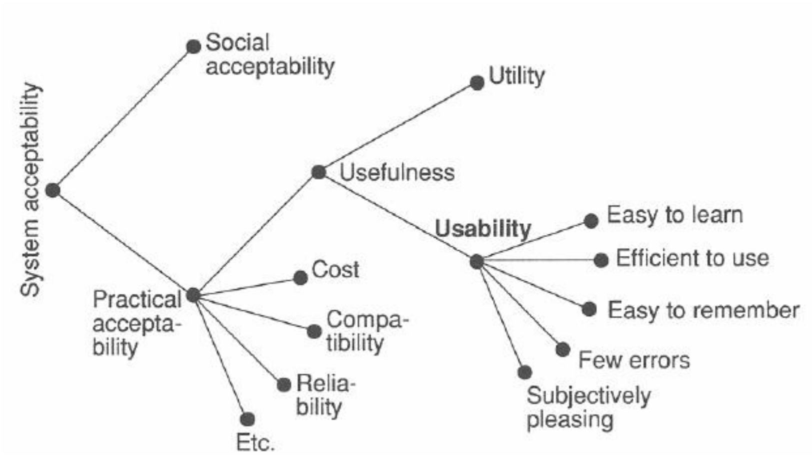

Figure 8: A model of the attributes of system acceptability (Nielsen, 1993).

We selected the four dimensions that would explain most of the practical acceptability in the case of the SHOW project Use Cases:

- the **utility** of the mobility services and/or vehicles,
- the **usability** of the mobility services and/or vehicles including the satisfaction,
- the **compatibility** of the mobility service,
- the **reliability** perceived by users.

The assessment of users' acceptance will allow us to know why the SHOW proposed mobility services are accepted or not and which components still need to be improved.

Synthesis and methodological elements

The previous elements allow us to construct the methodological bases of the assessment of the ecosystem's needs and to plan the different surveys. Here are listed the main points to consider:

- The collection of ecosystem needs must account of all the dimensions of a mobility service (see the categories of the journey if a mobility service user);
- The acceptance evolves over time, it is necessary to have multiple measurements during the project time;
- Some robust models offer the possibility to assess the different dimensions of acceptance (e.g., UTAUT, TAM).

We propose to conduct two types of surveys:

- <u>A "long" online survey</u> to collect both the ecosystem needs and users' *a priori* acceptance.
- <u>A short and optimal survey</u> (on-site and/or online) to collect the user experience and stakeholders' perceptions at three different times of the demonstrations (at the beginning, in the middle and at the end of the SHOW demonstrations).

Chapter 5 will present the objectives, key tools and engagement methods as well as a first proposal of assessment tools starting from the models proposed above and from the literature survey.

2.5 User opinion discovery in social media

The approach that has been followed to extract from the Social Media (Twitter & Reddit) the opinion/issues reported patterns (results) regarding the envisioned shared, connected, electrified fleets of AVs in coordinated PT, DRT, MaaS and LaaS operational chains in SHOW pilots is an adjusted version of the CRISP-DM, a cross industry standard process for data mining and the most widely-used analytics model as it is a robust and well-proven methodology. Our approach includes the following four general steps:

a) Business Understanding and data preparation;
b) Modelling;
c) Evaluation of the model and its results;
d) Order patterns identification.

Figure 9 presents the tools and the outcome of the processing more detail.

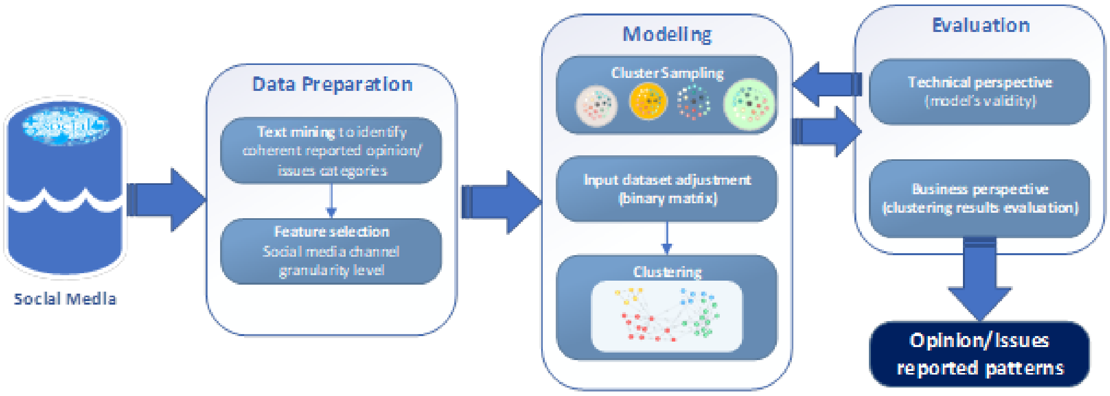

Figure 9: Opinion/Issues reported patterns extraction.

3. Ecosystem

To achieve the goal of an ecosystem definition of the SHOW project, which presents the particularity of having a lot of partners in the mobility field, we have chosen to define the ecosystem as follows:

- A first level of information (Generic Ecosystem) that includes all the stakeholders of the project. We used a table to present and provide a short description of all the different types of actors of the project.
- A second level of information (Experimentation sites) that includes for each SHOW pilot site a table that presents all use cases and stakeholders of the project and that describes the test means used for the experimentations.

3.1 First level: generic ecosystem

Description of the project actors

This level includes the stakeholders of the project and consists of a table in which all the types of actors of the project are presented with the definition of each of them (see Table 1). This table also lists the stakeholders who can intervene in the SHOW project even if currently there are no identified partners in the SHOW consortium.

Table 1: Ecosystem definition and connection to SHOW partners and external stakeholders.

Stakeholders		Definition	SHOW partners
OEM and transport/mobility operators	***OEM (Original Equipment Manufacturer)***	An industrial customer purchasing a product with the aim of integrating it into another product to be sold on another industrial market or to a final consumer. Example: Renault (OEM) buys tires from Michelin to be fitted on cars which will then be sold to end users.	4.NAVYA
			5.EASYMILE
			10.e.GO MOOVE GmbH (e.Go)
			12.IRIZAR e-MOBILITY S.L. (IRIZAR)
			13.SENSIBLE 4 OY (SENSIBLE)
	Transport/ Mobility operators	A mobility operator is a service provider to whom it is possible to subscribe. Following signature, a user who subscribes to a mobility operator will be able to access a mobility service. A user can also buy a ticket for occasional use of the service offered by operator.	6.TRANSDEV GROUP
			7.KEOLIS
			8.Wiener Linien GmbH & Co KG (Wiener Linien)
			9.Rhein-Neckar-Verkehr GmbH (RNV)
			11.EMPRESA MUNICIPAL DE TRANSPORTES DE MADRID SA (EMT)
			14.SOCIETE DES TRANSPORTS INTERCOMMUNAUX DE BRUXELLES SSF (STIB)
			15.Gruppo Torinese Trasporti S.P.A. (GTT)
			26.Trafikselskabet Movia (MOVIA)

Stakeholders		Definition	SHOW partners
Tier 1 suppliers, telecom operators, technology providers and services company	***Tier 1 Suppliers / Technology providers***	Tier 1 Supplier: Supplier who delivers directly to the company that produces, assembles or finishes the marketed product. Technology provider: means any individual, partnership, corporation, or association that designs, manufactures, installs, operates, distributes or supplies a technology.	16.VALEO VISION SAS 17.SIEMENS MOBILITY GMBH (SIEMENS) 18.ERICSSON AB (ERICSSON) 19.T-SYSTEMS INTERNATIONAL GMBH (T-Systems) 20.ROBERT BOSCH GMBH (BOSCH) 32.KAPSCH TrafficCom AG (KTC) 35.SWARCO MIZAR SRL (SWARCO) 37.Objective Software Italia SRL (OBJECTIVE) 38.INDRA SISTEMAS SA (INDRA) 39.BESTMILE SA (BESTMILE) 40.EUROMOBILITA SRO (EUROMOBILITA) 45.INFORMATION TECHNOLOGY FOR MARKET LEADERSHIP (ITML) 46.CTLUP SRL (CTLUP)
	Services companies	Company that carries out activities that add value to any product. It may also act as a service provider for a private individual or another company, in return for remuneration.	33.AVL LIST GMBH (AVL) 34.FEV EUROPE GMBH (FEV) 36.COMBITECH AB (COMBITECH) 41.BAX INNOVATION CONSULTING SL (Bax&Co) 43.SITOWISE OY (SITOWISE) 44.ARTIN spol, sr.o. (ARTIN) 55.AIT AUSTRIAN INSTITUTE OF TECHNOLOGY GMBH (AIT) 56.IDIADA AUTOMOTIVE TECHNOLOGY SA (IDIADA)
	Telecom operators	A telecommunications operator is an entity that offers remote communication services.	*External stakeholder*
Research and academia		An establishment, laboratory or research and teaching organisation specialising in technological and human sciences. They may specialise in basic research or may be oriented towards applied research. They may be linked in partnership with universities, companies and ministries.	2.ETHNIKO KENTRO EREVNAS KAI TECHNOLOGIKIS ANAPTYXIS (CERTH) 31.CENTRE HOSPITALIER UNIVERSITAIRE DE RENNES (CHU) 42.IESTA – INSTITUT FUR INNOVATIVE ENERGIE & STOFFAUSTAUSCHSYSTEME (IESTA) 47.JRC -JOINT RESEARCH CENTRE- EUROPEAN COMMISSION (JRC) 48.NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO (TNO) 49.STATENS VAG- OCH TRANSPORTFORSKNINGSINSTITUT (VTI) 50.VEDECOM, Institut du Véhicule décarboné communicant et de sa mobilité (VEDECOM) 51.Teknologian tutkimuskeskus VTT Oy (VTT) 52.VRIJE UNIVERSITEIT BRUSSEL (VUB) 53.RISE RESEARCH INSTITUTES OF SWEDEN AB (RISE) 57.INSTITUTE OF COMMUNICATION AND COMPUTER SYSTEMS (ICCS) 58.FZI Forschungszentrum Informatik (FZI Research Center for Information Technology) 59.National Technical University of Athens (NTUA)

Stakeholders	Definition	SHOW partners
		60.COMMISSARIAT A L'ENERGIE ATOMIQUE ET AUX ENERGIES ALTERNATIVES (CEA)
		61.FONDAZIONE LINKS – LEADING INNOVATION & KNOWLEDGE FOR SOCIETY (TECNALIA)
		62.SALZBURG RESEARCH FORSCHUNGSGESELLSCHAFT M.B.H. (SRFG)
		63.FONDAZIONE LINKS – LEADING INNOVATION & KNOWLEDGE FOR SOCIETY (LINKS)
		64.DANMARKS TEKNISKE UNIVERSITET (DTU)
		65.UNIVERSITA DEGLI STUDI DI GENOVA (UNIGENOVA)
		66.CENTRUM DOPRAVNIHO VYZKUMU v.v.i. (CDV)
		67.UNIVERSITE DE GENEVE (UNIGE)
		68. Virtual Vehicle Research GmbH (VIF)
		69.Deutsches Zentrum für Luft- und Raumfahrt (DLR)
Passengers and other road users encompassing VEC	Passengers: Any user of a vehicle who has no role in the operation of that vehicle. Other road users: Any individual that participates in the surrounding traffic without being a direct AV service user.	

<table>
<tr><th colspan="2">Stakeholders</th><th>Definition</th><th>SHOW partners</th></tr>
<tr><td colspan="2" rowspan="7">Umbrella associations/Non-profit organisations</td><td rowspan="7">An umbrella association is an association (often linked to a specific industry) of institutions that work together to coordinate activities or a set of resources.

A non-profit organisation can be an association, a society or a club. The members of a non-profit organisation do not receive any financial benefit from it. Any profit made must be reinvested in the organisation.</td><td>1.UNION INTERNATIONALE DES TRANSPORTS PUBLICS (UITP)</td></tr>
<tr><td>3.EUROPEAN ROAD TRANSPORT TELEMATICS IMPLEMENTATION COORDINATION ORGANISATION – INTELLIGENT TRANSPORT SYSTEMS & SERVICES EUROPE (ERTICO)</td></tr>
<tr><td>21.EUROCITIES ASBL (EUROCITIES)</td></tr>
<tr><td>22.INTERNATIONAL ROAD FEDERATION (IRF)</td></tr>
<tr><td>23.EUROPEAN PASSENGERS’ FEDERATION IVZW (EPF)</td></tr>
<tr><td>24.POLE DE COMPETITIVITE IDFORCAR (ID4CAR)</td></tr>
<tr><td>54.AUSTRIATECH – GESELLSCHAFT DES BUNDES FUR TECHNOLOGIEPOLITISCHE MASSNAHMEN GMBH (ATE)</td></tr>
<tr><td rowspan="8">Authorities (Cities, Municipalities, Ministries), policy makers, municipality agency and road operators</td><td>Road operators</td><td>Entity with the mission of operating and maintaining the road domain, which is assigned to the needs of land traffic.</td><td></td></tr>
<tr><td>Policy makers</td><td>Persons who have the power to influence or determine policy and practice at the national, regional, or local level.</td><td></td></tr>
<tr><td>Ministries</td><td>Administration, public services under the leadership of a minister.</td><td></td></tr>
<tr><td rowspan="4">Cities and Municipalities</td><td rowspan="4">A municipality is the territorial administration of a communal-type entity that may include a single city or several agglomerations (e.g., villages, hamlets, localities).</td><td>25.STADT AACHEN (Aachen)</td></tr>
<tr><td>27.BALLERUP KOMMUNE (BALLERUP)</td></tr>
<tr><td>29.STATUTARNI MESTO BRNO (BRNO)</td></tr>
<tr><td>30.TAMPEREEN KAUPUNKI (TAMPERE)</td></tr>
<tr><td>Municipality agency</td><td>An agency elaborating different programs of development in a specific field including the different investment funds on the national and international levels and certifications.</td><td>28.ANAPTYXIAKI ETAIREIA DIMOU TRIKKAION ANAPTYXIAKI ANONYMI ETAIREIA OTA – E-TRIKALA AE (E-TRIKALA)</td></tr>
</table>

Added value of the partners to the project

Table 2: Description of the different actors’ added value. lists the added values of different actors of the ecosystem. Two approaches of the added value are proposed:

- The added value in the project (i.e., what stakeholders bring to the project);
- The added value of the project (i.e., what the project brings to stakeholders).

Table 2: Description of the different actors' added value.

Stakeholders	Added value in the project (stakeholders -> SHOW project)	Added value of the project (SHOW project -> stakeholders)
OEM and transport/mobility operators	They will provide the vehicle technology and the capability to offer public transport services. They also share their first experiences by the use of autonomous vehicles, the operationality of a PT control centre, their expertise in terms of business models of public transport into which new mobility services are to be integrated and PTA (Public Transport Authorities) perspectives on contracting, planning and integration of AV service with existing PT.	The project will contribute to the exchange of experience among all the test sites and networking with competent business players regarding customers, technology and operation. It will bring possible solutions for the integration of autonomous vehicles into existing public transport systems, both technically and economically.
Tier 1 suppliers, telecom operators, technology providers and services company	They will contribute to the planning of physical and digital operations, services and infrastructure. They provide for example 5G expertise that can facilitate the visualisation of the situation in real time (3D, HD maps and digital maps).	The project will extend expertise in autonomous vehicles through their real-world deployment via automated driving use cases, facilitating the meshing of private with public transport including energy saving. It will allow the acquisition of knowledge and know-how related to operations and technologies (especially vehicles) which will make it possible to plan and provide integrated services, where autonomous objects / services will be an essential part of the integrated public transport system.
Research and academia	They will provide their research expertise to the many fields around vehicles (e.g., user experience, road safety, traffic modelling, road infrastructure evaluation, intelligent analysis processes, map matching or routing for high-precision maps as well as real-time processing, analysis and interpretation of high-resolution driving trajectories).	The project will improve their expertise and their knowledge in the field of autonomous vehicle research. This new knowledge will be disseminated (e.g., communications and publications) and scientific impacts are expected.
Passengers and other road users encompassing VEC	They will help to develop a product or service that meets their needs, thus increasing adoption and acceptance.	The project will provide offers and transport services adapted to their needs and wants with a quality user experience.
Umbrella associations/Non-profit organisations	They mainly act as representatives of the other stakeholder groups (e.g., users) and provide their expertise about different fields (e.g., coordination, valorisation).	The project will consolidate their expertise.
Authorities (Cities, Municipalities, Ministries), policy makers, municipality agency and road operators	They will provide the infrastructure and the transport system to the project. Their experience with providing public transport and the knowledge of their area/city are an asset for the project.	The project will provide know-how of automated transport in Europe, active cooperation between partners, good practices. It will allow to obtain first-hand experience with autonomous mobility for potential future large-scale implementation.

3.2 Second level: experimentation sites

SHOW project includes **five Mega Sites** (in green in Figure 10), with good geographical balance (Sweden in North Europe, Germany, France, Austria in Central Europe and Spain in South Europe). Mega Pilots constitute of a City or an agglomeration of them (within the same country), that collectively satisfy most SHOW

UCs and cover all vehicle types, traffic environments (urban, peri-urban, corridors) of varying population and traffic density as well as all key traveller groups.

SHOW also includes **six Satellite Sites** (in light red in Figure 10) covering specific SHOW UCs, as being complementary to the Mega Sites, in terms of UCs, applied technologies, traffic environments and geographical coverage (Finland and Denmark in North Europe, Netherlands in Central Europe, Italy and Greece in South Europe, Czech Republic in Eastern Europe).

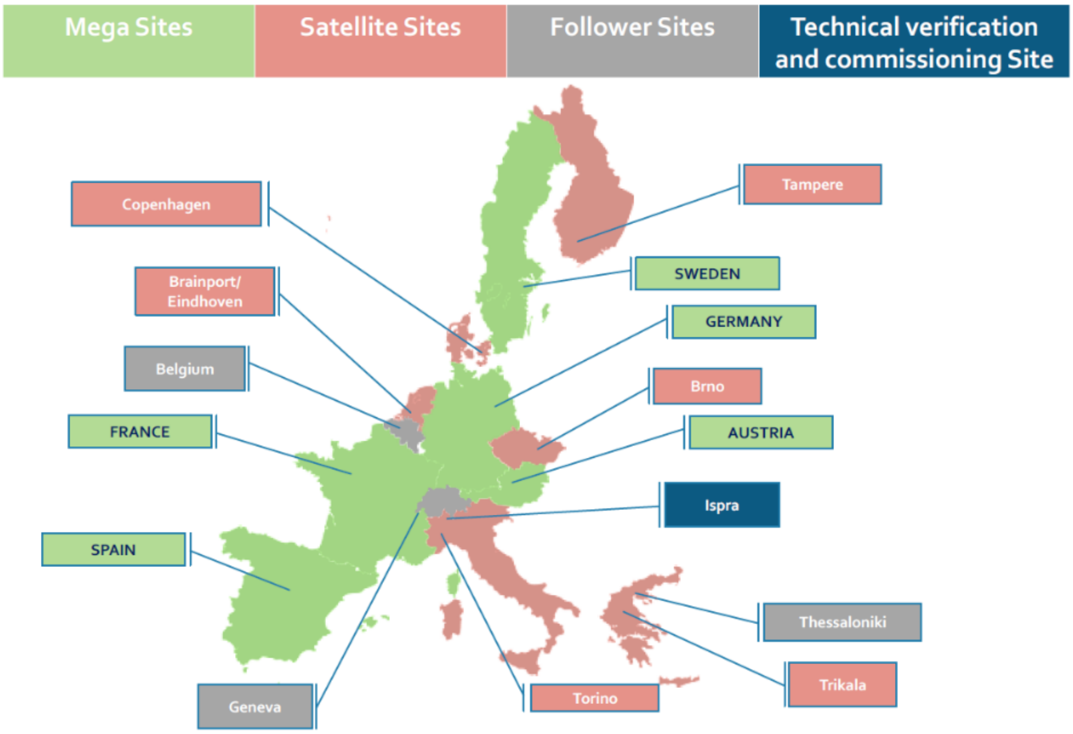

Figure 10: SHOW demonstration sites.

For each demo site, a table in Appendix I presents all use cases of the sites and the stakeholders involved in the project. All the data are not yet available due to current open bidding process. However, the different tables and use cases presented in Appendix I are based on those from the Grant agreement. More precise use cases definitions are currently being prepared and should be included in the deliverable D1.3 due for M9. The current use cases from the Appendix I might be slightly different from the ones that would effectively be tested during the project.

4. Terminology

Appendix II presents the list of terminology which has been built for the SHOW project.

The list includes 157 entries from the different sources listed in the Chapter 2. The Table 3 proposes an example of an entry of the terminology list. It contains [Term]; [Group]; [Common Abbreviation]; [Definition]; [Source].

The different sources are: EC-funded projects (Drive2theFuture, ARCADE, ENSEMBLE, HEADSTART, ENABLEs3, InterACT, PEGASUS, PROSPECT, SaferTec), DINSAE-91381, ERTRAC, IEC 61508, ISO 26262-1, ISO/IEC 27000, ISO/IEC 27032, PAS 11281, PAS 1885, SAE-J3016S and AE-J306.

Table 3: Example of an entry of the terminology list.

Term	Group	Common Abbreviation	Definition	Source
Field operational test	Operational-related	FOT	Study to evaluate functions or vehicles under typical operating conditions in uncontrolled environments encountered by the vehicle under test	DINSAE -91381

Partners have made the terminology available in the form of a spreadsheet on the collaboration tool of the SHOW project, so that everyone can perform dynamic sorting on the corpus.

5. Ecosystem needs, wants and priorities

In this chapter, the two main activities regarding the recognition of needs, wants and priorities of the ecosystem will be presented: the desktop research and the surveys. As a reminder, the grant agreement defines the expectations on A1.1. as "*a number of on-line surveys […] will be realised in each SHOW Mega and Satellite site before and during the Pilots. It will be reiterated in three phases; first at the end of the pre-demo evaluation, then at the midterm of large-scale real-life demonstrations and, finally, at the end of them. Feedback pool will be collected by a representative pool of 1000 stakeholders per Mega Site and 300 ones per Satellite site (covering all stakeholders and travellers cohorts). In the pre-demo phase, users will be basically "observers", while in the real-life demonstrations, respondents will be recruited from travellers experiencing the SHOW solutions*".

5.1 Desktop research

The review of literature sources, reports, and projects developments in relation to autonomous vehicles (AVs) is aimed at the investigation of the ecosystem's attitude towards the use of shared, autonomous, connected and electrified mobility solutions inside urban and peri-urban environments. In particular, the involved stakeholders' wants, needs and priorities were identified, while also their acceptance level towards the gradual penetration of autonomous mobility solutions was investigated. However, the list of sources is not exhaustive, as there are more relevant projects as well as autonomous operating systems that haven't been included. The selected sources are the most relevant ones to the SHOW project and to the scope of this report.

The involved stakeholder ecosystem comprises of the categories defined in Chapter 3.

The main sources reviewed incorporate past/running projects and studies on automated driving solutions, respective scientific and research papers and pilot demonstrations' results and findings on the application, testing and evaluation of autonomous mobility passenger and freight transport solutions. These solutions are mainly inside urban and peri-urban environments, implemented either in separate network or interrelating with the other conventional means of transportation and their respective systems and provided services. A number of different concepts was reviewed under the prism of user needs prioritisation, concerning private (passenger) vehicles, PT, DRT and freight transport, MaaS and LaaS. The autonomous mobility solutions were further assessed as per their potential to be integrated in the frame of large extent, on the upgrading of passenger and freight transport services, such as SUMP / SULP, in the context of spatial planning and design at strategic, tactical and operational level.

Furthermore, the autonomous mobility solutions reviewed were evaluated as per their relevance with the objectives, targets and thematic areas of the SHOW project, creating mature ground for the adoption, development and full integration of such innovations. Apart from the disruptive technology development issues and the legislative framework or legal constraints, the focus was mainly set on the social / ethical parameters and criteria, as determinants of acceptance and approval by the various stakeholders/users' categories. In particular, those solutions were further investigated based on scenario building as per their feasibility, sustainability, interoperability, accessibility (concerning VEC, VRU, PRM and people with other disabilities), replication and twinning, transferability and adaptability in different urban and peri-urban environments.

The sources with the highest level of relevance to the SHOW project objectives, incorporated results and findings on involved stakeholders' wants, needs and priorities mainly concerning the following characteristics:

- Implementation of shared, connected and electrified automation in urban transport networks promoting safety and security, as well as seamless and sustainable (environmentally and economically) mobility;
- High user acceptance, satisfying the majority of users' demands and being cost-efficient under realistic operation conditions, respecting the legal, operational and ethical restrictions;
- Wise decision making on planning and design, under a holistic approach, affiliating with the principles of equal access, i.e., not excluding VEC, VRU, PRM and people with sensory or cognitive disabilities and non-connected traffic participants, adopting appropriate interfaces and elaborating an iterative holistic impact assessment of the policies, measures and initiatives taken; based on users' perception on safety, security, accessibility, comfort, interoperability, ease of use, convenience, (re)liability as well as further added value services provided through automation of vehicles, systems and services;
- Integration of telecommunication, monitoring and controlling of services in real time through Internet of Things (IoT) and Cooperative Intelligent Transportation System (C-ITS) and also the potential for connection to TMCs for remote intervention at critical situations;
- Establishment of business models and exploitation plans promoting long-term partnership agreements and engaging public and private domain (e.g., Public-Private Partnerships), with a clear description of their duties, jurisdiction communication standards, as well as costs and benefits, especially focusing on who is responsible in case of accident or malfunction events;
- Setting up of guidelines, road-mapping, reskilling and training schemes for the future workforce based on research results, knowledge transfer and exchange of experience, know-how and best practices, providing input to certification and standardisation actions and policy recommendations, expressing all the involved stakeholders' points of view and meeting the prioritised user requirements, wants and needs.

Automation in Public Transport

Overview

Automation in Public Transport (PT) has long been along the curve. Metro lines in London and Paris have been operating autonomously already for the past decades. Automated Road Transport Systems (ARTS) though, are still developing. Automated vehicles in road transport are clearly more challenging to be developed and operate efficiently than track-based transport modes. Automation and connectivity are rapidly increasing in road transport and mobility, gradually making seamless PT a reality. Cities suffer from traffic congestion due to the excessive number of private vehicles and consequently travel time is high for the citizens and visitors. Although private vehicles offer a more pleasant environment and a personalised door-to-door commute, the vast number of them has negative impacts on the environment, causing air pollution, and also on people's social and psychological status, since they consume a lot of their time on travelling rather than personal pleasure. Autonomous PT vehicles are designed to be convenient, functional, accessible to all users, including VRUs, and fuel efficient since AVs used for PT will be electric. Therefore, the deployment of autonomous vehicles for PT is expected to lead to a reduction of vehicle ownership, with PT becoming an efficient and convenient mode of transport for all, while providing a safe, automated, time saving option for commuting.

Automation in PT is up to now more widely tested than in private vehicles. A number of pilots have taken place across Europe (e.g., Finland, Greece, Austria), in larger and smaller cities. In particular, in the city of Trikala, Greece, the EU project CityMobil2[4] conducted a pilot using a mini bus operating at SAE level 4, for a period of 6 months in mixed traffic, in the city centre. The fleet consisted of 4 vehicles, plus 2 back-ups. Each vehicle had a total capacity of 11 passengers of which 6 seated, 4 standing and 1 wheelchair user (Portouli et al., 2017). Although the vehicle could reach up to 20km/h speed, it usually operated at 10-12km/h. CityMobil2 conducted similar pilots also in Lausanne (Switzerland) and La Rochelle (France). Digibus is another trial of a self-driving shuttle, operating in a rural area of Koppl (Austria). The shuttle used was from Nayva Tech and it was tested on a 1.4km track in the village of Koppl, with a speed up to 20km/h (Rehrl & Zankl, 2018).

Along with the pilots, many surveys on users' acceptance and perception of the automated PT have been conducted. Although the feedback was positive, as to if users would use again an autonomous bus for their commute, a fear for the driver's absence emerged. Therefore, passengers' psychological status when riding an autonomous PT vehicle needs to be estimated so as to detect under which circumstances they would feel comfortable or not. PT users' needs and priorities have to do mainly with their feeling of safety during their trip, their comfort while being in the vehicle, the frequency of the scheduled routes and the cost of the corresponding services. Overall, automation in PT is expected to have an impact on travellers' behaviour, their social and psychological attitude towards automation, but also on urban development, environment, entertainment and commerce, growth and jobs.

Road transport of the future and particularly PT is expected to be characterised by increased automation and connectivity. User safety, energy consumption and efficiency, traffic congestion and drivers' and passengers' comfort and convenience are expected to be affected by automation and connectivity. In PT, autonomous vehicles can result in a cost reduction of approximately 50%. Instead of a driver in each vehicle, one person in a control centre may or shall monitor and, if needed, manoeuvre several vehicles (Kulmala et al., 2019). At the same time, new technologies and features, such as sensors, wireless communications (G5), 5G networks, IoT, AI and Big Data will be largely developed and their cost is expected to decrease, providing new business models for the automotive sector. Therefore, plenty of stakeholders are affected by this new era in transport. PT operators need to provide efficient, safe and connected transport with low cost. Many cities promote automation as it constitutes a potential alternative solution to current and future problems, such as increased traffic congestion, while also contributing to environmental sustainability, by increasing the use of PT. Besides, a sustainable smart city, comprising automated and connected PT, not only buses, but metro and tram lines as well, is more appealing to residents and businesses. The combination of high-capacity PT with automated car sharing services is expected to result in a considerable reduction of the average travel time comparing to the use of a private vehicle (Kulmala et al., 2019). Also, by investing in the enhancement of PT networks, systems and services, policy makers and authorities may accomplish the elimination of vehicle ownership. This is one of the reasons why

[4] *https://cordis.europa.eu/project/id/314190/reporting*

research institutes and academia focus their research interests on the integration of automated vehicles, in all aspects of road transport.

The sources reviewed concerning automation in PT were:

- Deliverables from EU and non-EU projects, such as:
  a. AVENUE (Bozi et al., 2019; Dubielzig et al., 2018; Fournier et al., 2018; Mathé et al., 2019; Zinckernagel et al., 2018; Zinckernagel et al., 2019);
  b. SOHJUA (Schirokoff & Koskela, 2016);
  c. ROBUSTA (Schirokoff, 2017);
- A report from Traficom (Kulmala et al., 2019);
- Papers and publications (Karaseitanidis et al., 2015; Madigan et al., 2016; Madigan et al., 2017; Portouli et al., 2017; Rehrl et al., 2018).

Critical findings

Quite a few pilot projects have taken place across Europe. The pilots conducted in Trikala, Greece and in Koppl, Austria involved a mini bus (shuttle bus), travelling in a dedicated lane, around a small city or rural area, operating in mixed traffic. The autonomous vehicles demonstrated required a supervisor on board, since they are not yet qualified for fully autonomous driving. Surveys have been conducted, addressing both commuters and inhabitants. Pertaining to those surveys, it appears that the autonomous mini buses were widely accepted small commutes use. A significant factor affecting users' acceptance is age, since younger passengers were identified as more frequent users. Safety was mainly inspired by the presence of a supervisor inside the vehicle. Passengers declared that they would be uncomfortable riding on a bus with no physical supervisor to be in charge of the vehicle and take control when/if needed. In the future plans for automated PT services, the supervisor of the vehicle will operate the vehicle remotely from a control centre.

Factors that affect users' preference towards ARTS over other PT systems have been assessed in various studies. Results suggest that the performance of ARTS compared to the performance of conventional PT systems is a significant factor taken into consideration, along with the social influence. Another important factor is the accessibility of these services by all users. A user-friendly service is appealing to a larger audience, including the elderly, people with disabilities and other VRUs.

Users of PT demand an efficient, punctual service, and this entails frequent service, affordable tickets, comfortable and clean environment. Therefore, automation should be developed and adopted, not only for operating shuttles but also for fleet management, cleaning and servicing. As road operators are seeking ways to redirect commuters' mode of transport from private to public, they need to promote PT by meeting users' demands. It takes a common effort to build and maintain a sustainable living environment, limit traffic accidents and increase safety. It is obvious that this common effort includes, not only users and operators, but also authorities and other stakeholders. In order to develop an efficient, connected, smart and pollution-free environment a common legislative framework should be applied.

The following table presents the outcomes of the literature review in terms of gaps, needs, wants and priorities per stakeholder group, for autonomous PT.

Table 4: Prioritised needs, wants and priorities per stakeholder group, for autonomous PT.

Stakeholder type	Gaps	Needs	Wants	Priorities	Prioritisation level (essential, secondary, additional)	Comments
Passengers and other road users encompassing VECs	• Traffic safety/ accident data are missing. • Due to lack of human support: ○ Insufficient QoS. ○ Insufficient security ○ Insufficient accessibility and/or social equity. • Limited speed of vehicles.	• Frequent service. • Safety/ security assurance. • Accessibility for all (including VECs). • Needs for fast transport. • Ensuring hygiene.	• Affordable tickets. • Clean interior. • Utilisation of travel time.	• Safety - need of constant contact to security personnel. • Proof of traffic safety level. • Efficient transportation time. • Ensuring hygiene.	**Essential**	VECs considered are: unaccompanied children, elderly, disabled, tourists, internet/language illiterate, unemployed, unprivileged, refugees
	• Ease of booking/ use. • Comfort during travel.	• User-friendly app. • Smooth driving style, no harsh brakes or impatient driving.	• Access remote areas.	• Optimised UI and infomobility service. • Smooth driving profile.	**Secondary**	Also relevant to the above VEC categories.
	• Lack of door-to-door service for PT.	• Clear announcements on board. • Comfortable interior of vehicles.	• Door to door service.	• Environmentally-friendly commute.	**Additional**	Also relevant to the above VEC categories.
OEMs, Road/Mobility operators	• Lack of depot management of automated buses (cleaning, service, etc.). • Limited speed of vehicles.	• Cooperate with authorities. • Decrease system cost.	• Decrease traffic volume by promoting PT. • Decrease traffic accidents.	• Pricing framework. • Environmental sustainability. • Healthy use.	**Essential**	Hygiene in vehicles- frequent cleaning- touchless contacts (e.g., wave detectors instead of buttons)
	• Absence of automated Bus Rapid Transit (BRT).	• Vehicles travelling in higher speed-closer to normal.	• Vehicles travelling off designated routes.	• Sufficient operations speed.	**Secondary**	
		• Well-maintained road-asphalt, • Slope<12%.	• Familiarise drivers with automation.		**Additional**	

Stakeholder type	Gaps	Needs	Wants	Priorities	Prioritisation level (essential, secondary, additional)	Comments
Tier 1 suppliers, telecom operators, technology providers and services company	• Low level of communication infrastructures (5G, G5, IoT). • Unclear how connected AVs will interface with non-equipped ones.	• Sufficient enabling infrastructure.	• Deploy AVs with software and sensors. • Develop a remote drive system, operating from a remote control room.	• Develop highly automated systems to deploy AVs so as to assure user security. • AVs to operate with multiple on-board and infrastructure enabling schemes; being interoperable.	**Essential**	• Technologies and sensors to be used for reducing traffic accidents. • Alternative infrastructure enabling schemes available.
	• Absence of remote control centre – remote operation.	• Cooperate with manufacturers- Deploy fleets of vehicles.	• Develop trustful systems to assure users' safety, efficiency, punctuality.	• Alter transportation time with productive, personal time.	**Secondary**	• Optimally integrated into a TMC.
	• Lack of data to optimise operation.	• Data to develop VASes.	• Develop Artificial Intelligence (AI), smart algorithms and machine learning.	• Gathering anonymised data for exploitation.	**Additional**	• Advanced functionalities and optimised services by data exploration.
Authorities (Cities, Municipalities, Ministries), policy makers, municipality agency and road operators	• Lack of seamless existence and operation of autonomous transport chains of automated PT, DRT, MaaS, LaaS.	• Environmental Sustainability • Review current legislation, road rules to comply with AVs. •	• Promote PT over private vehicles.	• Universal, legal framework. • Public-private cooperation schemes.	**Essential**	Develop AVs for PT by concentrating on users' needs, comfort, efficiency
	• Public acceptance not high enough. • Proven safety level.	• Organise public awareness campaigns	• Organise supporting traffic management schemes.	• Revise concept of operation for all (pedestrians, cyclists, commercial vehicles, heavy vehicles, etc.)	**Secondary**	

Stakeholder type	Gaps	Needs	Wants	Priorities	Prioritisation level (essential, secondary, additional)	Comments
Research and academia	• Lack of accessible transport for all VRUs (including road infrastructure, bus stops)	• Safe, accessible, reliable transport • Secure data privacy	• Environmentally sustainable.	• Integration of all different AVs (private vehicles, shuttles, cargo) in city traffic. • Avoid cyber-attacks in fully automated vehicles	**Essential**	Increase road network with electric chargers
	• Lack of robust, interoperable technologies.	• Optimal services within a single Architecture.	• Data to optimise operation.	• Algorithms for optimal operation pf AV fleets.	**Secondary**	

Automation of private vehicles

Overview

Autonomous vehicles (AVs) are emerging in our lives. Specifically, automated driving assistance functions are already integrated in commercial vehicles, such as automated pilot, park assist, cruise control and more. Private vehicles are also increasingly connected to the internet and equipped with electro-mechanical systems. All these new features and functionalities aim at providing safer, more accessible, cost and fuel efficient traveling, while contributing to a more sustainable environment. Although the general public is gradually adapting to these changes, they seem to be particularly hesitant when it comes to fully automated vehicles or even vehicles operating with a minor contribution from the driver. State of the art technology, AI and machine learning are used for autonomous vehicles, while communication infrastructure, such as 5G, G5 and IoT, is developing in order to reinforce connected vehicles. Automated and connected vehicles shape the future of transport, which is expected to be safer, due to the elimination of human errors. Furthermore, Connected and Autonomous Vehicle (CAVs) will be accessible to a wider audience, including elderly, children, people with disabilities that are incapable of driving a vehicle, and other vulnerable road users (VRUs). It seems that it will take some time to reassure passengers and drivers about automated driving, but the benefits are expected to outweigh their worries.

Quite a few applications with autonomous vehicles were conducted for the EU project AUTOPILOT with the following use cases: Urban Driving, Automated Valet Parking, urban platooning and highway piloting in different road environments across Europe. Specifically, in Tampere, Finland, Automated Valet Parking (AVP) and urban driving were tested with two, equipped for automated driving, vehicles; a Citroen C4 (for urban environments) and a Volkswagen Touareg (for harsh environments). The AVP pilot took place in a test track, whereas urban driving took place in real road conditions, at a signalised intersection. The pilot participants rode the vehicles only as passengers, for safety reasons. In the French pilot, located at Versailles, the use cases tested were urban driving (with car sharing and city chauffeur services for tourists) and platooning for driverless car re-balancing. For this pilot, the fleet consisted of 3 vehicles, operating at SAE L3-L4. Urban driving was executed in touristic destinations inside the city and contained planned touristic trips. During the platooning, vehicles could speed up to 20km/h in real traffic, while only the first vehicle was driven by a human operator and the others followed in a certain distance. All vehicles were equipped with Traffic Light Assist (TLA) to help them cross traffic lights without splitting. Another pilot site was located in Livorno, Italy, where a driver travelled with an AV, from Florence to Livorno port. Two Jeep Renegade were used at the pilot. The route included the Livorno-Florence highway and an urban-like environment upon arrival in the harbour. Similar use cases were also realised in other pilot sites, namely in Brainport, Netherlands, Virgo, Spain and Daejeon, South Korea.

Autonomous transportation is a major milestone of the 21st century. Yet, society seems hesitant to adapt to this new reality. People seem to be sceptic to accept and own AVs as a mean of transport, as studies show that about 50% are aware of automated mobility and are keen to try it in the near future. People are mainly concerned about issues related to road safety, liability, data security and privacy. Traffic rules explicitly state that the driver of the vehicle is responsible for it and its actions. So, when there is no driver, who will be charged with the responsibility? Questions like this encourage people's hesitance and provoke fear for the realisation of automated mobility. Meanwhile, violation of data privacy is considered another threat, since in order to develop an automated environment for autonomous vehicles to operate in, data collection and processing are necessary. Also, the interactions between autonomous vehicles and other road users, such as pedestrians, and non-automated vehicles, is an area of concern. People tend not to trust a vehicle with no driver, although autonomous vehicles function impartially as they cannot be affected by sentiments or human states such as fatigue, sleepiness, anxiety or under the influence of alcohol.

Different types of sources were reviewed for this research, including:

- Deliverables from various EU projects, such as:
    a. Adas&Me (Pereira Cocrone et al., 2018; Willstrand et al., 2017);
    b. CoExist (Rupprecht et al., 2018);
    c. Drive2theFuture (Sjörs-Dahlman & Anund, 2020);
    d. AUTOPILOT (Aittoniemi et al., 2018, Aittoniemi et al., 2019);
- Reports from research institutes and transport agencies (Kulmala et al., 2019; Winkler et al., 2019);
- Reports by the Joint Research Centre (JRC) (Gkoumas et al., 2019; Alonso Raposo et al., 2017; Alonso Raposo et al., 2019);
- The Special Eurobarometer 496 report, as well as a relevant research article (Zoellick et al., 2019);
- Reports from national projects, i.e., the British project UK Autodrive.

Critical findings

As it is suggested by the sources analysed, people are not ready to accept fully automated vehicles into their lives, either as drivers/passengers or as pedestrians in environments where autonomous vehicles operate. This hesitance is due to the lack of trust towards a vehicle operating without a supervisor, as many concerns accompany this situation. A critical issue raised is the assignment of the liability for the vehicle operation; whether this should be assigned to the vehicle manufacturer, the providers of the system or an insurance company that may be in charge of the vehicle. The same issue also applies to lower level of vehicles automation that provide a driver/supervisor to perform specific tasks while driving (SAE L4). It seems that a common and operational legislative framework needs to be developed prior to the introduction of semi and fully automated vehicles, in order to promote both safety and harmonisation of such transportation issues and to reassure all the involved users.

Furthermore, the general public is concerned about how cities will adopt autonomous mobility in the existing road infrastructure. While AVs will require less space, they will use advanced communication infrastructure, thus requiring the corresponding equipment and technology. Based on the CoExist automation survey[5] preliminary results, 61% of participating respondents believe that their cities are not well prepared for the introduction of CAVs. A majority of them (96%) support that a key policy that needs to be assessed towards the preparation for the arrival of CAVs is the formulation and existence of adequate legislation to regulate them. Also, of similar importance seems to be the definition of the data management responsibilities (85%), the prioritization of the user-friendliness and the sustainability of cities (73%) as well as the preparation of physical and digital infrastructure (71%).

Last but not least, the willingness to pay for an autonomous vehicle is also a key issue for users. According to a Cap Gemini recent survey (Winkler et al., 2019) , it appears

[5] https://www.h2020-coexist.eu/coexist-automation-ready-survey-first-results-available/

that over 50% of users are willing to pay from 1 to 20% over their current budget to own a self-driving car. Age and area of residence constitute significant factors when it comes to willingness to pay; younger people are more willing to pay over their budget, along with people living in urban areas but in contrary of inhabitants of rural areas.

To conclude, the “fear of automation” prevails among all the end users. The general public is not familiarised with the concept of autonomous vehicles and hence they do not trust “machines” over actual people to make safety-related decisions. At the same time, vehicle operators are seeking ways to maximise their revenue while minimising the cost, so that AVs can be appealing to users in the future. Setbacks include vehicles’ speed limits, since now AVs are operating up to 30km/h in city traffic.

What is yet to be realised, is the integration to the Traffic Management Centre (TMC), given the fact that proper communication infrastructure will be developed so that all AVs are also connected among them but also to the TMC. Along with connected vehicles, urban passenger platooning can be realised, connecting for example the city centre with peri-urban areas.

Users’ fear and hesitation towards AVs could be addressed if a universal legislative framework is formed. Then, issues such as “who is responsible for the autonomous vehicle”, “who secures our data privacy”, “how can we be assured that there will not be cyber-attacks intervening in the vehicle’s planned route/behaviour” will be answered. The co-existence of automated and non-automated vehicles is a real challenge that authorities, road operators, researchers will keep facing for the next years, before full automation can be established. Until then, laws and traffic rules should be renewed at a regular basis, so as to create a liable, trustworthy, sustainable, and safe transportation system. Co-operation of public and private authorities and policy makers is vital for such a multi-parameter and integrated system to operate, towards the decrease of traffic accidents and the overall enhancement of traffic safety.

In a larger context, automated transport systems might lead to a change of how cities should and could be developed and designed. Automated vehicles typically require less space as they navigate with very high precision. Parking in attractive areas can be avoided and parking areas can be designed differently as the passengers can exit the vehicle before it is parked. In addition, the expected vehicle ownership degree, due to the application of sharing and pooling concepts, is expected to reduce the traffic by 80-90%, as each AV has the potential to replace up to 8-9 conventional vehicles if used in an optimized way. This could result both to elimination of traffic through enhanced routing and in the respective increase of the available vacant parking places for environmentally friendly vehicles, such as electric mopeds and conventional bicycles.

Regarding user acceptance of autonomous systems, age constitutes a significant factor, as younger people have been identified as regular users. Indeed, in many cases all over the world, young people already commute for every day destinations from/to home, work, school / education / sports premises and leisure activities and are the ones most familiarised with driving automation. Thus, younger people are expected to prefer fully autonomous over manual driving and would approve the use of an autonomous, connected and shared multipurpose vehicle (e.g., performing passenger and freight transportation services). In particular, according to a recent survey (Hohenberger et al., 2016), younger people (30-39 or younger) are more eager to use or even pay for AVs or different services offered in AVs. Also male users appear more open to use AVs than female ones. Age is also a factor affecting the perception of accessibility during both design and implementation/operation phases. Internet illiteracy affects mostly elderly people; this is even more true for IoT and C-ITS based services. Therefore, the deployment of AVs needs to be specially adapted to the needs and abilities of vulnerable road users, disabled, elderly, etc. In any case, it remains a very critical discussion whether and how much the operator and user of the vehicle are willing to pay for the driverless option.

The results of this research are common for all different modes of transport, as long as AVs are concerned. And thus, the same measures should be taken from authorities, since the overall aim is to raise user acceptance towards AVs. SHOW will address many of these issues and gaps through its use cases.

A summary of the findings of the desktop research on private vehicles automation is presented in the table below, per stakeholder type.

Table 5: Prioritised needs, wants and priorities per stakeholder groups for automated private vehicles.

Stakeholder type	Gaps	Needs	Wants	Priorities	Prioritisation level (essential, secondary, additional)	Comments
Passengers and other road users encompassing VECs	• Lack of familiarisation with automation	• User friendly HMI. • Driver to be able to take control of the vehicle.	• Accessible to different user groups-tourists, visitors, VRUs, under-aged, who cannot have a driving license.	• Safety • Willingness to pay	**Essential**	People are afraid of system failure in fully autonomous vehicles
	• Missing customer training plans based on age groups with Virtual Reality (VR) / Augmented Reality (AR)	• Appropriate training schemes.	• Comfort and better usability of travel time	• Environmentally sustainable	**Secondary**	For electric AVs to be widely used, corresponding infrastructure is required
OEM and transport/mobility operators	• Lack of AVs that can perform in snowy & icy conditions • Limited integration to city's Traffic Management Centre (TMC)	• Environmentally sustainable use under all circumstances (weather, traffic).	• Minimize cost/maximize revenue	• Safety functions under all weather conditions. • Integration into TMC.	**Essential**	
	• Lack of AVs operating under higher speed, in complex environments (cities) • Lack of urban passenger platooning (e.g., city centre to peri urban)	• Better sensors and enabling technologies.	• Cost-efficient solutions.	• Testing of relevant solutions under controlled environments.	**Secondary**	

Stakeholder type	Gaps	Needs	Wants	Priorities	Prioritisation level (essential, secondary, additional)	Comments
Tier 1 suppliers, telecom operators, technology providers and services company	• Lack of communication infrastructure for remote control/monitor of AVs in poor weather and road conditions. • Inaccurate vehicle positioning where missing road markings and unrecognized roads.	• Assist interoperability with other automated modes of transport in mixed traffic. • Use traffic cameras at intersections to detect VRUs and communicate with the AVs.	• Establish a common communication infrastructure (5G, G5, IoT).	• Develop systems for AVs to operate in complex city environments.	**Essential**	
	• Missing enabling UCs.	• Improved sensor and algorithms for enabling UCs.	• Develop parking applications for AVs	• Use IoT and smart algorithms to develop urban platooning	**Secondary**	
Authorities (Cities, Municipalities, Ministries), policy makers, municipality agency and road operators	• Lack of common/universal Legislative Framework • Lack of interactive cooperation with other stakeholders (in urban areas: city transport operators & police officials)	• Appropriate legislative framework. • Road infrastructure, enabling communication infrastructure.	• Environmentally sustainable schemes.	• Safety-who is responsible. • Legislative Framework. • Insurance framework.	**Essential**	Promote safe, efficient and accessible transport with AVs while decreasing vehicle ownership
	• Limited connection to Operation Centre for tele-operation and remote supervision	• Operation centres (development, staffing, operation legal framework).	• Decrease vehicle ownership	• Operational centres framework.	**Secondary**	
Research and academia	• Limited or no co-operation with authorities, public, private or Public Private Partnerships (PPP) schemes to promote AVs	• Encourage user acceptance • Promote safe use. • Promote accessibility for all users	• More efficient and environmentally-friendly traffic flows •	• Improve safety through lower accident probability and severity • Data privacy	**Essential**	

Automation and MaaS

Overview

The continuously increasing demand for more personalised transport services has created a market space and momentum for MaaS. However, the introduction of AVs in transportation networks together with the co-existence of conventional vehicles is currently covered with a veil of ambiguity as the involved stakeholders are: 1) suspicious of this innovative venture's success, especially at critical situations, 2) unaware or misinformed on the operation and effectiveness of the smart concepts of MaaS and 3) worried as per the legal and operational framework determining their application and interrelation with other modes of transport and road users, with focus on the responsibility share among the involved parties and the insurance companies, in case of accident. So, the users' acceptance is case sensitive and depends mainly on the levels of automation and complexity of the transportation environment and the degree of familiarisation with C-ITS and concepts such as autonomous driving, automated and electric vehicles, etc. Users' expectations, needs and priorities have to do with mobility will be affected, in the sense of the provision of safer, faster, cost and fuel efficient, as well as environmentally friendly travel, easing traffic congestion or reducing transport's impacts on human health, air quality, safety, optical and noise nuisance, especially inside urban areas.

Up until now, there are several, mostly private, very promising initiatives around the world concerning autonomous mobility solutions with connected and shared AVs, interrelated with MaaS. For example, Keolis, a UK-based transportation company, elaborates a project concerning the development of a global network of autonomous shuttles with focus on last-mile connections primarily for public transport. Recently, the company in collaboration with the Greater Lyon public transport authority, SYTRAL and Navya, released in Lyon (France) the first two autonomous shuttles, which are also connected and integrated within the existing public transport network. It is the first time in France that the vehicles operate alongside cars on public roadways, interacting with road signals. The same project is near realisation phase in Newcastle, Australia, where the shuttle already circulates among other vehicles on the road, while it is connected to the city's network of buses, trams, river shuttles and other on-demand services.

Japan is taking MaaS one step further and connects Toba to Toshijima, an island on Ise Bay with a population of about 2,000 habitants, by replacing the currently existing small parking and ferry terminal (port) with the use of autonomous flying vehicles (flying taxis service), reducing trip time and upgrading the level of provided services. In line with flying taxis and on the direction of individualised transport services, Aeronext, a start-up founded in 2017, promotes a flying gondola concept for a single passenger drone, which, just like the Ferris wheel cabins, (the drone) stays at the ground level to maximize passenger safety. Besides, ZMP - Japan, promotes the automated driving vehicles RoboCar series concept together with MaaS, not only in Japan, but in other parts of Asia, such as China, Korea, Vietnam as well as in the United States, Europe, Africa and other parts of the world. In particular, ZMP provides an "Autonomous Driving platform" that realises a MaaS service created by customers, combined with their own Autonomous Driving technology. The concept incorporates different alternative solutions with the use of connected, shared and remotely controlled vehicles regarding passenger and freight transport, such as the autonomous driving taxi, autonomous tour and sightseeing bus, automated transport between buildings / factories / companies, autonomous transportation packages, etc. The services provided comprise the arrangement and customisation of automated driving vehicles that RoboCar series developed independently by ZMP, an integrated computer (IZAC) that carries out all recognition, judgment and operation necessary for moving automated vehicles and also the autonomous Driving management system (Fleet Management System - FMS) that manages vehicles, etc. while remotely monitoring vehicles. By linking the “Autonomous Driving platform" of ZMP and a "user application" developed by a service provider, mobility service using Autonomous Driving is realised (Figure 11).

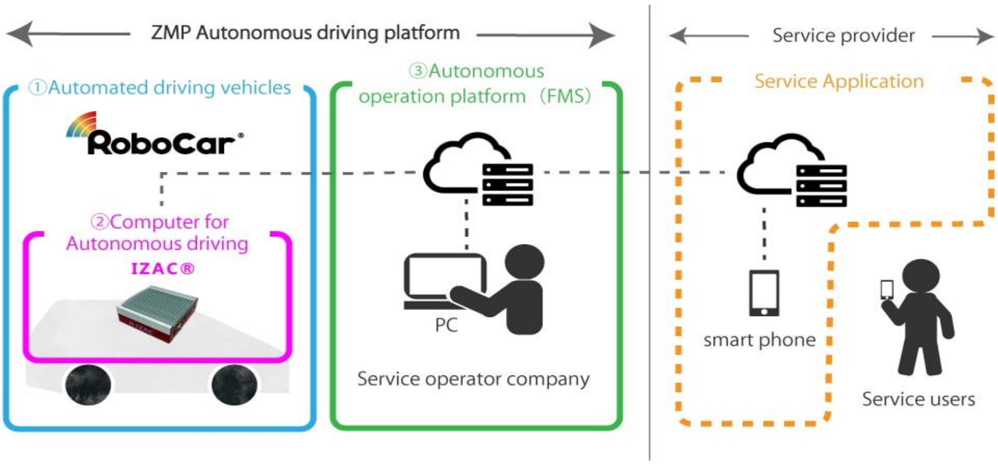

Figure 11: The ZMP Japan concept on AVs and MaaS (source: www.zmp.co.jp).

In search for sustainable mobility, major steps have been attempted through spatial strategic planning, legislation and technology contribution. What is demanded by the end-users is the maximisation of the quality of provided services, achieving also time and cost savings (both internal costs for construction, operation, maintenance and recycling of systems throughout their life cycle, as well as external costs, since their internalization seem to be of equal importance). In fact, based on past and recent experience gained from live demonstrations, relevant studies and surveys, what is necessary beyond industrial, software and hardware smart C-ITS oriented solutions is the integration of services and their implementation in a resource and energy efficient way. In particular, measures such as the ones listed below constitute solutions applied, tested and evaluated during the last 3-4 decades:

- the last mile urban distribution of cargo in small dimensioned, non-polluting (e.g., electric plug-in), flexible moving mopeds;
- the low traffic zones’ constraints or even automated, connected and (remotely) controlled vehicles or demand responsive public transport;
- shared mobility schemes for passenger and freight or car sharing / carpooling and platooning (with use of a towed vehicle);
- the harmonization of traffic, mobility and logistics rules and legislative area.

However, in most cases such measures were adopted at local and regional level as stand-alone initiatives and not as part of a coordinated national, international or transnational – universal strategic plan.

So, the solution is to face MaaS, providing continuously upgraded services through machine learning procedures and their adaptability and transferability in high scale and large extent, with the contribution of all stakeholders; reaching the goal of services provision, using technological innovations and at the same time meeting all users’ needs, priorities and expectations, towards the enhancement of their quality of life, incorporating equal accessibility principles for VECs, VRUs and PRMs.

At the beginning, it seems that there are some restrictions, as the innovative C-ITS and IoT based smart solutions, even though they appear to be appealing especially for young users, they do not enjoy universal approval due to emerging problems with safety, security and data confidentiality. In addition, there seem to be problems concerning system, equipment, vehicles and applications cyber security / cyber attacking or hacking, in combination with the level of provided services, value for money, as well as questions or doubts on whether they provide seamless communication, interoperability, accessibility and legislation compliance. Advances in sensorial systems, communication technologies and especially in the interfaces between AVs and non-equipped traffic participants (through IoT, mobile networks, intelligent map services, etc.) may enhance a great share of them. However, without targeted business and collaboration schemes, long term exploitation plans, inter-stakeholder agreements, cost efficient planning, coordinated management and central controlling, the effect will not reach the required optimisation level according to users' needs, wants and priorities. In this direction, the adoption and implementation of MaaS high scale mobility concepts, based on rigid legislative frameworks and regulations should be part of the roadmaps or action plans for future time horizons.

With regard to MaaS and automation, all 6categories of stakeholders are involved and interrelated, as listed in Chapter 3.

The sources that were reviewed comprise:

- Deliverables and reports from the following EU and non-EU projects:
    a. AUTOPILOT (Aittoniemi et al., 2018; Aittoniemi et al., 2019);
    b. AVENUE (Bozi et al., 2019; Dubielzig et al., 2018; Fournier et al., 2018; Mathé et al., 2019; Zinckernagel et al., 2018; Zinckernagel et al., 2019);
    c. Drive2theFuture (Sjörs-Dahlman & Anund, 2020);
    d. Adas&Me (Pereira Cocrone et al., 2018; Willstrand et al., 2017);
    e. CoExist (Rupprecht et al., 2018);
    f. HUB.CONNECT project reporting;
- Research papers (Beirigo et al., 2018; Kepaptsoglou et al., 2019; Panou & Maglavera, 2019; Prevedouros et al., 2019);
- The Special Eurobarometer 496 report and other reports (Gkoumas et al., 2019; Kulmala et al., 2019; Alonso Raposo et al., 2017; Alonso Raposo et al., 2019).
- Reporting from ERTRAC (2019).

Critical findings

Based on past experience worldwide, it seems that AVs may accelerate MaaS adoption, as they have the potential to disrupt the business model of the traditional automotive industry and the passenger and cargo transportation methods. In particular, the current trends seem to strive towards more integrated, connected, environmentally friendly, individualised, on-demand and shared mobility solutions with equal accessibility to all (e.g., internet or intelligent Transportation System (ITS) illiterate, VECs, VRUs, PRMs, etc.). However, for the time being, there seem to be considerable inefficiencies and problems in the technological and legal domains, as well as gaps in the fields of social / ethics issues. Thus, the share of partly or even fully automated, connected and (remotely) controlled vehicles, especially inside urban areas, is not expected to achieve a considerable increase until a time horizon of almost two decades from now. So, until the advances on the reliability, interoperability and technological excellence of the vehicles, infrastructure, equipment and telecommunication or interconnection systems are matured and completed, it seems that the next years should be dedicated to the quest of gaining credibility and preparedness towards research, planning, development, testing or live demonstration, and eventually integration of the provided services, under a common application, operational and legislative or regulatory framework.

Towards the adoption and realisation of MaaS concepts, the harmonisation of rules and the exchange of experience, know-how and best practices should also comprise respective innovative business models, exploitation plans and collaboration schemes, as well as the creation of a case sensitive roadmap based on specific guidelines and targeted recommendations. Those virtual and/or applied development approaches should support the authorities' decision making and serve as a means of proof and validation, gaining the stakeholders' confidence, acceptance and contribution. This would assist bringing IT solutions from idea to market in the long term, while also promoting the introduction of a common decision support system at political/strategic level. As a result, a potential roadmap towards significant change in mobility patterns through MaaS adoption shall comprise some or all of the following steps/recommendations. These could serve as a type of checklist towards the identification of priority areas to be addressed according to the emerging needs:

1. Select a coordination and leadership board and establish strategic national alliances to fully make use of the potential of each member country contribution in the domains of excellence, involving leading automobile, software and hardware industries (e.g., engage OEMs and Tier 1 suppliers), academia and public authorities, bodies and organisations, towards the institutionalization of globally accepted – universally approved technological standards.
2. Build on research, knowledge and competence excellence in specific areas of specialisation and fields of interest per country (e.g., engage research and academia), according to its technological background and with respect to national socioeconomic priorities. This would lead to the determination of each country's development paths and follow the centralised coordination guidelines of the previous steps.
3. Allow for incremental innovations after intensive and iterative testing of the developed solutions in different traffic (urban) environments, aiming at system and service integration, optimization and excellence; steadily increasing the degree of automation and generating positive cash-flow (need for collaboration amongst private and public stakeholders through proper agreements and need to engage public authorities through a more substantial role in addition to the one of supervisor).
4. Involve all potential stakeholders, representing all transportation networks and means, from the phase of the idea conception to planning and designing. Currently there is a need for a dedicated programme/tool that coordinates the efforts and ensures focus on innovative initiatives, engaging the OEMs, providers and operators of all transportation modes and networks (at least the surface transport ones) through inter-partnership protocol contractual agreements, also determining their communication, jurisdiction, duties, interrelation and coordination.
5. Foster an action-plan that supports a short period from idea to first implementation, estimating future constraints, risks, developments and emerging needs; also including iterative processing and continuous upgrading of provided services through machine learning methodologies and techniques (need for strategic planning from the public authorities side, having the role of the decision maker).
6. Establish and promote transnational alliances and synergies between growing technological advances, such as automation, electrification and IoT, promoting

twinning, adaptability and transferability of innovative concepts and exchange of best practices and know how. This will set the ground for the implementation of long-term sustainable IT solutions, allowing for open innovation at universal basis (e.g., engage research and academia).

7. Develop an appropriate legislative, regulatory and operational framework (e.g., standardisation), meeting system architecture requirements (always in collaboration with the research community and industry) and providing mature ground for the development of 1) digital infrastructure, 2) efficient solutions for communication between vehicles, passengers, goods and transport infrastructure, 3) business models, including smart payment solutions and 4) the establishment of a pilot test area with universal experience exchange on system/service applicability. Taking into consideration General Data Protection Regulation (GDPR) and data confidentiality constraints, as well as accessibility principles.
8. Promote the launching of connected support services in the traffic system (e.g., digital traffic regulations and support for heavy vehicles), focusing on areas such as the elaboration of transport automation impact assessment, the enhancement of public funds and legal support (e.g., through PPPs) of pilot areas for automated vehicles in mixed traffic environments, as well as the institutionalisation (e.g., through globally accepted standardization) of methods for system and services verification and validation and the use of experimental studies on business models and business ecosystems integration.

However, apart from legislative and regulatory framework gaps and differences or even contradictions between countries, there are still technological, constructional and interoperability issues. For example, autonomous driving requires a full technological background of hardware (sensors, servers) and non-hardware components (AI software and high-definition maps) which are completely different from the traditional automotive approach. The automated transportation MaaS depends to a large extent on the successful integration of technologies from the telecommunication and the automotive industries. Thus, one of the key emerging needs is to adopt efficient methods to develop, test (using both simulation approaches and real-environment scenarios) and demonstrate new systems. The automated driven, connected, electrified, shared vehicles' industry has a predetermined ascending trajectory within the next decades, targeting at technological and operational excellence of products, vehicles, applications and systems. During this period, this evolution needs to be supported and promoted by the integration, optimisation and effectiveness of the respective provided services. EU research projects may act like a starting point, such as SHOW which does not only allow for the establishment of valuable networks between various stakeholders in transport automation all over the world, but it also offers co-funding possibilities both for EU Member States and other eligible countries, establishing alliances for coordinated twinning research and innovation actions.

Business model development is amongst the key issues that future research should be focused on in order to transform mobility as a set of integrated services. In particular, different city traffic automation business models are necessary to be tested and evaluated at different pilot sites and (urban) traffic environments, twinning and exchanging findings. On this direction, SHOW incorporates dedicated use cases at mega sites, also testing the adaptability and transferability of results at satellite and follower sites, while providing validation at technical verification and commissioning sites. The ultimate goal is the establishment of draft bankable exploitation plans, closely connected to relevant future spatial planning concepts such as city SUMP / SULPs. The roles of public and private domains and even novel actors both as individual stakeholders and in the context of alliances such as PPP schemes will be further analysed and validated, regarding the future Automation as a Service (AaaS) provided by automated vehicle fleets and accompanied by services aggregators at city and intercity or interregional or even international level.

Especially concerning the first and last mile connection (through modal shift for passengers and transhipment for cargo) meeting all types of user needs (with special care for VRUs), SHOW will be investigating the links between the above-mentioned automated fleets with MaaS services, including concepts with relevant car, e-bike and bike fleets. However, as in the future many of these services will be offered by AVs (i.e., Share Now Daimler / BMW joint venture), SHOW is engaged also to connect relevant automated MaaS to some of its sites (s.a. Rouen, Aachen, Karlsruhe, Vienna and Madrid).

In parallel with automation, central and remote control (e.g., operational control centre) through C-ITS nodal points in city network and TMCs for better monitoring and optimized controlling are included within the aims and concepts targeted to be implemented through SHOW. The real time monitoring and controlling are going to be deployed respecting GDPR constraints, but intervening in critical situations, with view to:

1. avoid road traffic accidents and congestion impact,
2. preserve environment, rationalize resource and energy management,
3. enhance seamless and sustainable mobility,
4. upgrade the level of provided services, introducing new standards concerning accessibility (equal access to infrastructures, equipment, services, applications etc. without depending on socioeconomic status, age, gender, technology familiarisation and internet application illiteracy) and
5. empower / validate / justify decision support system from the part of authorities towards a better quality of life especially for citizens inside urban areas, meeting users' and other involved stakeholders' needs and priorities, incorporating special planning and designing guidelines and roadmap for VRUs.

In particular, the use cases of SHOW project are going to deal with several MaaS-related concepts, such as provision of automated services at bus stops, depot management of automated buses (servicing, clearing, maintenance), implementation of parking applications, self-learning DRT (planning, routing, operation) and added value services based upon big data and AI algorithms (metadata) for better integration and resource and energy use and management optimisation.

The key findings of the reviewed sources are briefly summarised and prioritised within Table 6, per stakeholder type.

Table 6: Critical findings concerning automation in MaaS.

Stakeholder type	Gaps	Needs	Wants	Priorities	Prioritization level (essential, secondary, additional)	Comments
• **Passengers and other road users encompassing VECs** • **Umbrella associations/Non-profit organisations**	• Lack of familiarisation with automation. • Lack of evidence on efficiency and sustainability of systems / services. • Lack of evidence on the safety and security of involved stakeholders or personnel or other (road) users and cargo.	• Easy to use and friendly systems and apps reducing congestion, while enhancing environmental and economic sustainability, also guaranteeing (quantifiably and qualifiedly) the safety and security parameters.	• Affordable and probably free of charge, on-demand and individualized door to door services.	• Safety and security on board. • Protection against cyberattacks and hacking, in compliance with GDPR and data confidentiality.	**Essential**	Mistrust on shared autonomous mobility solutions' effectiveness, safety and operation without failures / accidents.
	• Low level of maturity and poor acceptance of measures, initiatives and human factor's absence or role change.	• Accessibility (for VEC, VRU, PRM etc.) and proof or evidence of vehicle control any time, either on board or remotely for psychological.	• Human (on-board or remotely) to take control of the vehicle / intervene at any time or security personnel available on board or remotely	• Long term operational excellence, environmental and economic sustainability with upgraded, additional or added value services, complementary to the currently existing ones.	**Secondary and additional**	People need a holistic approach (technology, legal and ethics / social parameters taken into consideration) under strategic planning and DSS.
• **OEM and transport/mobility operators** • **Tier 1 suppliers, telecom operators, technology**	• Lack of or low integration of SAV solutions to TMC and other existing conventional solutions to gradually migrate towards autonomous mobility era.	• Legal framework and inter partner agreements to broadly open market opportunities.	• Minimize cost/maximize revenue and increase market share.	• Safety and security, development of HMIs, establishment of business models and collaboration schemes in market.	**Essential**	Roadmap of priorities and action plan on gradual transition from conventional to autonomous mobility missing.

Stakeholder type	Gaps	Needs	Wants	Priorities	Prioritization level (essential, secondary, additional)	Comments
providers and services company	• Insufficient level of integration and interoperability of proposed concepts for vehicles operating with higher speed and in complex environments, being connected or remotely controlled, enabling for city platooning (e.g., city centre to peri urban). • Missing evaluation tests of autonomous mobility solutions in real conditions (not sufficient yet to convince, so as to better integrate and promote).	• Increased interoperability, integration, environmental and economic sustainability.	• Project funding and opportunities for more testing and test beds for evaluation of AVs inside urban environments in order to further optimise systems and services.	• Technological evolution and excellence.	**Essential**	
Authorities (Cities, Municipalities, Ministries), policy makers, municipality agency and road operators	• Lack of strategic planning, guidelines, roadmap, action plan, common universal legal framework and SUMPs / SULPs integration of MaaS and LaaS schemes.	• Road, system and telecommunication infrastructures and networks based on a well-established framework and structured in line with a holistic development plan.	• Gradual transition from conventional to autonomous mobility under successful collaboration schemes and accessibility design principles (for VECs).	• Safety and security, business and collaboration schemes determining the responsibility share amongst involved stakeholders and legislative framework on integration procedures.	**Essential**	Optimal use of AVs in MaaS/ LaaS schemes
	• Limited connection to TMC and control center for remote monitoring and management.	• Holistic approach solutions through integrated initiatives from private domain.	• Long-term environmental and economic sustainability.	• Operational excellence, business models and exploitation plans.	**Secondary and additional**	Authorities in search of private operators, managers and PPP collaborations.

Stakeholder type	Gaps	Needs	Wants	Priorities	Prioritization level (essential, secondary, additional)	Comments
Research and academia	• Low co-operation with authorities, public, private or PPP schemes to promote AVs. • Limited funding to support research on AVs and interrelated systems development and integration.	• Projects funding to provide evidence on efficiency, safety and security of vehicles, systems and services, encouraging user acceptance and promoting accessibility for all.	• Research and scientific excellence through a) the increase of funding and test beds for evaluation of autonomous mobility solutions b) reduction of vehicle ownership and human role towards system automation and the upgrading of provided services.	• Safety and security, operational excellence and data privacy.	**Essential**	Promotion of safety, security, sustainability and accessibility of transport with AVs while decreasing vehicle ownership and prepare the ground for the driverless era and the transformation of human role from driver to controller, manager and operator
	• Inexistence or not sufficiently developed international communication channels for exchange of experience, know-how and best practice. • Limited funding and support for knowledge transfer and twinning through project MoUs	• Inter-partner agreements and interconnection with other stakeholders (especially private domain) and the market for the capitalization of research results • A stable and adapted framework from the part of public authorities towards the exploitation of innovative research results and findings	• Promote science and research on the optimization of fully autonomous mobility solutions in urban and peri-urban areas for public profit and QoL benefit of end users, as well as minimization of involved costs	• Speed up the integration of fully autonomous mobility solutions in real conditions within the urban and peri-urban network	**Secondary**	Making eMaaS/eLaaS Automated

Automation and DRT

Overview

Demand Responsive Transport (DRT) services aim at providing personalised trips, depending on users' demand. A cost efficient and user-oriented transport service is developing, by deploying DRT systems. DRT is a flexible service that can be adjusted in many different environments and situations. In particular, DRT services are suggested for first/last mile transport services between terminals (e.g., airports, train stations) and a city landmark, for specific areas (e.g., inside a university campus or in hospital areas), for linking the city centre with peri-urban areas or rural areas, so that people living in more remote places can have easy access to services, leisure activities and their work, whilst promoting decentralisation.

Developing an automated system for DRT services is undoubtedly challenging for policy makers, mobility operators and communities. The world's first fully automated, real-time demand responsive public transport service (Helsinki Regional Transport Authority, 2016) Kutsuplus, was launched in 2012 and it was open for general use from 2013 to 2015 in the Helsinki area. The fleet comprised of 15 minibuses (with 9 seats available each). Kutsuplus was funded by the regional transport authority (HSL), which was also responsible for the service design and for defining the requirements for partners and subcontractors (including transport operators, telecom system vendors, software and hardware development companies). Local transport operators provided the vehicles, while a software company developed the core control and service systems, programmed the information systems for passengers and drivers and implemented and maintained databases (including geographic data) and payment solutions (Pettersson, 2019).

Advanced communication infrastructures that are connected in terms of data and business cases have to be developed for automated DRT systems to operate in a complex environment, together with other autonomous transport modes and schemes, such as PT, MaaS and LaaS. Also, vehicle manufactures and mobility operators need to decide upon vehicles' types and fleets needed per specific area of service, since the requirements vary in the different environments. The major issue depicted here is the coordination of such policies, since a universal strategic plan is missing.

The sources reviewed concerning automation and DRT are:

- Findings from the projects RESPONSE, WEpods and VTAFLEX;
- Publications and papers (Winter et al., 2016; Institution of Mechanical Engineers and Community Transport Association, 2017; Interreg Europe, 2018; Kulmala et al., 2019; Petterson, 2019; Winter et al., 2018).

Critical findings

Demand Responsive Transport (DRT) has developed decades ago, yet automation in DRT has not been addressed so eagerly. Moreover, many people are not familiar with the service of DRT, is mostly a niche service, apart from some user groups, such as people with disabilities, who use such services, on demand and with a personalised route. The challenge in developing DRT services for the general public is the cost, as DRT offers an instant, on-demand service, customised to meet users' needs. At the same time though, it offers a convenient and personalised mode of transport, reducing the total travel time. Researchers need to deploy AVs for DRT services and test them in pilots, with the participation of the general public so that awareness is raised. It is needless to say that DRT users share the same fear and hesitance towards AVs as for all the other transport schemes. Therefore, providing them with such different options for commuting and making them appealing by deploying new, clean vehicles, accessible to all and developing user-friendly apps to be used for reservations, will definitely lead to an increase of user acceptance.

The role of authorities in this case is to financially support such initiatives and to cooperate with other stakeholders, namely road operators, vehicle manufacturers and policy makers, towards forming an updated traffic management roadmap.

Table 7 presents the prioritised needs, wants and priorities per stakeholder group, for automation of DRT.

Table 7: Prioritised needs, wants and priorities per stakeholder groups, for automation of DRT.

Stakeholder type	Gaps	Needs	Wants	Priorities	Prioritisation level (essential, secondary, additional)	Comments
Passengers and other road users encompassing VECs	• Minimized number of transits.	• Reduced travel time .	• Affordable price. • Comfortable and clean interior.	• Safety. • Accessible for all. • Well-integrated to PT/ MaaS.	**Essential**	
	• Lack of familiarisation with DRT service	• User-friendly app.	• Environmentally sustainable		**Secondary**	
Authorities (Cities, Municipalities, Ministries), policy makers, municipality agency and road operators	• Limited financial support of mobility services (depending on their environmental impact)	• Increase safety.	• Environmentally sustainable.	• Update traffic management operations through cooperation with industry and road operators.	**Essential**	Eliminate environmental effects & traffic congestion
	• Lack of adequate first/last mile services. • Non-optimal coverage of specific areas.	• Offer first/last mile services.	• Operate in specific areas (universities' campus, hospitals).	• Increased use of AV services to connect terminal (e.g., airports, ports, train terminals) with city centres).	**Secondary**	
Research and academia	• Lack of deployment of AVs for DRT services • Lack of relevant pilots • Absence of self-learning DRT (planning, routing, operation)	• Low-cost high quality services.	• On-demand mobility services.	• Accessible for all. • Reduce environmental footprint.	**Essential**	
	• Pick-up and drop-off stations are not defined • The appropriate type of vehicles (shuttles, cars) is not defined.	• Better service definition.	• Door-to-door service.	• Promote personalised modes of transport. • Develop user-friendly apps.	**Secondary**	

Automation in freight transport

Overview

Even though automated, connected and environmentally friendly mobility solutions have become a very popular trend introducing a revolution during the last years, they yet have to reach an acceptable level of interoperability, integration, sustainability and excellence. Concerning freight transport, state of the art technology, (e.g., 5G, G5 and IoT together with C-ITS, AI and machine learning), as well as development and testing within the lab (with use of VR/AR software applications) or within the context of pilot demonstrations or even in real traffic conditions are used towards the optimisation of autonomous vehicles' use. Up until now, it has been proven that the elimination of human presence as a driver and the transformation of human role to a controller or operator has been successful in terms of safety and security and cargo transported, always with the support of the technology, e.g., through real time monitoring, tracking and tracing systems with use of sensors, telecommunication systems, etc. However, there are still several legislative and regulatory framework gaps, as well as technological, constructional and interoperability issues, requiring a solution. In addition, ethical and social issues, incorporating user acceptance or meeting of the user prioritised wants, needs and expectations from such vehicles, systems and services, as well as the generic approval or concern from the part of all the involved stakeholders (e.g., shippers, receivers, last mile distribution companies, 3PL etc.) remain unspecified.

As a result, autonomous freight transportation solutions may constitute a major milestone especially in the 21st century, however the society is not ready to adapt to this innovative reality, mainly due to lack of confidence in the maturity, effectiveness and sustainability of autonomous mobility services. In particular, all the involved stakeholders and especially the users seem to be hesitant to accept automated driven transportation solutions, mainly worrying about safety and security (e.g., hacking), cost of provided services, responsibility in case of an accident, liability, data confidentiality and privacy against competitors (e.g., cyber-attacks and GDPR). According to relevant studies, almost half of the involved stakeholders have already been informed about or even experienced the new concept, but, unless those issues are satisfactorily tackled, the potential customers are not willing to pay for such services, at least not for now, transposing or migrating the attempt or venture for the near future, in a potential business as usual situation, approximately within one or two decades from today.

Apart from the insurance companies, other stakeholders as well as different parameters and factors are involved, such as software and hardware system developers, telecommunication systems' providers, TMCs, OEMs, infrastructure operators and definitely controllers in case of remote systems' use. In addition, the interaction between autonomous vehicles and other road users, such as pedestrians and non-automated vehicles, constitutes another area of concern.

In freight transport operations, in order to develop an automated environment for autonomous vehicles to operate in, data collection and processing protection against abuse is a fundamental issue. In addition, operators, shippers, forwarders, logistics providers, as well as public authorities or even end-users, are seeking for improved, affordable and green means of transport, either because they are obliged to do so by legislation, standards and constraints or just because of environmental awareness and sensitivity (this ecological tendency seems to be continuously growing, gaining ground during the last one or two decades).

Electrified and automated mobility for freight transport, especially during the last mile distribution inside urban areas, low carbon or traffic zones, comes as a solution to a lot of everyday problems, such as congestion, parking, environmental and economic sustainability. However, proper and optimized vehicle fleet management, operational and controlling techniques and strategic spatial planning regarding MaaS seems to be an essential prerequisite and condition of success story. Yet, people's main concerns are safety and security, as mentioned above, and the level of provided transportation services in correlation with cost, easiness of use and accessibility. In this phase, the parallel freight vehicles' circulation is added in the equation, as those vehicles use the same transportation network with the rest of the road users, but have a different way of moving, driving, turning, speeding, accelerating, decelerating, etc. And of course, their services and system application structure are engaging the same interconnection and telecommunication network, meaning that in some cases there may also be some intervention or system overload, especially at rush hours.

Another interesting concept examined is the mixed use of ride sharing vehicles for both passenger and freight transportation (e.g., use of SAVs with separate passenger and freight compartments or parcel lockers performing on demand, individualized and door to door time window urban passenger trips and cargo deliveries), especially during the last mile distribution or pickup and delivery operation inside urban areas. Such vehicles are supposed to combine freight and passenger overlapping journeys on the shared mobility infrastructure network, in order to support e-commerce and same day last mile deliveries. This alternative solution is expected to optimize shared and connected vehicles' use through the elimination of idle time (increase of daily occupancy rate according to customer travel / transport requests), as well as to eliminate traffic congestion (reduction of private vehicle use and respective internal and external costs, especially concerning freight transport), leading to increased environmental and economic sustainability, as well as upgraded efficiency of the provided services. According to a recent survey (Beirigo et al, 2018), it has been proven that the mixed systems' performance is higher than the single systems' one. In addition, another interesting finding is that the busier the logistical scenario the better the performance of the mixed-purpose vehicle fleet setting. However, in this case, special and targeted route and vehicle fleet management optimization algorithms are needed in order to provide a feasible solution to this NP-Hard problem, as the demand and supply are dynamically modified in time, while the relevant resources (human labor, operation, monitoring and telecommunication systems, equipment and infrastructure) have a finite capacity, qualification standards, resistance, resilience and life cycle. Overall, according to the authors of the survey, the results have shown that employing a fleet of mixed-purpose vehicles is more profitable on the condition that geographically overlapping people and freight demand can be further combined to design more efficient routes.

Finally, another important parameter when it comes to freight transport is that all of the afore-mentioned issues, barriers and special circumstances have to be faced under the prism of value for money. This means that an important parameter concerning freight transport is the cost of the level of provided services and the willingness of the operators, providers and manufacturers to undertake it in order to proceed with the necessary investments towards the new era of automation. But, on the other hand, there comes also the willingness to pay from the part of the freight operators in order to experience the new product and services, provided that this cost is affordable and worth a try. In other words, the motivation of moving forward is always in direct correlation with the sustainability of the new project no matter how promising and challenging this may seem. In this issue, the role of the public and governmental authorities through initiative support with funding, subsidy, PPPs, etc. or the provision of extra incentives may prove to be of principal importance towards the change from conventional to autonomous freight transport mobility solutions and practice.

Within the issue of freight transport and LaaS in automation, all six categories of stakeholders are involved and interrelated, as listed in Chapter 3.

The following sources were reviewed in order to identify the current gaps, needs, wants and priorities of the various stakeholder groups in relation to automated freight transport systems:

- Deliverables from the following EU and non-EU projects:
    i. AUTOPILOT (Aittoniemi et al., 2018; Aittoniemi et al., 2019);
    ii. AVENUE (Bozi et al., 2019; Dubielzig et al., 2018; Fournier et al., 2018; Mathé et al., 2019; Zinckernagel et al., 2018; Zinckernagel et al., 2019);
    iii. Drive2theFuture (Sjörs-Dahlman & Anund, 2020);
    iv. Adas&Me (Pereira Cocrone et al., 2018; Willstrand et al., 2017);
    v. CoExist (Rupprecht et al., 2018);
- Research papers (Beirigo et al., 2018; Kepaptsoglou et al., 2019; Panou & Maglavera, 2019; Prevedouros et al., 2019);
- Reports: the Special Eurobarometer 496 report and other reports (Gkoumas et al., 2019; Kulmala et al., 2019; Alonso Raposo et al., 2017; Alonso Raposo et al., 2019);
- Other: reporting from ERTRAC, HUB.CONNECT project reporting (Flämig, 2016; Shin, Roh, & Hur, 2018).

Critical findings

Autonomous vehicles are designed to offer an unambiguous way of interaction between the vehicle and the driver or cargo, but they should meet the users' and other stakeholders' needs, priorities and expectations, in order to enjoy acceptance towards their accelerated large scale penetration in everyday's activities. This is because autonomous mobility concepts are designed, developed and implemented in such a way so as to increase real time monitoring, controlling of the vehicle, the driver or operator or security personnel on board (if any), as well as the tracking and tracing of cargo (location and status). Up to now, such systems have been deployed, examined, tested and evaluated as per their safety, security, efficiency in the provision of services and connectivity with each other, the TMC or the remote control centre. Numerous field applications and demonstration pilot tests have been elaborated concerning connected SAVs for freight transport, both in real traffic conditions in urban / peri-urban or interurban environments and in "secure" traffic environment, with use of separate or isolated lanes, entrances and exits, etc. However, most of the test results and findings from projects, studies, reports and papers depicted in the list of references of the current deliverable have been produced through the elaboration of research in labs (VR, AR, AI, etc.) or currently ongoing project demonstration tests based on predetermined use case scenarios within pilots in a "protected or isolated" traffic environment; only a few of them have allowed for the interrelation of autonomous mobility solutions with the current conventional ones. Within the following paragraphs, some of them are indicatively depicted.

In the report "Autonomous Vehicles and Autonomous Driving in Freight Transport" (Flämig, 2016), it is investigated how, for what purpose and to what extent can fully automated vehicles also be meaningfully used in road freight transport, based on public infrastructure. Amongst others, three distinct use cases are identified:

i. Interstate Pilot, as highly automated highway driving with a driver and free navigation.
ii. Vehicle On Demand, as highly automated highway driving without a driver and with free navigation.
iii. Full Automation Using Driver for Extended Availability — Follow-me Vehicle (platooning), as highly automated driving without a driver and without free navigation.

According to the authors, the pioneers concerning the use of Automated Guided Transport (AGT) systems and Automated Guided Vehicles (AGVs) for commercial purposes were the USA in the early 1950s and Germany approximately ten years later. As per the first application case, it was already reported in 1987, when the University of the Armed Forces in Munich, Germany, experimented with a lorry driving on a motorway. In 2013, the vehicle-manufacturer Scania presented a truck that could "independently accelerate, brake and steer" up to a speed of 50 km/h. In 2014, Daimler had a truck driving up to 85 km/h amid other vehicles on a closed section of interstate.

In addition, during the past two or three decades, in several test sites in Germany, a set of pilot demonstration tests have been realized either inside freight terminals using robotic vehicles from point to point (e.g., between warehouses, marshalling yards, etc.) following predetermined routes and trajectories. In the interstate pilot, connected SAVs were tested as per their efficiency in freight transport operations without a driver and with free navigation between rendezvous points in the medium term, for example between rest areas on highways or between well-connected commercial zones. For safety reasons, several precautions and safety measures were taken in advance, such as separate highway entrances and exits for autonomous vehicles or dedicated lanes for autonomous, coupled vehicles, etc. The coupling of vehicles (platooning) combined the initial concept of having a driver available in the lead vehicle (as a backup) with the extended concept in which vehicles drove autonomously without drivers and utilized the benefits of each concept. The platooning vehicles were connected via a software system.

In addition, a number of alternative pilot tests in intermodal freight transport systems in the US, Germany, the Netherlands and Japan are described within Shin et al, 2018. In the Japanese DMT, the system reached the point of full development and deployment at which a 760 m pilot track has been built to test the performance of the DMT system. The system undertakes transport using common trucks and is only capable of unmanned operation along dedicated roads. In the case of the Combi Road in the Netherlands, despite the system having completed pilot tests, the immense construction costs involved in building dedicated roads and the reported feelings of insecurity from vehicle drivers have halted operations. The system has the advantage of being capable of modular transport without the need for separate unloading processes within inland terminals.

Regarding the use of connected SAVs in urban logistics and last mile distribution, in Germany, Daimler Trucks is testing the autonomous concept "Mercedes Benz Future Truck 2025", while in the US, Freightliner (a Daimler-owned company) is testing the "Freightliner Inspiration Truck" also featuring platooning. Moreover, Tesla's Semi truck has recently tested freight SAVs' efficiency in urban and interurban environments, transporting equipment between the giga factory in Nevada and the Tesla factory in California. In Singapore, the Belgian logistics company Katoen Natie elaborates pilot tests using freight SAVs on an eight-kilometre route between US oil giant ExxonMobil's packaging and intermediate storage facilities. In the final stage of the pilot, the truck is scheduled to go on public roads.

In another case, autonomous-driving technology company TuSimple is expanding its freight-hauling pilot program in collaboration with UPS, reaching 20 trips a week and adding another route. The San Diego-based company is already transporting parcels for the shipping giant between Phoenix and Tucson, Ariz. It will now run 10 trips between Phoenix and El Paso, Texas. TuSimple is using retrofitted trucks for the SAE Level 4 autonomous driving program. The trucks can drive autonomously, but regulations and legal constraints on safety and security require that at least initially (currently and until the legislation is modified) security personnel should be present during every trip in order to monitor operations and take over control if needed (e.g., at critical situations when system override is necessary). TuSimple plans to demonstrate fully driverless operations in the context of the “Hamburg Truck Pilot”, currently running from 2019 until mid-2020, as part of the transport partnership between Volkswagen AG and the City of Hamburg, host of the World ITS Congress in 2021. In parallel, MAN Truck & Bus and Hamburger Hafen und Logistik AG (HHLA) are testing automated and autonomous trucks in real use. The HHLA Container Terminal Altenwerder (CTA) and 70-kilometre of the A7 motorway serve as the field testing environment.

In Florida, US, there are currently many initiatives on the use of connected SAVs. In particular, the Florida Department of Transportation (FDOT) is currently in the process of developing a pilot project (Driver Assisted Truck Platooning Pilot) to demonstrate Driver Assistive Truck Platooning technologies and operations to local transportation stakeholders. The pilot project will highlight performance and safety considerations through a set of operational scenarios. Florida's Connected Vehicle Initiative includes Vehicle to Infrastructure (V2I) and Infrastructure to Vehicle (I2V), aiming to exchange information amongst vehicles, drivers, the roadside, bicyclists and pedestrians in real time. This is expected to help all road users and all the other stakeholders involved towards optimized decision making on actions interrelated with traffic circulation, management, safety of passengers and personnel, as well as security and protection of transported cargo and systems, applications, equipment and infrastructure used against damage, abuse and malfunction. In parallel, according to “Supply Chain Dive news”[6], the California-based autonomous trucking company Plus.ai completed its first SAE Level 4 autonomous coast-to-coast delivery, according to a press release. The vehicle completed the 2,800-mile journey in less than three days, carrying a refrigerated truckload from a distribution hub in Tulare, California to a hub in Quakertown, Pennsylvania. Given that SAE Level - 4 autonomous vehicles have sufficient technical capabilities to navigate a range of road conditions without a driver, the collaborating companies and involved stakeholders expect that they would be close to the driverless concept realization in real traffic and environmental conditions. However, for Pulse.ai's pilot, a licensed driver and safety engineer (security personnel) were on board at all times, in order to comply with the respective legal requirements for operating autonomous vehicles on public roads. During the pilot, the truck navigated a variety of terrain, traffic and weather conditions during the day and at night (off-peak hour deliveries). To comply with regulatory requirements, the truck driver took over (AVs’ system override) when getting off the highway for rest stops and breaks, otherwise, the journey was completed autonomously. The company has run smaller-scale pilots across the U.S. and has operations underway in Beijing and Shanghai, China. In addition to the afore-mentioned use cases, as stated before, TuSimple, an autonomous trucking company, is planning to run fully autonomous commercial freight deliveries in 2021. The company's trucks also run at SAE Level 4 autonomy and

[6] www.supplychaindive.com

completed pilots delivering cargo for UPS and the U.S. Postal Service in Arizona. Finally, Amazon, Google and other major companies have explored using autonomous trucks to speed up delivery times, address the driver shortage, or potentially phase out drivers.

Concerning Canada, in early 2019, Ontario's Ministry of Transportation, expanded its 10-year pilot project and currently evaluates the efficient use of AVs on Ontario roadways. Towards this direction, the government announced a pilot program for cooperative truck platooning (Platoon Pilot). It incorporates two or more commercial motor vehicles that use an ADAS and V2V communication system to travel in a convoy where the vehicles steer, accelerate and brake cooperatively and synchronously. The Ministry allows for a limited pilot of truck platoons to demonstrate their potential, compatibility with existing road users and infrastructure and confirm their overall efficiency in providing advanced level or added value freight transport services and guarantee safety and security of the personnel and cargo. There are several conditions crediting the interested stakeholders for participation in the Platoon Pilot. They mainly include the following prerequisites:

- Trucks should be equipped with at least SAE Level 1 or 2 technology.
- Security personnel is required in each AV to steer and take over full manual control of the AV, if required (at critical situations).
- A maximum of three AVs is permitted in each platoon (vehicle convoy).
- For safety and security reasons, it is mandatory that the platoon should only operate on certain designated highways, which include portions of the 400 series of highways and only after approval from the Ministry (concerning the days and times of field testing).
- Reporting at predetermined time intervals is mandatory. The required documents include an annual report, as well as daily reports to be completed and provided on time to the Ministry on demand.
- There are limitations and technical standards applying to the types of cargo that may be carried.
- A declaration of the cyber-security measures taken by the applicant is mandatory in order to avoid road traffic accidents, damage, abuse and / or malfunction of vehicles and systems used, entailing human loss or injury and / or infrastructure, telecommunication network and equipment damage, failure or inefficiency.

In ADAS&ME project and specifically Use Case A – Attentive long-haul trucking, the inability of Scania to deliver either an automated truck or a dual control truck within the time frame requested necessitated the coordination team to request Scania to proceed with a single control truck. With regard to the ADAS&ME system, the primary difference between the current, single control truck and an automated or dual-control truck is the lack of automated driving after a handover of control. Although the single control solution was not ideal, the driver monitoring system and ADAS&ME HMI still functioned as planned. This evaluation was conducted on a high-speed track. In particular, during the test a test engineer (having the role of security or operational monitoring personnel) was inside the vehicle in case of an unexpected event (drivers were informed about this and also that they should not communicate with the test engineer). A speed between 50-80 km/h would have to be maintained during the test (in both manual and simulated automated conditions). To ensure the evaluation remains within the given timeframe, the time allowed in manual driving and simulated automated driving would have to be limited in all conditions. If the driver did not engage in a handover after approximately 16 minutes (two circuits on the test track) of manual driving, the trial would end and be recorded as "no handover". Similarly, if the driver did not take control back from the vehicle in simulated automated mode, at the time of upcoming road works, the trial would end.

Based on the results and findings from relevant studies on user acceptance of autonomous system solutions in freight transport, it seems that part ofthe involved stakeholders hold a rather suspicious or hesitant attitude towards autonomous vehicles. Even though automated driven concepts have proven to be safer, more effective, environmentally friendly and better value for money, this hesitance is due to the threat that many drivers will (have to) lose their jobs to “robots” and, at the same time, due to the fear of the absence of a “supervisor” in critical situations.

In particular, even though automated freight transport systems have been on the agenda many years, there is still a great uncertainty about the benefits and weaknesses linked to them. One critical issue is the responsibility sharing between the operator or controller of the freight vehicle and the providers/developers of the systems (OEMs, Tier 1 suppliers, etc.). The challenges in this case are related with the a) transfer of control between the vehicle and driver/operator and vice versa, b) behaviour of vehicles in relation to other road users, c) communication of system reliability status to the driver/operator and d) clarification of the impact on societal values.

Furthermore, an important factor that stakeholders will consider in deciding whether or not to use an automated freight transport solution is how well they believe it will perform in comparison to conventional ones. The level of service at the proposed price or cost for it, plays a very important role when it comes to freight transport incorporating connected SAVs. This is because, apart from techno-economical, operational and environmental sustainability parameters, in the end, when a private freight transport company provides services, it is also the company image that counts when users – potential customers choose who to trust and collaborate with. In any case, concerning users’ acceptance level, users’ enjoyment of the system plays a big part in their will to use it again, while the performance of the system, the resources provided to support its use and the social popularity of the system all appear to be important factors. Thus, value for money constitutes a very important factor, almost equal with safety and security, as the cost in freight transport is required to correspond to the level of the services provided, in order for the whole system to be sustainable in long term. This is possible under the condition that the quality and quantity of services meet the users’ requirements and priorities and of course is according to the users’ willingness to pay.

Gaps that are hindering the development of autonomous freight transport mobility solutions are identified in the technological, legal and operational framework. The most important ones have to do with infrastructure coverage, interoperability issues, cyber security of new generation of shared, connected, self-adaptive (according to city / traffic environment) and cooperative automated vehicle fleets services.

Both for first and last mile distribution services, as well as for full urban logistics delivery of specific loads (mail, perishable goods, non-bulky commodities) automated vehicle fleets constitute a necessity. The flexible, non-polluting and small dimensioned vehicles seem to ease traffic congestion and its impacts due to freight transport, as well as increase effectiveness, upgrade provided services and minimise the costs; so, given the continuous increase in e-commerce and the need for individualized pickup and delivery services, the automated driven, connected and controlled vehicles seem to provide feasible, sustainable and value for money solutions. SHOW project considers them as standalone (e.g., FURBOT cargo vehicle in Trikala), but mainly in mixed schemes with passengers and goods delivery by a common automated vehicle fleet, under vehicle sharing concepts, in temporal (i.e., passenger during the day, goods at night) or spatial (passenger and goods in different compartments within the same vehicle or goods vehicle following the passengers one by platooning). Relevant SHOW pilots include Rennes and Aachen.

In parallel with automation, future research on freight transport mobility automation should be focused on the development of central and remote vehicle (fleet) management, routing, platooning, monitoring and generic control (e.g., operational control centre) through C-ITS nodal points in city network and TMCs. Those technological developments are required to comply with GDPR and data confidentiality against competition, but they also need to be intervening at critical situations based on real time monitoring and controlling in order to support and guarantee:

- involved personnel, users and stakeholders' safety,
- infrastructure, equipment and cargo security,
- elimination of human injury or loss,
- enhancement of seamless and sustainable mobility,
- successful adoption of resource and energy efficient ways of automated driven solutions' management,
- upgrade of provided services (with focus on time reliability against delays and real time vehicle and cargo tracking and tracing),
- time and cost savings' maximisation,
- holistic promotion, validation and justification of the authorities' decision support system for freight transport activities' planning and programming (e.g., city logistics, vehicle routing, sharing, pooling, prioritization, monitoring, controlling etc.).

Any initiative on freight transport mobility automation should be adopted and applied regarding logistics as a service, towards a better quality of life especially for citizens of urban areas, meeting users' and other involved stakeholders' needs and priorities, introducing new accessibility standards, incorporating special planning and designing guidelines and roadmap for VRUs. Concerning the promotion of business alliances, the focus should also be set on the establishment of integrated business models, collaboration schemes, partnership agreements (e.g., MoUs or harmonisation of city logistics rules at regional or peripheral level) amongst involved stakeholders and long term exploitation plans, based on strategic planning and designing, also taking into consideration the socioeconomic indices and trends of the current situation and future time horizons. In addition, future action plans in the field of automated freight transport services should also consider research directions from the part of automotive, automobility and software / hardware industry, as well as the differences on the way the commercial activities take place (e.g., warehouse management, e-commerce, Business to Business (B2B) or Business to Consumer (B2C) services and personalization of deliveries and payments through internet applications and use of flexible, light, autonomous and electric vehicles and robotic systems or new innovative routines for last mile urban distribution that are gaining ground and market share). The trap in the ITS area is often to be too technology-oriented and 'forget' that there must be a clear business case, having in mind that several interesting potential innovations never reach the market as one or several parts of the business concept do not work in practice.

However, what will be the added value of the pilot UC demonstrations of SHOW is the investigation of adaptability and transferability of urban freight transport automated driven mobility solutions in different city environments, in order to come up with a roadmap of actions and a set of guidance and preconditions with DOs and DON'Ts towards their successful implementation. In the end, the maximization of their effect will be accomplished provided that such measures are twinned and applied under a harmonization of rules' framework at large extent or even universal level.

Moreover, specific future research and development themes should incorporate the development of a software (and hardware) platform for remote control of autonomous or robotic systems and vehicles, 5G network as an enabler technology, real-time sensor data, AI assisted human-machine communication, remote control room, etc. In addition, it seems necessary to promote investigation and exploration of the preconditions required for effective ways that autonomous freight vehicles could be fitted into existing mobility ecosystem, taking into consideration any future business opportunities and assessing the user experience of both users and remote operators. Indeed, special attention is needed on the development of remote operation systems and interfaces that are easy and intuitive for humans to operate and yet reliable and robust enough to provide the necessary functionality and safety. Developers of automated road freight transport vehicles should place their primary focus on ensuring that the vehicles perform to a high standard, providing an efficient and convenient mode of transport. Also, in order to maximise system uptake, designers and developers of such automated systems should consider factors such as effectiveness, level of provided services and the social popularity of the automated driven solutions.

Finally, it seems that the more intensive the twinning, the knowledge transfer and the exchange of experience and know how, the bigger the effect and benefit. So, alliances and partnerships, e.g., in the context of a project consortium funded by EU in this domain, such as SHOW, should be encouraged. Finally, there is evidence that much attention is devoted to driverless cars, but it should be noted that the potential is larger for cargo logistics (and passengers) in a broader worldwide perspective.

The critical findings of the desktop research on automated freight transport are summarized and prioritized in Table 8 below, per stakeholder type.

Table 8: Critical findings concerning automation in freight transport.

Stakeholder type	Gaps	Needs	Wants	Priorities	Prioritisation level (essential, secondary, additional)	Comments
• **Passengers and other road users encompassing VECs** • **Umbrella associations/Non-profit organisations**	• Lack of familiarisation with automation. • Low level of maturity and acceptance of human absence or role change. • Doubt on SAV mobility solutions' efficiency, level of service and safety and security level. • Missing framework concerning responsibility sharing amongst involved stakeholders in case of system malfunction or accident occurrence. • Lack of connectivity with non-equipped AVs, users, systems and services.	• Easy to use and friendly systems and apps. • Evidence on the efficiency of autonomous mobility solutions. • Transfer of control between the vehicle and driver / operator and vice versa. • Behaviour control of vehicles in relation to other road users. • Clarification of the impact on societal values.	• Affordable, on-demand, door to door delivery and individualised services with equal access to all. • Data confidentiality against competition. • Human driver to take control of the vehicle / intervene at any time, or security personnel on board or remotely. • Real time information on the location and status of AVs and their cargo.	• Provision of evidence of AVs' integration and efficiency in real traffic conditions (interrelation with conventional traffic, systems and services), also evaluating access degree in real conditions in urban environment. • Safety and security on board and protection against cyber-attacks and hacking, in compliance with GDPR data confidentiality. • Investigation of potential ways of interconnection and integration.	**Essential**	• The majority of the involved stakeholders have not yet been convinced on the autonomous mobility solutions' efficiency, level of service and value for money (they are not sure if it is worth a try in order to make investments on it). • Mistrust on the effectiveness, safety and operation of autonomous mobility vehicles, systems and services without failures / accidents
• **OEM and transport/mobility operators** • **Tier 1 suppliers, telecom operators, technology providers and services company**	• Insufficient access of remote areas, infrastructure and telecommunication systems coverage. • Interoperability issues while machine learning processes and respective algorithms missing. • Lack of sufficient level of integration and interoperability of proposed concepts, for vehicles operating with higher speed, adapted in different complex environments, being	• Operational interoperability • Establishment of legal framework in order to allow for development of technological solutions • Development of business models and partner agreements • Environmental and economic sustainability and connectivity	• System sustainability and simplified use in compliance with an "open" legal framework in favor of seamless mobility for cost and time (delay) minimization and revenue maximization • Project funding and opportunities for more testing and test beds for evaluation of AVs inside urban environment in order to further optimize systems and services	• Development of inter-partner agreements and collaboration with authorities and other stakeholders towards operational excellence, simplicity and interoperability of the systems towards seamless mobility on transport networks. • Safety and security. • Technological evolution and excellence.	**Essential**	• Interoperability issues in infrastructure, telecommunication and services has been the main barrier against seamless mobility and progress of cross-border autonomous mobility solutions • Missing evaluation tests of autonomous mobility solutions in real conditions (not

Stakeholder type	Gaps	Needs	Wants	Priorities	Prioritisation level (essential, secondary, additional)	Comments
	connected or remotely controlled, enabling for city platooning (e.g., city centre to peri urban)					sufficient yet to convince and better integrate and promote).
Authorities (Cities, Municipalities, Ministries), policy makers, municipality agency and road operators	Lack of a common universal legal framework and SUMPs / SULPs on operational excellence, environmental and economic sustainability and the establishment of LaaS concepts, also promoting successful business models, collaboration schemes and exploitation plan	• Road, system and telecommunication infrastructures and networks with operational interoperability and accessibility. • Holistic approach solutions through integrated initiatives from private domain.	• Gradual strive from conventional to autonomous mobility under successful collaboration schemes and accessibility design principles • Long-term business and economic sustainability	Establishment of legislative framework on integration procedures and creation of business and collaboration schemes, towards the development of long-term autonomous mobility solutions with environmental and economic sustainability.	**Secondary and additional**	Authorities are in search for holistic approaches towards the development of universal autonomous mobility concepts managed and controlled by the private domain in the long term to provide services.
	Lack of or insufficient interconnection of SAVs, systems and services to TMC and control center for remote monitoring and management (infrastructure and telecommunication interoperability).	• Operational excellence of monitoring and controlling systems and mixed schemes with passengers and cargo delivery by common automated vehicle fleet, under vehicle sharing concepts.	• Guarantee safety, and security of personnel and cargo even through remote controlling. • Upgrade level of service and implement seamless mobility with operational interoperability.	Safety and security, operational excellence and avoidance of deficiencies, failures, malfunction, accidents and inefficiencies.	**Essential**	Authorities in search of private operators, managers and collaborations, but also promoting the development of AI, AR / VR, smart algorithms and machine learning for operational excellence.

Stakeholder type	Gaps	Needs	Wants	Priorities	Prioritisation level (essential, secondary, additional)	Comments
Research and academia	Limited or lack of co-operation with authorities, public, private or in the context of PPP schemes to promote and further support or fund SAVs and respective systems and services.	• Projects funding to provide evidence on efficiency, safety and security of vehicles, systems and services, encouraging user acceptance and promoting accessibility for all.	• Research and scientific excellence through the increase of funding and test beds for evaluation of autonomous mobility solutions.	• Safety and security, operational excellence and data privacy • Speed up the integration of fully autonomous mobility solutions in real conditions within the urban and peri-urban transportation network Speed up the integration of fully autonomous mobility solutions in real conditions within the urban and peri-urban transportation network • Environmental, business, economic and operational sustainability • Collaboration schemes development and adoption of resource and energy efficient ways of automated driven solutions' management • Provision of justification acting as auxiliary DSS. • Time and cost savings for all involved stakeholders and mainly end users.	**Essential**	Promotion of safety, security, sustainability and accessibility of transport with AVs while decreasing vehicle ownership and prepare the ground for the driverless era and the transformation of human role from driver to controller, manager and operator.

Stakeholder type	Gaps	Needs	Wants	Priorities	Prioritisation level (essential, secondary, additional)	Comments
	• Inexistence or not sufficiently developed of international communication channels for exchange of experience, know-how and best practices. • Limited funding and support for knowledge transfer and twinning through project MoUs.	• Inter-partner agreements.	• Promote science and research on the optimisation of fully autonomous mobility solutions in urban and peri-urban areas.	Business agreements.	**Secondary**	The interrelation and bond between science, research and the market is the requiring key factor for market penetration and sustainability.

Correlation of findings per stakeholder type

In the context of this section, the comparison of findings among the different stakeholders is elaborated in order to point out common gaps, views, etc. as well as main differences.

A first commonality amongst the involved stakeholders is the “lack of familiarization with automation”, which relates to mistrust, safety and security concerns, as well as low user acceptance. On the other hand, there are also major differences on the prioritization of needs and wants among the stakeholders, especially pointed out when comparing passenger and freight transport. Of course, safety and security is ranked first in both cases, however, for passenger transport a main issue is the provision or upgrading of services related to comfort, reliability and cost, while in freight transport the value for money for the provided services constitutes a key issue towards the implementation of autonomous mobility solutions, taking also into consideration environmental impact and other constraints and legal obligations, e.g., on environmental sustainability and footprint.

Focusing on the passenger transport, almost all of the reviews prove the prioritization of safety, pointing out the "fear of the unknown” or “the lack of confidence" as the main reason of concern, inconvenience and doubt from the part of the passengers, the authorities, the public transport operators, the network and technology providers. This endogenous mistrust is empowered by the fact that until now the legislative framework is a little obscure regarding the share of responsibility in case of accident and who pays except for the insurance companies. Nevertheless, the road safety level constitutes the main issue from the part of all the involved parties and stakeholders in passenger transport. In addition, the willingness to pay is also a key issue for everyone, according to who is going to be burdened with the initial investment and how affordable is the new automated passenger transportation system going to be for the average user; with or without public subsidy and / or other support or participation from the private domain or through public private partnership schemes. In fact, the potential costs versus the expected revenues constitutes one of the most important parameters to be taken into consideration in the frame of spatial planning at strategic and governmental decision-making level, but it is equally significant at tactical and operational level as well.

Service providers and operators are also interested in the compliance with regulations on environmental friendliness, while the environmental preservation is ranked high for public authorities as well. Furthermore, there is also the accessibility matter which is twofold: of course there is the issue of accessibility concerning the VRUs, VECs, etc. that is expected to be introduced since the design phase, but on the other hand there is the need for easy and equal access from all the potential users regardless of the level of their familiarization with the new technologies (IoT, C-ITS and smart mobility concepts and services). This means that any service or application developed towards the integration or upgrading of the provided services is desired to be equally accessible by all, irrespective of the socioeconomic status of the user, the available equipment – hardware or software (e.g., smart phone or tablet running a simple easy to download and operate app) and the level of knowledge, know how, technology (il)literacy and familiarization. Another issue is the difficulty from the part of the users towards sharing and compiling of their personal data according to the General Data protecting Regulation (GDPR).

Several other issues and concerns apply to the parties and stakeholders involved in the realization of the automated driven freight transport. In particular, the prioritization and significance of each gap, need, preference and priority is slightly different and depends more on economics, on the level of the provided services that interrelate with the company image and on the current and future legislative frameworks from the part of the transportation companies using AVs. Of course, in this situation, the (road) safety and accident prevention issues are prevailing and ranked first in the list of needs and wants among all the involved stakeholders, from freight forwarders, shippers, retailers and third party logistic providers and operators, to infrastructure, equipment and technology providers and operators (including industrial OEMs, etc.), public authorities and the general public – customers – end users.

Second in line comes the economic dimension, in the sense of how high is the level of provided services set, according to the respective resources invested and the share of cost which is contributed by each one involved. Based on the surveys reviewed, it seems that the need from the part of the private stakeholders is the optimization of the level of services, the minimization of cost and the maximization of the expected revenues and benefits. In addition, the willingness to pay from the part of the private domain is limited in case there is no public subsidy or support (e.g., PPP scheme), unless there is clear potential that the adoption of any new and innovative alternative solution is going to bring significant profit in short or medium term. Apart from the economic and environmental sustainability and mainly due to the legislative and regulatory framework, the private transportation companies need to be aligned with any accessibility standards, no matter the cost and effort involved, mainly as they are obliged to do so rather than because it fits their internal prioritization strategy. Finally, freight forwarders, retailers, shippers and other private companies involved in freight transport are rather suspicious or even negative towards (big) data sharing and compilation or even the individualization of the information due to confidentiality and competitiveness issues. This prevents smart solutions from full and rapid integration, adoption, adaptability and transferability widely and in the meantime constitutes an additional barrier that calls for immediate, convincing and solid answers.

5.2 Surveys

The SHOW user acceptance surveys will be conducted in two stages: a baseline measurement before the implementation of the experiments and three on-site measurements during the automated service experiments, involving *a representative pool of 1000 stakeholders per Mega Site and 300 ones per Satellite site (covering all stakeholders and travellers' cohorts).* Based on this objective fixed in the grant agreement, this sample will be split in almost 4 parts corresponding to the 4 times of measurement (1 baseline and 3 on-site measures), that is, **250 stakeholders per Mega Site and 75 ones per Satellite site by time of measurement**. This repartition includes both the answers to the different questionnaires but also the answers to the interviews. The goals of the two methods are different. In the case of questionnaires (for the end-users, see Table 9), it is necessary to have an important number of respondents in order to generate useable "quantitative" data. For interviews, since the generated data is qualitative the required number of respondents is reduced (for the other stakeholders, see Table 9). The proposed ratio is as follow: approximatively 90% of the sample would complete the questionnaires (approximatively 230 end-users per Mega Site and 65 end-users per Satellite site) while only 10% would be interviewed (approximatively 20 other stakeholders per Mega Site and 10 other stakeholders per Satellite site).

The Table 9 presents a synthesis of the survey proposition.

Table 9: Synthesis of survey targets, campaign, instruments, moment, administration and tools.

User/ Stakeholder	Campaign	Instrument	When	Administration	Tool
Traveller (passenger/ driver)	Needs / wants & *a priori* acceptance	Surveys (long)	Before the implementation of the experiments	Online via invitations	Typeform, surveymonkey, socsurvey, etc.
	Acceptance in use	Short questionnaire	On-site during the automated service experiments	Asked by personnel entering stops or the PT vehicle – contextually appropriate with high face validity	Same as above via a tablet or mobile phone, QR code
OEM, Operators, authorities, infrastructure operators, Tier 1 service providers	Needs/wants & acceptance	Interview	Before the implementation of the experiments	Face to face	Hard copy/ tablet/ recordings
	Needs/wants & acceptance	Interview/ Guerilla tests	On-site during the automated service experiments	Face to face	Hard copy/ tablet/ recordings

Baseline measurement: online questionnaire and *a priori* interviews

Objectives and approach of the baseline measurement

The main aim of the online survey is to collect a baseline measurement of the users' needs and acceptance of all the mobility services tested in the SHOW project. Because the *a priori* measurement data requires to be realised before the implementation of the different experiments, the needs and acceptance survey will be composed of:

- An online questionnaire with the end-users;
- Interviews with all the stakeholder groups.

As mentioned in the chapter 2, a questionnaire based on a user journey adapted to the mobility context of each pilot will be used to collect information on the needs, wants and priorities of the different stakeholders. The *a priori* acceptance will be measured specifically among the passengers/future travellers by the mean of a questionnaire based on the UTAUT (Venkatesh, Morris, Davis & Davis, 2003). The interview template will be also based on the 6 different aspects of the end-user's journey (defined in section 2.5), but the questions will be adapted to the specificity of each stakeholders group.

Considering the number of sites across the EU and the diversity of the stakeholders, using both quantitative and qualitative methods allows us to:

- Have a structured set of questions to the final users on a single form, easy to conduct in large numbers,
- Have an appropriate means to collect specific data and to perform rough statistical analysis,
- Reduce the interaction time and allow the users to participate in the survey when they have time and where they are available to do it,

- Understand the reasons and process involved in the decisions and the perceptions and consider the differences between the stakeholders (interviews),
- Target accurately the data collection.

Population and stakeholders' engagement of the baseline measurement

Based on the grant agreement and to guarantee a good sample to allow robust statistical analysis, data will be collected from a representative pool of 250 stakeholders per Mega Site and 75 per Satellite site (covering all stakeholders and travellers cohorts).

End-users

The population of end-users will be made up of people from each of the demonstration sites. This contact list will be completed and validated by each demonstration site manager. A specific communication will be drawn up before the questionnaire is distributed. Indeed, it is mandatory that the end-users understand the issues of the survey in order to feel encouraged and able to participate further in the consultation. Informing and recruiting end-user respondents may be done with the help of the stakeholders themselves (by advertising displays and/or in partnership with associations of public and private travellers/citizens) or with the help of a specific agency of panel recruitment if necessary. In this last case, incentives for voluntary participants have to be defined, to motivate them to participate and continuously use the services. Based on the objectives defined in the Grant Agreement, a sample of 230 end-users per Mega Site and 65 per Satellite site is expected. As mentioned above, approximatively 90% of the sample (the end-users) would complete the questionnaires while only 10% (the stakeholder groups) would be interviewed.

Users' recruitment will be accommodated through the user engagement initiatives of A9.3.

Stakeholder groups

Each stakeholder group be represented in the responses to be provided. To be representative, a sample of 20 stakeholders per Mega Site and 8-10 per Satellite site is expected. The list of people who will be invited to participate will be based on the definition of the ecosystem (per pilot) presented in Chapter 3 of this deliverable. A specific communication will be drawn up before the recruitment. Indeed, it is mandatory that the stakeholders understand the issues of the survey in order to feel encouraged and able to participate further in the consultation. Stakeholders' recruitment will be accommodated through the participant engagement initiatives of A9.3.

Questionnaire of the baseline measurement to the end-users

Questionnaire structure

Several categories of questions will be included in this questionnaire. Moreover, it is important to underline that the elements relating to the economic field (e.g., price to pay, cost, etc.) will be included in this questionnaire. They will be addressed by the WP2, so exchanges will be necessary with this WP to integrate these elements.

Table 10 below presents the suggested structure of the data to be collected in the online survey. First versions questionnaires can be found in Appendix III, addressing a long 'needs & wants' survey and a short acceptance survey. The same Appendix includes a generic interview structure, which can be further adapted to the requirements of each of the stakeholder groups. The initial versions accommodate many of the categories presented in Table 10. An incremental approach and a validation process with the partners and the pilots will allow us to propose a final version of the tools in M10 of the project.

Table 10: First proposition of collected information by the online survey.

Main categories	Indicative example of requested information
PART 1: PERSONAL INFORMATION	
Socio-demographics data	• Age • Gender • Disability • Household structure • Education • Income • Employment • Residential situation • Geographical area • Category of stakeholder *(filter for the parts 3A and 3B)*
Technology and AV knowledge and relationship	• Experience with AVs • Knowledge of AVs • Technology savviness
PART 2: NEEDS, WANTS AND PRIORITIES	
Prerequisites and conditions of deployment	• Road/street type • Road/street conditions (e.g., bad infrastructure, narrow lanes, twisty bits) • Shared or individual vehicles • Traffic conditions (e. g., congestion, peak hours) • Weather conditions (e.g., fog, rain, snow, ice, cold, heat) • Urban, peri-urban, rural or confined area of operation • Vehicle type (e. g., PT, DRT, other) • Time of day (e. g., daylight: peak and non-peak, night, dusk, dawn) • Compatibility with other existing services • Acceptance to walk between 2 different lines or modes. • Trip purpose (e.g., commuting, leisure)
Information & Signage	• Display at bus stops or mobility hub • Means of recognizing the correct vehicle • Information for the first use
Service Request	• Reservation on an application • Ticketing or included in a subscription card • On-demand (DRT) or continuous with a timetable • Punctuality • Frequency
Identification & Boarding	• Validation, code, automatic doors • Privacy
Service Start	• Automatic start or with a button press • Waiting for other passengers (e.g., for shared DRT)
On-board activities	• Available space per person (sitting or standing), • Infotainment • Shared activities • Control on the driving and/or on the vehicle • View of the cameras • Safety and on-board reassurance

Main categories	Indicative example of requested information
	• Presence of an operator or supervisor • Cleanliness • Comfort
Descent	• Need of an automatic stop or a stop button stop • Type of doors opening • Satisfaction assessment after each course
Generic expectations	• Facilitating conditions • Safety and perceived risk • Data security and privacy • Responsibility
A priori acceptance of automated mobility service	• Performance expectancy (usefulness) • Effort expectancy (ease-of-use) • Attitudes • Behavioral intentions

Before addressing the questions of part 2, a concise description of the automated mobility service and the used AV will be presented. This description will be provided, or at least validated, by each demonstration site leader (e.g., a vehicle picture, a short descriptive text), to allow respondents to better picture themselves using the service.

The final recommendations based on the survey tools will be finalized and reported in the next issue (D1.3 for M42).

Key tool

An online software will be used to implement the questionnaire (e.g., Limesurvey, Sphinx or specific site of one or several partners; this point will be decided by all WP1 and WP13 participants).

Practical details

When the first consolidated version of the questionnaire will be finalised, it will be validated by the demonstration sites leaders, by the partners in A13.5 impact assessment and the A3.2 about the Ethical and privacy issues.

Pilot sites will be responsible of the setting-up of all questionnaires and tools that will be made under the guidance and organization of A1.1 and A9.2 (Capturing and monitoring tools; Within this task the subjective and objective data analysis tools for the Pilots will be defined and developed).

The different partners are also responsible for translating and pretesting the questionnaire in their national languages.

Regarding the data analysis, the demonstration sites should be categorized according to the addressed UC, while further comparisons will also be performed. Thus, the analysis will include two levels of information: (a) a specific site-level and (b) a UC-level. Partners involved in the A1.1 and A13.5 will coordinate the analysis. A preliminary frame of analysis will be proposed when the definitive version of the questionnaire will be stabilized.

Guarantee of data protection and privacy

The collected data will not allow us to recognize the identity of the respondents in order to guarantee compliance with the European law on data protection and privacy (GDPR). The requirements of the GDPR mainly include:

- Requiring the consent of subjects for data processing
- Anonymizing collected data to protect privacy
- Providing data breach notifications
- Safely handling the transfer of data across borders
- Requiring each partner to appoint a data protection officer to oversee GDPR compliance

Key points of attention

The distribution of the questionnaires' respondents will comply with the principle of gender equity.

The procedures for engaging the end-users should start as quickly as possible, coordinating with other project activities (e.g., WP2, WP9).

Interview of the baseline measurement for all stakeholders

Interview structure

The interview grid will be **adapted according to each stakeholder group's specificities** (i.e., *OEM and transport/mobility operators, Tier 1 suppliers, telecom operators, technology providers and services company, Research and academia, Passengers and other road users encompassing VEC, Umbrella associations/Non-profit organisations, Authorities (Cities, Municipalities, Ministries), policy makers, municipality agency and road operators*). Nevertheless, for each group, it will be expected to collect the following data:

- **Expectations** regarding the automated service and **key points**;
- **Roles** to play in the implementation of the automated service;
- Information and contact needs on the automated service and its implementation;
- **Pain points** and difficulties encountered in preparing the implementation of the automated service and solutions implemented or envisaged;
- Personal ***a priori*** **acceptance**;
- **Perception** and projection of the acceptance of end-users.

Key tools

We propose different forms to conduct the *a priori* interview stage:

- **Individual interviews "in room"** (or online if physical meetings are impossible) that will allow the interviewers to collect in-depth data.
- **Focus groups "in room"** (or online if physical meetings are really impossible) that will allow the interviewers to compare points of view inside a group of people from one or more stakeholder categories (this point remains to be defined according to the specificity of the stakeholders of each site).

Practical details

The different partners are also responsible for translating and pretesting the interview grids in their national languages.

Regarding the data analysis, the demonstration sites will be categorised according to the addressed UC, while further comparisons will also be performed. Thus, the analysis will include two levels of information: (a) a specific site-level and (b) a UC-level. The partners involved in the A1.1 and A13.5 will coordinate the analysis. A preliminary frame of analysis will be proposed when the definitive version of the interview grids will be stabilized.

Guarantee of data protection and privacy

The collected data will not allow us to recognize the identity of the respondents in order to guarantee compliance with the European law on data protection and privacy (GDPR). The requirements of the GDPR mainly include:

- Requiring the consent of subjects for data processing
- Anonymizing collected data to protect privacy
- Providing data breach notifications
- Safely handling the transfer of data across borders
- Requiring each partner to appoint a data protection officer to oversee GDPR compliance

Vigilance points

It will be necessary to ensure that the interview grid is adaptable and suitable:

  - For all use cases,
  - For all type of stakeholders.

An appropriate location will need to be found to conduct the different interviews and focus groups with the use of the appropriate tools, especially in the case of online administration (e.g., recording methods involving the necessity to obtain the agreement of the participant to be recorded).

The constitution of focus groups must be balanced and organized accordingly to ensure constructive exchanges.

On-site acceptance measurements: on-site questionnaires and interviews

Objectives

As for the baseline measurement, two activities are planned; one with the end-users by using a questionnaire and one with all the stakeholder groups by using interview methods (individual and/or focus groups).

For this next step of investigation directly during the real-life demonstration, the used questionnaire for the users will be shorter to provide the opportunity to be filled in directly in the vehicle, during the service. This short version of the questionnaire aims at assessing the context of the journey and the acceptance of the vehicle/service (see Appendix III). As presented in the chapter 2, we propose to use the Nielsen’s model about the acceptance in use for this survey (Nielsen, 1993) because, in this step, the service will be implemented and the different actors will experiment a real use. Only the dimensions[7] of the model which are relevant to the mobility service use are included in the questionnaire survey. We suggest asking only one question per dimension in order to limit the number of questions.

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[7] As a reminder, dimension (or factor) in Psychology is defined as a variable of the behaviour, thought or perception which can be measured objectively or subjectively.

The interviews will aim at collecting the potential new needs appearing during the demo periods, the perceptions of the implemented automated service and the feedback of all the stakeholder groups.

In order to understand the acceptance progression and the perception change, three measurement times will be performed during the demonstrations period (several months): at the beginning, at the middle and at the end.

Population and engagement of the on-site measurement

End-users

The population will consist of passengers using the various services being tested at each of the SHOW pilot sites. Depending on the site, the targeted samples will have specific characteristics (e.g., medical staff, people with disabilities, students, etc.). The questionnaire will also be adapted to be filled in by the other road users (e.g., vulnerable road users: pedestrians, cyclists), in order to also evaluate their acceptance of the different demonstrations related to their usual journeys.

Users' recruitment will be accommodated through the user engagement initiatives of A9.3. To ensure the engagement of passengers to participate in the survey, several actions will be implemented:

- Information will need to be provided about the service and the importance of providing their opinions to improve the offer;
- Participation of the ecosystem to reach the end-users (e.g., meetings, advertising, …);
- Incentives for voluntary participants must be defined by each partner and demonstration site leader (e.g., vouchers, lottery) to motivate them to participate and continuously use the services. In the communication, it will be important to insist on the free demonstration offer.

One of the main arguments to ensure the respondents' willingness to participate will be the response time to this questionnaire. Therefore, the duration required to complete the questionnaire should not exceed 5 to 10 minutes.

A sample of minimum 230 end-users per Mega Site and 65 per Satellite site for the 3 moments of measurement is expected (in total, 660 end-users per Mega site and 195 per Satellite site). The end-users will not necessarily be the same in the three measurements due to the sample size.

Stakeholder groups

As for the baseline measurement, the list of people to be contacted and invited to participate will be based on the ecosystem (per pilot) presented in Chapter 3 of this deliverable. A specific communication will be drawn up before the recruitment. Itis mandatory that the stakeholders understand the issues of the survey in order to feel encouraged and be able to participate further in the consultation. The recruitment of stakeholders will be accommodated through the participant engagement initiatives of A9.3.

A sample of minimum 20 stakeholders per Mega Site and 8-10 per Satellite site for the 3 phases of measurement (i.e., at the beginning, in the middle and at the end of the SHOW demonstrations) is expected (in total, 60 stakeholders per Mega site and 24-30 per Satellite site). The stakeholders will not necessarily be the same in all three measurements.

Questionnaire for the on-site measurement

Questionnaire structure

The questionnaire proposed is short, precise and comprehensive. Based on the previously cited Nielsen's model (see Chapter 2.4), only one item per tested dimension (see Table 11 appended below) was retained (instead of 3 or 4 in a long version of questionnaire). This current version may change slightly especially upon the results of the pre-test, and we may include additional questions. This reduction in the number of questions is counterbalanced by the great sample size.

The detailed categories and dimensions are presented in Table 11. This structure includes less than 20 questions. The detail of the first draft is presented in the Appendix III. We propose to focus the questionnaire on the global automated service of mobility and not on the vehicle. To this purpose, the manner to present the objectives of the survey to the respondents will be crucial to be sure that they respond to the correct "object of this survey". For example, the sentences of presentation must include the following keywords: autonomous/automated, mobility service, innovation …

Table 11: Proposition for the on-site survey.

Categories	Dimensions
Mobility context	Day and time Reason of the journey Duration of the journey or line start/stop Problem encountered on the journey
Acceptance in use	Satisfaction Perceived utility Usability Easy to learn Perceived reliability Perceived safety Compatibility with the needs Perceived comfort Intention to use again Intention to advise their peers to use or not use the service
Socio-demographic information	Age Gender Socio-professional category

Key tools

Depending on the configuration of each site and the available means to each partner, different tools could allow to collect the data:

- **A paper form to distribute to passengers** – in addition to the ecological impact, the major drawback will depend on the means used to collect the filled questionnaires and the processing time of the data.
- **"Satisfaction-type" response terminals** inside vehicles or at stops – the cost of this equipment must be considered, as well as the possibility of asking more than 1 or 2 question(s) and the safety of such a device on board. Moreover, only one person can use this type of device, others waiting their turn (risk of loss of participants). These feedback pods and/ or strips are explored as options to gather fast and large acceptance feedback.
- **Survey tablets (guerilla test) –** it is a good means to collect answers to a complete questionnaire, but this method requires the presence of one or more

interviewers. It is also interesting if partners want to collect additional qualitative data.

- **QR Codes and web link –** Each demonstration manager in contact with stakeholders could set up displays with a simple web link and a QR code to scan to answer the survey online either directly during the journey or when people are at home. The use of a different QR code and web link would identify which line or service was chosen.

The final recommendations based on the survey tools will be finalized and reported in the next issue (D1.3 for M42).

In the current draft version of the questionnaire, the response scale is a 9-Points Likert scale and multiple choices scale, in order to match with the KPI 4 which refers to assess traveller acceptance rating of services (Target: Traveller acceptance rating (1-9 scale) over 7 (mean value)).

Practical details

When the first consolidated version of questionnaire gets finalized, it will be validated by the demonstration sites leaders, the partners involved in the impact assessment (A13.5 and in A3.2 concerning the Ethical and privacy issues. The collected data will not allow us to recognize the identity of the respondents in order to guarantee compliance with the European law on data protection and privacy (GDPR, see above to the rules to guarantee).

Pilot sites will be responsible of the setting-up of all questionnaires and tools that will be made under the guidance and organization of A1.1 and A9.2 (Capturing and monitoring tools; Within this task the subjective and objective data analysis tools for the Pilots will be defined and developed).

The different partners are also responsible for translating and pretesting the questionnaire in their national languages.

To facilitate the analysis of the data, demonstration site will be categorized according to the addressed UC to allow certain comparisons to be performed. Thus, the analysis will include two levels of information: (a) a specific site-level and (b) a UC-level. The partners involved in the A1.1 and A13.5 will coordinate the analysis. A preliminary frame of analysis will be proposed when the definitive version of the questionnaire gets stabilized.

Vigilance points

The distribution of respondents to the questionnaires must comply with the principle of gender equity. As the participation will be more spontaneous, before the end of the campaign, pilot partners will have to follow up on the response quota and put in place incentive measures for less represented groups, considering gender but also age and passengers' categories to obtain the most balanced quota possible. Significant work must be done in partnership with the stakeholders concerned.

As mentioned above, the object of evaluation (i.e., a connected, automated service of mobility) must be well defined.

Regarding the acceptance model, there is a limitation of the accuracy of the measurement due to the use of only one item per dimension.

Any delays or technical incidents should be checked when analysing the results of the fact-finding campaigns to better understand possibly more negative opinions (i.e., importance to obtain this information from the operators).

Interview of the on-site measures

Interview structure

The interview grid will be **adapted according to the stakeholder groups**. Nevertheless, for each group, it will be expected to collect the following data:

- **Expectations** regarding the results of assessment of the automated service and **key points** to be addressed after the pilots,
- **Perception and assessment** of the automated service,
- **New or remaining needs** to address,
- **Pain points** and difficulties encountered during the implementation of the automated service and planned solutions
- Personal **acceptance in use**.
- **Perception** of the end-users satisfaction (i.e., Do users seem satisfied with the automated service provided?).

Key tools

We propose different forms to conduct the on-site interviews:

- **Individual interviews "in room"** (or online if physical meetings are not possible) – they allow the interviewers to collect in-depth data.
- **Focus groups "in room"** (or online if physical meetings are really not possible) – they allow the interviewers to compare points of view inside a group of people from one or more stakeholders' categories (this point remains to be defined according to the specificity of the stakeholders of each site).
- **Individual interviews on-site** (e.g., in the vehicle or at the descent of the vehicle) – they allow us to enquire into the perception of specific stakeholders (e.g., end-users, transport operator, authorities) during or immediately after the use.

Practical details

When the first consolidated version of the interview grids (individual and by focus group) is finalized, it will be validated by the demonstration sites leaders, by the partners in A13.5 impact assessment and the A3.2 about the Ethical and privacy issues. The collected data will not allow us to recognize the identity of the respondents in order to guarantee compliance with the European law on data protection and privacy (GDPR).

Pilot sites are responsible as for all interviews and tools that will be made under the guidance and organization of A1.1 and A9.2.

The different partners are also responsible for translating the interview grid in their national languages.

To facilitate the analysis of the data, demonstration site will be categorized according to the addressed UC to allow certain comparisons to be performed. Thus, the analysis will include two levels of information: (a) a specific site-level and (b) a UC-level. The partners involved in the A1.1 and A13.5 will coordinate the analysis. A preliminary frame of analysis will be proposed when the definitive version of the questionnaire gets stabilized.

Vigilance points

It will be necessary to ensure that the interview grid is adaptable and suitable:

- For all use cases,
- For all groups of stakeholders.

An appropriate location will need to be found to conduct the different interviews and focus groups with appropriate tools (e.g., recording methods involving the necessity to obtain the agreement of the participant to be recorded).

The constitution of focus groups will be balanced and they must be well organized to ensure constructive exchanges.

6. User opinion discovery in social media

6.1 SHOW Social Media Mining Tool

The social media mining tool is implemented in Python 3.6 and it uses a lexicon of intended terms (Keywords used - Appendix IV) to crawl and query the social media channels that have been selected (Twitter & Reddit) for data in a structured form. This initial version of the tool runs and collects posts, comments (or comments of comments) from the selected social media that adhere to specific constraints regarding the posting time and relevance to predetermined terms (keywords used) in order to discover hidden, useful and interesting opinion/issues reported patterns. Moreover, this tool anonymization will anonymize all the gathered data (deletion of personal mentions), and perform the first level of data cleaning for removing non needed text (e.g., URLs).

For Twitter, beyond the initial list of keywords used, an additional tool is also used to scrape tweets that refer to the services provided by SHOW (i.e., autonomous vehicles, autonomous driving, etc.) and that extracts relevant tags from the text (NER: Named Entity Recognition). Named-entity recognition (NER) (also known as entity identification, entity chunking and entity extraction) is a subtask of information extraction that seeks to locate and classify names entity mentioned in unstructured text into pre-defined categories such as person names, organisations, locations, medical codes, time expressions, quantities, monetary values, percentages, etc. After the filtering/cleaning process, the tool is fed with more than 5.000 related items from Reddit and Twitter the SHOW Sentiment Analysis Tool.

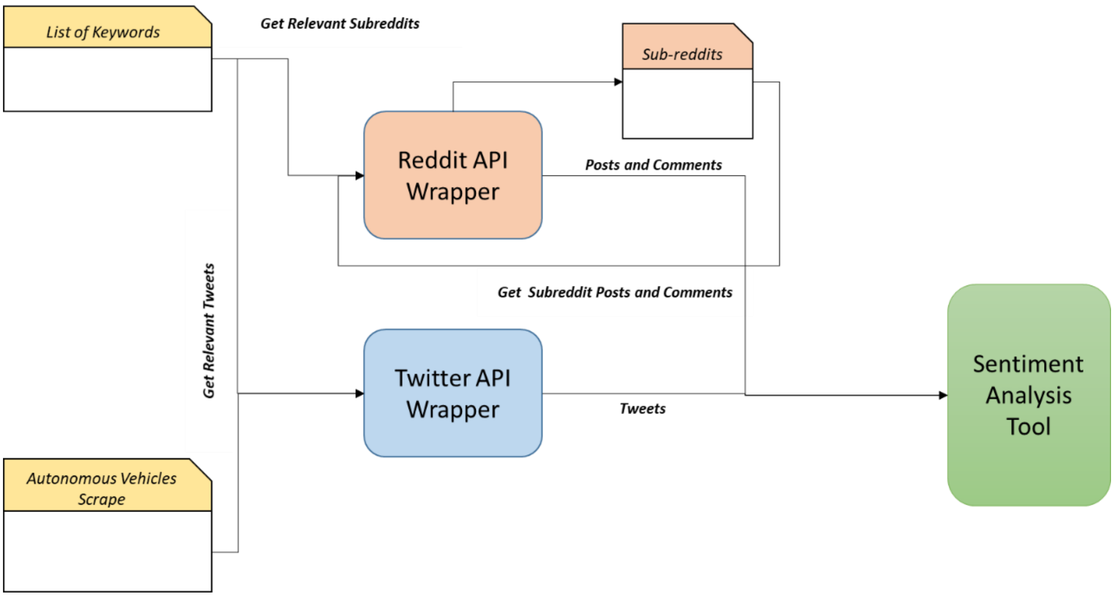

Figure 12: Dataflow diagram for Social Media Mining.

Both mining tools are based on API wrappers developed in Python, provided as official Python libraries from the respective social media channels.

6.2 SHOW Sentiment Analysis Tool

The SHOW Sentiment Analysis Tool uses the Bidirectional Encoder Representations from Transformers (BERT) model with a wide variety of Natural Language Processing (NLP) tasks. This type of feature extraction applies bi-directional training to a

Transformer for a non-causal analysis where the classification results of one specific instance is affected by both past and future instances. So, as the tool assesses the emotional polarity of a word, it uses both past and future words appearing in a post to optimise the classification. This allows our approach to capture long-range dependencies with the use of a Bi-directional Long Short-Term Memory (LSTM) network. LSTMs are of similar structure with the bidirectional recurrent regression models, but each node in the hidden layer is replaced by a memory cell, instead of a single neuron.

The input layer of the sentiment analysis tool gets the collected social media text data (Posts/Comments) from the social media mining tool and pre-processes it in order to increase the accuracy output and maximize the classification performance. This pre-processing includes anonymization of the post, deletion of links and replacing emoji characters with corresponding text/keyword. Following this pre-processing step and given that the resulting processed post is of sufficient length (at least one full sentence), the system progresses to the feature extraction phase. This feature extraction uses a BERT, a state-of-the-art tool in natural language processing. The model turns the pre-process to an attention mechanism that learns contextual relations between words (or sub-words) in a text/post. In its used form, Transformer includes two separate mechanisms — an encoder that reads the text input and a decoder that produces a prediction for the task. Since BERT's goal is to generate a language model, only the encoder mechanism is necessary. The proposed model is specifically trained to extract sentiment polarity features. This training was done over the Stanford Sentiment Treebank, a commonly used dataset for such tasks.

The BERT transformation produces kernel parameters that are estimated in a way that minimizes the performance error on a ground-truth training set. The *L* feature maps, denoted as f_1, f_2,…, f_L are used as inputs in the final (pre-classification) layer. The final component of the filter is the pre-classification layer that receives the $f_1, f_2, \ldots, f_L$ feature maps and triggers a supervised behaviour classification. The architecture of the deployed model can be viewed below:

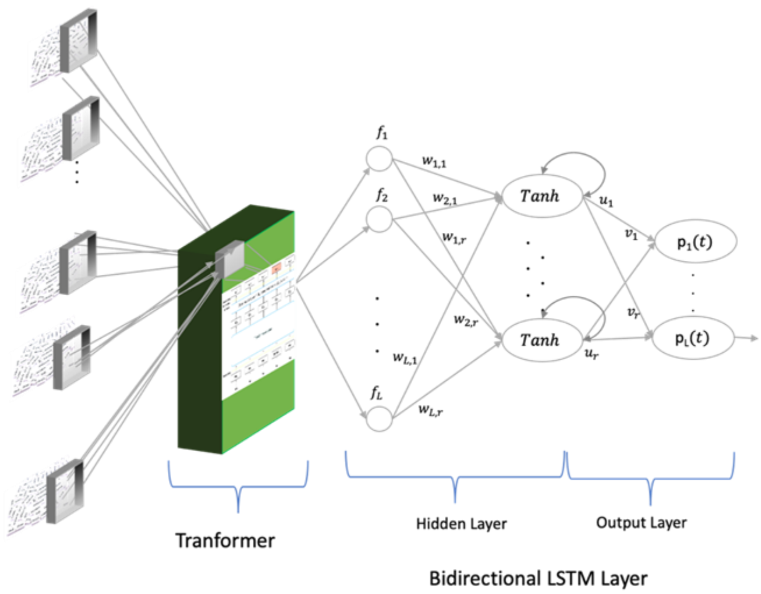

Figure 13: Internal architecture of the Sentiment Analysis Tool.

SHOW data classification / clustering tool

The SHOW data classification / clustering tool receives the processed items (data) from the selected Social Media channels, which are being collected by the SHOW social media mining and sentiment analysis tools.

The first pre-processing step of the classification / clustering tool to the acquired data is to eliminate irrelevant information from the sentences of the collected social media items. More specifically, to ignore items that are too short in word length as they offer little to no information after the implementation of filtering techniques. As data understanding is a crucial step in text analysis, performing clustering techniques on the collected dataset, such as the terms that appear in the data, their distribution, and their importance along the different collected items, is considered in order to find common words that do not add any value to the context of a social media item. Therefore, such words are excluded from the corpus. In our case, in order to identify the topics within the collected social media items, terms that are relatively common in the analysed items are ignored. These terms are the keywords used by the data-mining tool which are also found in the majority of the collected items. The next step of the pre-processing phase is to tokenize the collected items into lists of words and to remove punctuation symbols and unnecessary characters. Then, the terms are lemmatized to obtain a linguistically valid lemma of each complex word. The sequence in which the terms appear in the documents has also been considered, by calculating N-grams (specifically bigrams). The main point behind this concept is to highlight sets of co-occurring words that might otherwise be insignificant as individual terms. Terms importance is calculated using tf-idf scoring measures for applying weighting factors to the words of the corpus based on the frequency they appear on each individual social media item and on the complete collection of the collected items.

For the clustering process, the Latent Dirichlet Allocation (LDA) algorithm, which is a generative commonly used statistical model for topic modelling/extracting tasks, has been chosen. Firstly, the number of topics is declared and then, each word of a social media item is iteratively examined and randomly assigned to each one of the topics. Consequently, the LDA calculates the probability of a word found in each different topic and the word is ascribed to the topic with the highest probability value. After several iterations, each topic is connected to the top k words that according to the model is describing best the context of topic. Many words co-occur in declared topics as each one of the collected social media items is describing the topic in a different degree. It should be also noted that the LDA model is implemented by tuning the number of topics and then by assessing the coherence of the results. Currently, the aforementioned process results in 3 main topics within the collection as the most meaningful and consistent topics to be visualized by the SHOW front end visualisation of the results tool.

6.3 SHOW front-end visualisation of the results

The front-end visualisation for the collected aggregated, processed and analysed data could be helpful for designing a strategy based on collected insights (opinions/issues reported) coming from the social media channels. Specifically, in the case of the SHOW project, the implemented 1st version of the front-end visualisation of the results consists of the following features:

1. A word cloud describing the terms most often discussed by the social media users (Figure 14).

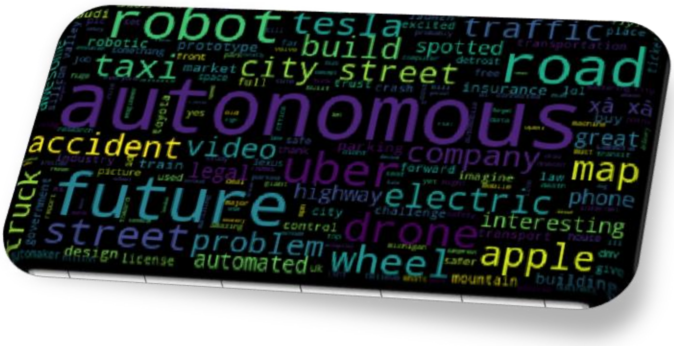

Figure 14: Word Cloud for the complete collected dataset.

2. An interactive visualisation of the topics found within the collection of social media items where each cluster represents a different topic that refers to the services provided by SHOW. The size of each sphere is also in relation to the number of social media belonging to each cluster (Figure 15).

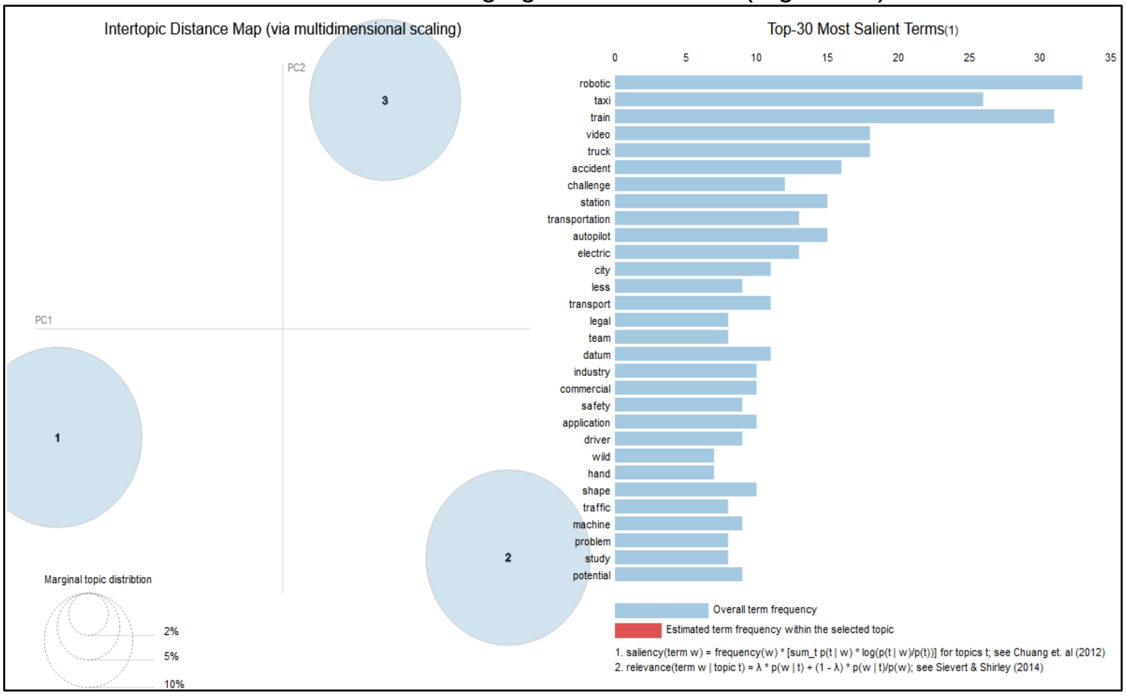

Figure 15: Topic Modelling Clusters for the complete collected dataset.

3. Word clouds describing the resulting topics of interest that were found within the collection. Namely “Monitoring of Automated Vehicles”, “Trial implementation of Automated Vehicles in cargo transportation” and “Automated transportation and safety hazards” (Figure 16).

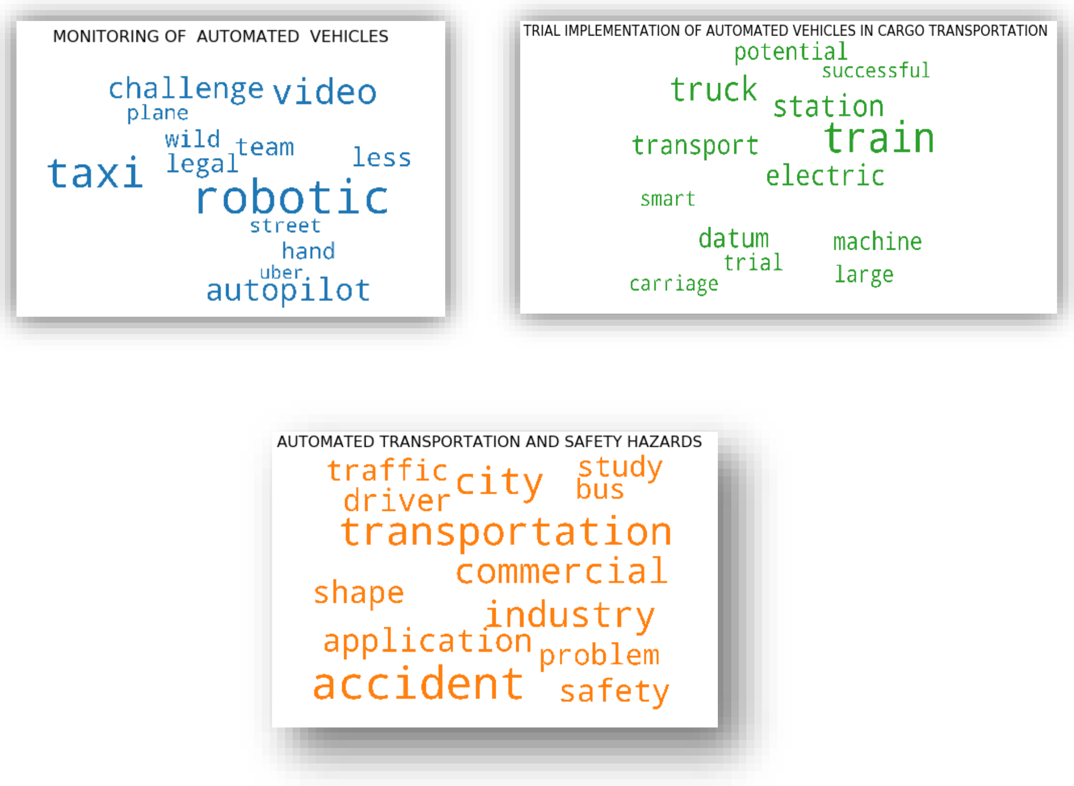

Figure 16: Topics word clouds.

4. Comparative histogram depicting popularity of the extracted topics (Figure 17).

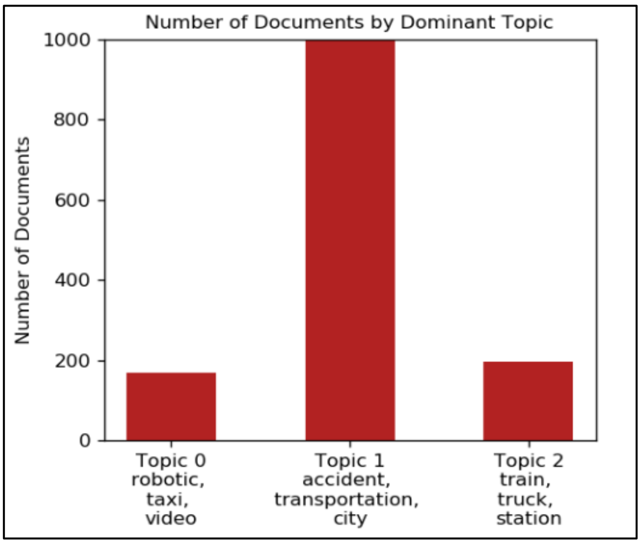

Figure 17: Extracted topic Histogram.

Currently, the operational visualisation tool and its results can be accessed through the following URL of the SHOW website staging server:

➔ https://show-project.eu/information-hub/information-results/

7. Conclusions and next steps

This deliverable is composed of four main sections (i.e., the ecosystem, the terminology, the ecosystem needs, wants and priorities, and the user opinion discovery in social media). It provides a solid base for the different SHOW WPs and demonstration sites:

1) The ecosystem definition will be used in all the WPs and disseminated to all the project partners as a common reference, which will get updated during the project time. It identifies the various stakeholders to be solicited in the different pilot sites of the project.
2) Terminology will also be a shared element within the different WPs to avoid confusion in the case of terms having different meanings depending on the field of activity of the different stakeholders.
3) Chapter 5 provides a very comprehensive review of the ecosystem needs, wants and priorities by listing the elements resulting from existing research projects on autonomous vehicles / services. A methodology and tools are proposed to assess the needs of the stakeholder groups. They will constitute a large part of the impact of the different services on the end-user aspect in terms of acceptance. This work will contribute to the KPI.4 as currently defined in the Grant agreement, which refers to assess traveller acceptance rating of services.
4) All the demonstration sites will have to be involved in the process of assessment.
5) The work about the social media and the user acceptance will contribute to provide detailed insights about end-users' opinion regarding the services provided by the SHOW shared, connected, electrified fleets of autonomous vehicles deployed in each of the pilot sites.

For the next steps, the ecosystem and terminology will need to be completed and updated throughout the project. They will be fed by the development of the project activities.

The first version of the tools on the needs, wants and priorities of the ecosystem will be shared with the impact assessment WP and the pilot sites for a final version of the tools in M12. By providing the goals of the assessments and the ecosystem's characteristics to address, this deliverable allows A9.3. to initiate the recruitment procedures, the information of stakeholders, the choice of survey tools and all the procedures to be implemented before and during the deployment of the pilots. A strong link will have to be constructed between these activities to develop incentivization or nudging strategies related to the content of the different assessments.

The assessment tools and the produced algorithm regarding the measurement of the social media opinion will provide data at different times of the project (M12, M22 and M40).

In this deliverable, two tasks were involved, task A1.1 on the real and perceived needs of the ecosystem and task A1.2 on the discovery of social opinion in social media.

Table 12 below presents the next milestones.

Table 12: Milestones for the tasks involved in this deliverable.

Tasks	Milestone	Date
A1.1	User acceptance tools and approach closed and ready for use in pre-demo activities. Preparation of sites respectively.	M6 – final revision M10
	User acceptance baseline survey conducted.	M10 – M12
	Consolidation of user acceptance survey first round outcomes in the context of pre-demo activities.	M21
	Revision (if needed) of user acceptance tools and approach for use in demo activities.	M22
	Consolidation of user acceptance survey second and third round outcomes in the context of final demonstration activities.	M41
A1.2	First iteration of tools implemented.	M12 (before the pre-demo activities)
	Second iteration of tools implemented.	M22 (before the demo activities)
	Third iteration of tools implemented.	M40 (towards the completion of the demo activities)

Table 13 below presents the next deliverables planned in the WP1.

Table 13: List of next deliverables in WP1.

Del. number	Del. title	Description	Related tasks	Due date (in month)
D1.2	SHOW Use Cases	Identification and elaboration of the priority urban automated mobility Use Cases of the project that guarantee high user acceptance and true user demand. Target is at least 7 UC families, 23 single UCs to work upon, each one to be addressed in at least one pilot site; all meeting local stakeholder interest and (later) acceptance.	A1.3	9
D1.3	Stakeholder & travellers needs evolution through Pilots	Will include the final consolidation of ecosystem needs, wants and priorities captured throughout the project via the respective mechanisms developed. As a minimum, consolidation of feedback from at least 5,000 stakeholders and travellers and 35 different (literature and other) sources will be targeted until the end of the project.	A1.1; A1.2	42

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Appendix I – Ecosystem

The different members of the ecosystem are presented in the different tables below according to the use case and by demonstration site. Each table was filled in by the demonstration sites leaders. Currently, the tables of this appendix only include the stakeholders of the SHOW project. A further version will include all the involved stakeholders of the project even those that are not mentioned yet. These are currently not considered since some new stakeholders may join the project during the project duration thanks to the dissemination steps. Besides, the different tables and use cases appended below are based on those from the Grant agreement. However, more precise definitions of the use cases are currently being prepared and should be included in the deliverable D1.2 planned for M9. The current use cases from this appendix might be slightly different from the ones that would be effectively tested during the project.

AUSTRIA

Unique characteristic: Connecting peri-urban regions to intermodal mobility hubs in mixed traffic.

The Austrian Mega Site consists of Graz, Salzburg and Vienna.

The Graz demos include: On-demand shuttle service for people and goods.

The Salzburg demos include: Automated DRT for peri-urban regions connecting them to city centers via intermodal mobility hubs.

The Vienna demos include: Semi-automated DRT for flexible mobility services including C-ITS aspects.

Graz

	OEM and transport/mobility operators	**Tier 1 suppliers, telecom operators & technology providers**	**SME**	**Umbrella associations**
UC1.2 In complex environments with real curvatures in roundabouts	VIF, AVL	SIEMENS	IESTA	ATE
UC1.3 Interfacing non equipped vehicles/ travellers (VRU)	VIF, AVL	SIEMENS	IESTA	ATE
UC2.2 With different vehicle types	VIF, AVL	SIEMENS	IESTA	ATE
UC6.1 Automated service at bus stop	VIF, AVL	SIEMENS	IESTA	ATE
UC7.2 Added value services based upon big data and AI algorithms (metadata)	VIF, AVL	SIEMENS	IESTA	ATE

Salzburg

	OEM and transport/mobility operators	Tier 1 suppliers, telecom operators & technology providers	Research & academia	Passengers and other road users encompassing VEC	Umbrella associations	Road operators	Authorities (Cities, Municipalities, Ministries) & policy makers	Other
UC1.2 In complex environments with real curvatures in roundabout **UC1.7** Mixed traffic flows **UC2.4** All connected in terms of data & business cases **UC7.1** Self-learning DRT (planning, routing, operation)	ÖBB Postbus	KTC (Kapsch Traffic Com)	SRF G, AIT	Salzburg Transport Association		Federal State of Salzburg (road authority)	Federal State of Salzburg (road authority)	ATE

Vienna

	OEM and transport/mobility operators	Tier 1 suppliers, telecom operators & technology providers	SME	Research & academia	Authorities (Cities, Municipalities, Ministries) & policy makers	Other
UC1.1 Under "normal"(higher) speed	Wiener Linien	SIEMENS	Upstream Mobility	AIT	City of Vienna (MA 18)	ATE
UC1.7 Mixed traffic flows	Wiener Linien	SIEMENS	Upstream Mobility	AIT	City of Vienna (MA 18)	ATE
UC2.3 With different infrastructures (5G, G5, IoT, none)	Wiener Linien	SIEMENS	Upstream Mobility	AIT	City of Vienna (MA 18)	ATE
UC2.4 All connected in terms of data & business cases	Wiener Linien	SIEMENS	Upstream Mobility	AIT	City of Vienna (MA 18)	ATE
UC7.1 Self-learning DRT (planning, routing, operation)	Wiener Linien	SIEMENS	Upstream Mobility	AIT	City of Vienna (MA 18)	ATE
UC7.2 Added value services based upon big data and AI algorithms (metadata)	Wiener Linien	SIEMENS	Upstream Mobility	AIT	City of Vienna (MA 18)	ATE

CZECH-REPUBLIC

Unique characteristic: Traffic centre controlled remote automated driving over long distance (up to 200km).

The Czech-Republic Satellite Site consists of Brno.

The Brno demos include:

- Autonomous traffic in real-city environment;
- Automated driving with tele-operations demo;
- Self-learning DRT demo.

Brno

	OEM and transport/mobility operators	*Comments or suggest ideas.*	SME	Research & academia	Passengers and other road users encompassing VEC	Road operators	Authorities (Cities, Municipalities, Ministries) & policy makers
UC1.1 Under "normal"(higher) speed	TBD (Sensible 5, NAVYA, EasyMile, Ohmio) An existing ARTIN vehicle will already be used for robotaxi.	A risk analysis for route selection will be established. .	ARTIN	CDV	students, commuters, elderly	They will cooperate on the selection of roads and the definition of safety measures with regard to traffic and legislation.	City of Brno. Other authorities will cooperate on the selection of roads and the definition of safety measures with regard to traffic and legislation.
UC1.2 In complex environments with real curvatures in roundabout							
UC1.3 Interfacing non equipped vehicles/travellers (VRU)	The vehicles will be equipped with anti-collision safety features and warning devices announcing their presence.						
UC1.7 Mixed traffic flows	the needed TBD (Sensible 5, NAVYA, EasyMile, Ohmio) An existing ARTIN vehicle will already be used for robotaxi.	A risk analysis for route selection will be established .					
UC1.8 Connection to Operation Centre for tele-operation and remote supervision		We will probably build a supporting network infrastructure on some routes.					
UC2.2 With different vehicle types	Will Provide data on line utilization.						
UC2.4 All connected in terms of data & business cases							
UC7.1 Self-learning DRT (planning, routing, operation)	It will be decided how to make real-time data online operation available.		Prepares a dashboard that integrates data into the endpoint for users.				
UC7.2 Added value services based upon big data and AI algorithms (metadata)							

DENMARK

Unique characteristic: Level 4+ (with no on-board driver) in real PT and DRT operations in the City.

The Denmark Satellite Site consists of Copenhagen.

The Copenhagen demos include:

- Autonomous BRT supplementing/replacing regular PT demo;
- Interface to TMC demo;
- Energy optimization demo;
- Self-learning DRT demo;
- Fully automated service at bus stop demo.

Copenhagen

The ecosystem characteristics regarding the UC and the demos still need to be defined.

FRANCE

Unique characteristic: Seamless automated vehicle chains for PT, DRT and MaaS (Rouen) / LaaS (Rennes).

The French Mega Site combines demonstrations in Rouen and Rennes which are two regional metropolises (Rouen for Normandy, Rennes for the Brittany region).

For both cities, connected and automated mobility is in the centre of their SUMP policies.
The French sites demos include:

- Integrated and automated PT demo;
- Automated driving with the support of tele-operated manoeuvres demo;
- Full automated service at bus stop demo;
- Self-learning DRT demo;
- Mixed passenger-cargo transport (temporal, spatial) demo;
- Interface to TMC demo;
- Energy application demo.

Rennes

	OEM and transport/mobility operators	**Tier 1 suppliers, telecom operators & technology providers**	**SME**	**Research & academia**	**Passengers and other road users encompassing VEC**	**Road operators**	**Authorities (Cities, Municipalities, Ministries) & policy makers**	**Other**
UC1.1 Under "normal"(higher) speed	NAVYA EASYMILE KEOLIS	Orange		IFSTTAR, CEREMA	visitors	city of Rennes and Metropolis services, CHU	city of Rennes, Metropolis, Ministry of Transport	CHU, ID4CAR, CEREMA
UC1.2 In complex environments with real curvatures in roundabout		Orange, Lacroix,			visitors	city of Rennes and Metropolis services, CHU	city of Rennes, Metropolis, Ministry of Transport	

UC1.3 Interfacing non equipped vehicles/travellers (VRU)				CEREMA	Visitors and users of the hospital, medical staff, support staff and logistic staff, students	city of Rennes and Metropolis services, CHU	city of Rennes, Metropolis, Ministry of Transport	
UC1.4 In an energy soustainable way	KEOLIS	EDF ENeDIS		ESTACA	Visitors and users of the hospital, medical staff, support staff and logistic staff, students	city of Rennes and Metropolis services, CHU	city of Rennes, Metropolis, Ministry of Transport	CHU, ID4CAR
UC1.6 Actual integration to City TMC	KEOLIS	PTV			visitors and students	city of Rennes and Metropolis services, CHU	city of Rennes, Metropolis, Ministry of Transport	
UC1.7 Mixed traffic flows	NAVYA EASYMILE KEOLIS	Lacroix	IFSTTAR		Visitors and users of the hospital, medical staff, support staff and logistic staff, students	city of Rennes and Metropolis services, CHU	city of Rennes, Metropolis, Ministry of Transport	
UC1.8 Connection to Operation Centre for tele-operation and remote supervision						city of Rennes and Metropolis services, CHU	city of Rennes, Metropolis, Ministry of Transport	
UC2.1 With different operators	NAVYA EASYMILE KEOLIS							
UC2.2 With different vehicle types								
UC2.3 With different infrastructures (5G, G5, IoT, none)		Orange			Visitors and users of the hospital, medical staff, support staff and logistic staff, students			
UC2.4 All connected in terms of data & business cases			KEREVAL	IMT	Visitors and users of the hospital, medical staff, support staff and logistic staff, students			

UC4.1 Spatial within the same vehicle		Gruau	Mobhilis; INHALIO	CEREMA	medical staff	city of Rennes and Metropolis services, CHU	city of Rennes, Metropolis, Ministry of Transport	CHU, ID4CAR
UC4.3 Temporal			Mobhilis	CEREMA	medical staff			
UC7.1 Self-learning DRT (planning, routing, operation)	KEOLIS		Mobhilis		all	city of Rennes and Metropolis services, CHU	city of Rennes, Metropolis, Ministry of Transport	CHU, ID4CAR

Rouen

	OEM and transport/mobility operators	**Tier 1 suppliers, telecom operators & technology providers**	**Research & academia**	**Passengers and other road users encompassing VEC**	**Umbrella associations**	**Road operators**	**Authorities (Cities, Municipalities, Ministries) & policy makers**
UC1.1 Under "normal"(higher) speed	TRANSDEV, RENAULT	Autonomous Driving provider (TORC, etc.), Ericsson, …	VEDECOM, ESIGELEC	Commuters, residents, scholar, VRU, tourists		Cities (Rouen, Grand-Quevilly)	Métropole Rouen Normandie, DGITM (French Ministry of Transport)
UC1.2 In complex environments with real curvatures in roundabout	TRANSDEV, RENAULT	Autonomous Driving provider (TORC, etc.), Ericsson, …	VEDECOM, ESIGELEC	Commuters, tourists, residents, scholars, vulnerable road users and persons with disabilities		Cities (Rouen, Grand-Quevilly)	Métropole Rouen Normandie, DGITM (French Ministry of Transport)
UC1.3 Interfacing non equipped vehicles/travellers (VRU)	TRANSDEV, RENAULT	Autonomous Driving provider (TORC, etc.), Ericsson, …	VEDECOM ?	Commuters, tourists, residents, scholars, vulnerable road users and persons with disabilities		Cities (Rouen, Grand-Quevilly)	Métropole Rouen Normandie, DGITM (French Ministry of Transport)
UC1.4 In an energy soustainable way	TRANSDEV, RENAULT	Autonomous Driving provider (TORC, etc.), Ericsson, …		Commuters, tourists, residents, scholars, vulnerable road users and persons with disabilities		Cities (Rouen, Grand-Quevilly)	Métropole Rouen Normandie, DGITM (French Ministry of Transport)
UC1.6 Actual integration to City TMC	TRANSDEV			Commuters, tourists, residents, scholars, vulnerable road users and persons with disabilities	UITP	Cities (Rouen, Grand-Quevilly)	Métropole Rouen Normandie, DGITM (French Ministry of Transport)
UC1.7 Mixed traffic flows	TRANSDEV, RENAULT	Autonomous Driving provider (TORC, etc.), Ericsson	VEDECOM, ESIGELEC	Commuters, tourists, residents, scholars, vulnerable		Cities (Rouen, Grand-Quevilly)	Métropole Rouen Normandie, DGITM (French

	OEM and transport/mobility operators	Tier 1 suppliers, telecom operators & technology providers	Research & academia	Passengers and other road users encompassing VEC	Umbrella associations	Road operators	Authorities (Cities, Municipalities, Ministries) & policy makers
				road users and persons with disabilities			Ministry of Transport)
UC1.8 Connection to Operation Centre for tele-operation and remote supervision	TRANSDEV, RENAULT	Autonomous Driving provider (TORC, etc.), Ericsson		Commuters, tourists, residents, scholars, vulnerable road users and persons with disabilities		Cities (Rouen, Grand-Quevilly)	Métropole Rouen Normandie, DGITM (French Ministry of Transport)
UC2.1 With different operators	TRANSDEV			Commuters, tourists, residents, scholars, vulnerable road users and persons with disabilities	UITP	Cities (Rouen, Grand-Quevilly)	Métropole Rouen Normandie, DGITM (French Ministry of Transport)
UC2.2 With different vehicle types	TRANSDEV, RENAULT	Autonomous Driving provider (TORC, etc.), Ericsson		Commuters, tourists, residents, scholars, vulnerable road users and persons with disabilities		Cities (Rouen, Grand-Quevilly)	Métropole Rouen Normandie, DGITM (French Ministry of Transport)
UC2.3 With different infrastructures (5G, G5, IoT, none)	TRANSDEV, RENAULT	Autonomous Driving provider (TORC, etc.), Ericsson		Commuters, tourists, residents, scholars, vulnerable road users and persons with disabilities		Cities (Rouen, Grand-Quevilly)	Métropole Rouen Normandie, DGITM (French Ministry of Transport)
UC2.4 All connected in terms of data & business cases	TRANSDEV, RENAULT			Commuters, tourists, residents, scholars, vulnerable road users and persons with disabilities		Cities (Rouen, Grand-Quevilly)	Métropole Rouen Normandie, DGITM (French Ministry of Transport)
UC3 Seamless autonomous transport chains of Automated PT, DRT, MaaA, LaaS	TRANSDEV			Commuters, tourists, residents, scholars, vulnerable road users and persons with disabilities		Cities (Rouen, Grand-Quevilly)	Métropole Rouen Normandie, DGITM (French Ministry of Transport)
UC6.1 Automated service at bus stop	TRANSDEV	Autonomous Driving provider (TORC, etc.), Ericsson		Commuters, residents, scholars, vulnerable road users and persons with disabilities		Cities (Rouen, Grand-Quevilly)	Métropole Rouen Normandie, DGITM (French Ministry of Transport)
UC7.1 Self-learning DRT (planning, routing, operation)	TRANSDEV, RENAULT	Autonomous Driving provider (TORC, etc.), Ericsson		Commuters, tourists, residents, scholars, vulnerable		Cities (Rouen, Grand-Quevilly)	Métropole Rouen Normandie, DGITM (French

	OEM and transport/mobility operators	Tier 1 suppliers, telecom operators & technology providers	Research & academia	Passengers and other road users encompassing VEC	Umbrella associations	Road operators	Authorities (Cities, Municipalities, Ministries) & policy makers
				road users and persons with disabilities			Ministry of Transport)

FINLAND

Unique characteristic: Real operations under adverse weather conditions.

The Finland Satellite Site consists of Tampere.

The Tampere demos include:

- Seamless automated transport chain demo;
- Automated driving with the support of tele-operated maneuvers demo;
- Self-learning DRT demo.

Tampere

	OEM and transport/mobility operators	Tier 1 suppliers, telecom operators & technology providers	SME	Research & academia	Passengers and other road users encompassing VEC	Umbrella associations	Road operators	Authorities (Cities, Municipalities, Ministries) & policy makers	Other
UC1.2 In complex environments with real curvatures in roundabout	TBD (Sensible 5, NAVYA, EasyMile, Ohmio)	TBD (open bidding process)		VTT Technical Research Centre of Finland	Special users. students, elderly, disabled & PMR, immigrants, housewives, etc.	ITS Finland, Business Tampere,	The City of Tampere (urban streets)	Finnish Transport and Communications Agencty, the City of Tampere	Challenging city and hospital campus areas
UC1.7 Mixed traffic flows									Streets, pedestrian & bicycle lanes (mixed traffic).
UC1.8 Connection to Operation Centre for tele-operation and remote supervision									Operator's traffic management and surveillance center (OTMSC). Traffic Management Centre (TMC) of the City of Tampere
UC2.3 With different infrastructures (5G, G5, IoT, none)									LTE, 5G and ITS G5 (by Nokia).
UC2.4 All connected in terms of data & business cases									Tampere smart city development projects and new infrastructure
UC3 Seamless autonomous transport chains of Automated PT, DRT, MaaA, LaaS									MaaS development (separate project)
UC7.1 Self-learning DRT (planning, routing, operation)									DRT
UC7.2 Added value services based upon big data and AI algorithms (metadata)									several initiatives and activities (intelligent trams, 3d-digital)

GERMANY

Unique characteristics: Level 4/5 operation in complex scenarios & combined urban and peri-urban environments.

The Germany Mega Site includes three cities: Aachen, Karlsruhe and Mannheim.

These cities follow a SUMP approach, and through the active involvement of administrations and transport operators, these goals are also valid for the test sites.

The Aachen demos include:

- Autonomous traffic in real city environment demo;
- Integrated automated PT with automated DRT and automated MaaS demo;
- Energy applications demo.

The Karlsruhe demos include:

- Tele-operated manoeuvres demo;
- Mixed passenger – cargo and platooning demo.

The Mannheim demos include:

- Automated bus stop demo;
- Self-learning DRT demo.

Aachen

<table>
<tr><th></th><th>OEM’s and transport/mobility operators</th><th>Tier 1 suppliers, telecom operators & technology providers</th><th>Authorities (Cities, Municipalities, Ministries) & policy makers</th></tr>
<tr><td>UC1.1
Under "normal"(higher) speed</td><td></td><td rowspan="5">FEV, Ericsson, Telekom</td><td rowspan="7">Stadt Aachen</td></tr>
<tr><td>UC1.4
In an energy soustainable way</td><td>e.GO</td></tr>
<tr><td>UC1.7
Mixed traffic flows</td><td rowspan="2">e.GO, ASEAG</td></tr>
<tr><td>UC2.2
With different vehicle types</td></tr>
<tr><td>UC2.3
With different infrastructures (5G, G5, IoT, none)</td><td></td></tr>
<tr><td>UC2.4
All connected in terms of data & business cases</td><td></td><td></td></tr>
<tr><td>UC6.1
Automated service at bus stop</td><td>e.GO, ASEAG</td><td>FEV, Ericsson, Telekom</td></tr>
</table>

Karlsruhe

	Research & academia	Road operators	Other
UC2.3 With different infrastructures (5G, G5, IoT, none)	FZI	VBK	TAF-BW (Testfeld autonomes Fahren - Baden Württemberg)
UC2.4 All connected in terms of data & business cases			
UC4.1 Spatial within the same vehicle			
UC4.3 Temporal			

Mannheim

	OEM's and transport/mobility operators	Tier 1 suppliers, telecom operators & technology providers	SME's	Research & academia	Passengers and other road users encompassing VEC	Umbrella associations	Road operators	Authorities (Cities, Municipalities, Ministries) & policy makers
UC6.1 Automated service at bus stop	transport operator rnv, OEMs will be selected following the tendering procedure	Suppliers are selected following the tendering procedure	Suppliers are selected following the tendering procedure	KIT, other research institutions can be involved if necessary	passenger advisory association, associations representing VRU	VDV (Association of German Transport Undertakings), VRN (Regional Transport Authority)	City of Mannheim	City of Mannheim, Regierungspräsidium Karlsruhe, Ministery of Transport Baden-Württemberg
UC7.1 Self-learning DRT (planning, routing, operation)					passenger advisory association, associations representing VRU	VDV, VRN		City of Mannheim, Regierungspräsidium Karlsruhe, Ministery of Transport Baden-Württemberg
UC7.2 Added value services based upon big data and AI algorithms (metadata)					passenger advisory association	VDV, VRN		City of Mannheim, Regierungspräsidium Karlsruhe

GREECE

Unique characteristic: Combined automated passenger and freight transport.

The Greece Satellite Site consists of Trikala.

The Trikala demos include:

- Autonomous traffic in real city environment demo;
- Seamless autonomous transport chain of automated DRT and MaaS demo;
- Automated LaaS demo.

Trikala

	OEM and transport/mobility operators	Tier 1 suppliers, telecom operators & technology providers	SME	Research & academia	Passengers and other road users encompassing VEC	Umbrella associations	Road operators	Authorities (Cities, Municipalities, Ministries) & policy makers
UC1.1 Under "normal"(higher) speed	BMW (for BMWi3).	Vodafone		ICCS, CERTH	Commuters, tourists, residents or VEC	ERTICO	e-Trikala	Municipality of Trikala, Ministry of Transport. E-Trikala
UC1.2 In complex environments with real curvatures in roundabout	Astiko KTEL and KTEL.	Vodafone		ICCS, CERTH	Commuters, tourists, residents, VEC	ERTICO	e-Trikala.	Municipality of Trikala, Ministry of Transport. E-Trikala
UC1.3 Interfacing non equipped vehicles/travellers (VRU)	Astiko KTEL and KTEL.	Vodafone		ICCS, CERTH	Commuters, tourists, residents, VEC	ERTICO	e-Trikala	Municipality of Trikala, Ministry of Transport. E-Trikala.
UC1.5 For passengers and cargo (including automated cargo delivery at warehouse)	University of Genova (FURBOT vehicle).	Vodafone	Private supplier	ICCS, CERTH, University of Genova	freight	ERTICO	e-Trikala	Municipality of Trikala, Ministry of Transport. E-Trikala
UC1.6 Actual integration to City TMC	Astiko KTEL and KTEL.	Vodafone		ICCS, CERTH	Commuters, tourists, residents, VEC	ERTICO	e-Trikala	Municipality of Trikala, Ministry of Transport. E-Trikala.
UC1.7 Mixed traffic flows	Astiko KTEL and KTEL.	Vodafone		ICCS, CERTH	Commuters, tourists, residents,VEC	ERTICO	e-Trikala	Municipality of Trikala, Ministry of Transport. E-Trikala.
UC1.8 Connection to Operation Centre for tele-operation and remote supervision	Astiko KTEL and KTEL.	Vodafone		ICCS, CERTH	Commuters, tourists, residents, VEC	ERTICO	e-Trikala	Municipality of Trikala, Ministry of Transport. E-Trikala.
UC2.4 All connected in terms of data & business cases	BMW (for BMWi3).	Vodafone		ICCS, CERTH	Commuters, tourists, residents, VEC	ERTICO	e-Trikala.	Municipality of Trikala, Ministry of Transport. E-Trikala
UC5.1 Urban passenger platooning for higher speed traffic during connectors (city centre to peri urban, at the city ring, etc.)	BMW (for BMWi3).	Vodafone		ICCS, CERTH	Commuters, tourists, residents, VEC	ERTICO	e-Trikala	Municipality of Trikala, Ministry of Transport. E-Trikala

ITALY

Unique characteristic: Cross-domain integrated automated and flexible services.

The Italy Satellite Site consists of Turin.

The Turin demos include: Cross-domain integrated, automated and flexible services.

Turin

	OEM and transport/mobility operators	Tier 1 suppliers, telecom operators & technology providers	Research & academia	Umbrella associations	Authorities (Cities, Municipalities, Ministries) & policy makers	Other
UC1.1 Under "normal"(higher) speed **UC1.3** Interfacing non equipped vehicles/travellers (VRU) **UC1.6** Actual integration to City TMC **UC1.8** Connection to Operation Centre for tele-operation and remote supervision **UC2.2** With different vehicle types **UC2.4** All connected in terms of data & business cases **UC3** Seamless autonomous transport chains of Automated PT, DRT, MaaA, LaaS	NAVYA GTT	BESTMILE SWARCO OBJECTIVE	LINKS	TTS (subcontractor)	Città di Torino (Letter of Support = LoS)	Città della Salute di Torino (LoS) 5T (subcontractor

NETHERLANDS

Unique characteristic: Integrated L4-L5 Bus and car operating on dedicated bus lanes of a city environment.

The Netherlands Satellite Site consists of Eindhoven (Brainport).

The Brainport demos include:

- Integration of automated PT and DRT with MaaS demo;
- Operational services in semi-control environment demo.

Eindhoven (Brainport)

<table>
<tr><th></th><th>OEM and transport/mobility operators</th><th>Research & academia</th><th>Authorities (Cities, Municipalities, Ministries) & policy makers</th></tr>
<tr><td>UC1.1
Under "normal"(higher) speed</td><td rowspan="7">(VDL)</td><td rowspan="5">TNO</td><td rowspan="7">City of Eindhoven</td></tr>
<tr><td>UC1.3
Interfacing non equipped vehicles/travellers (VRU)</td></tr>
<tr><td>UC1.4
In an energy soustainable way</td></tr>
<tr><td>UC2.2
With different vehicle types</td></tr>
<tr><td>UC2.3
With different infrastructures (5G, G5, IoT, none)</td></tr>
<tr><td>UC6.1
Automated service at bus stop</td><td></td></tr>
<tr><td>UC6.2
Depot management of Automated Buses (servicing, clearing, maintenance)</td><td></td></tr>
</table>

SPAIN

Unique characteristics: Full bus-stop and depot operation and links to established MaaS platform.

The Spain Mega Site consists of Madrid.

The Madrid demos include:

- Seamless autonomous transport chain demo;
- Automated driving and teleoperation demo;
- Convoying / Platooning demo;
- Autonomous docking and parking applications demo;
- Self-learning DRT.

Madrid

The ecosystem characteristics regarding the UC and the demos still need to be defined.

SWEDEN

Unique characteristic: 5G control tower concept for remote monitoring, tele-operation & AV fleet management.

The Sweden Mega Site consists of Kista and Linköping.

The Kista and Linköping demos include:

- Autonomous traffic in real city environment demo;
- Connection to actual TMC and centralized teleoperation demo;
- Multi actor business environments demo;
- Operational services in bus stops;
- Enhanced services demo.

Kista

<table>
<tr><th></th><th>OEM and transport/mobility operators</th><th>Tier 1 suppliers, telecom operators & technology providers</th><th>Research & academia</th></tr>
<tr><td>UC1.2
In complex environments with real curvatures in roundabout</td><td rowspan="8">Keolis Sweden</td><td rowspan="8">Ericsson</td><td rowspan="6">RISE</td></tr>
<tr><td>UC1.3
Interfacing non equipped vehicles/travellers (VRU)</td></tr>
<tr><td>UC1.7
Mixed traffic flows</td></tr>
<tr><td>UC1.8
Connection to Operation Centre for tele-operation and remote supervision</td></tr>
<tr><td>UC2.2
With different vehicle types</td></tr>
<tr><td>UC2.4
All connected in terms of data & business cases</td></tr>
<tr><td>UC6.1
Automated service at bus stop</td><td></td></tr>
<tr><td>UC7.2
Added value services based upon big data and AI algorithms (metadata)</td><td>RISE</td></tr>
</table>

Linkoping

<table>
<tr><th></th><th>OEM and transport/mobility operators</th><th>Tier 1 suppliers, telecom operators & technology providers</th><th>Research & academia</th></tr>
<tr><td>UC1.2
In complex environments with real curvatures in roundabout</td><td rowspan="9">Transdev Sweden</td><td rowspan="2">Combitech</td><td rowspan="2">VTI, RISE</td></tr>
<tr><td>UC1.3
Interfacing non equipped vehicles/travellers (VRU)</td></tr>
<tr><td>UC1.7
Mixed traffic flows</td><td rowspan="3">Combitech, Eriksson</td><td rowspan="3">RISE, VTI</td></tr>
<tr><td>UC1.8
Connection to Operation Centre for tele-operation and remote supervision</td></tr>
<tr><td>UC2.2
With different vehicle types</td></tr>
<tr><td>UC2.4
All connected in terms of data & business cases</td><td>Combitech</td><td></td></tr>
<tr><td>UC6.1
Automated service at bus stop</td><td rowspan="3">Combitech, Eriksson</td><td rowspan="3">RISE, VTI</td></tr>
<tr><td>UC7.1
Self-learning DRT (planning, routing, operation)</td></tr>
<tr><td>UC7.2
Added value services based upon big data and AI algorithms (metadata)</td></tr>
</table>

Appendix II – Terminology

Term	Group	Common Abbreviation	Definition	Source
Accident	Operational-related		Any unplanned event that resulted in injury or ill-health of people or damage or loss to property, plant, materials or the environment or a loss of business opportunity	PAS 11281
Accident scenario	Operational-related		It is the scenario investigated during the entire accident analysis including levels of injury severity, as well as the transport modes that represent a higher risk for VRUs. It is described by the type of road users involved in the accident, their motions expressed as 'accident types' and further most contextual factors like the course of the road, light conditions, weather conditions and view obstruction.	HEADSTART PROJECT / PROSPECT PROJECT
Active safety system	Vehicle-related	ASS	Active safety systems are vehicle systems that sense and monitor conditions inside and outside the vehicle for the purpose of identifying perceived present and potential dangers to the vehicle, occupants, and/or other road users, and automatically intervene to help avoid or mitigate potential collisions via various methods, including alerts to the driver, vehicle system adjustments, and/or active control of the vehicle subsystems (brakes, throttle, suspension, etc.)	SAE-J3063
Adaptive cruise control (including Stop & Go)	Vehicle-related	ACC	Adaptive cruise control with stop & go function includes automatic distance control (control range 0–250 km/h) and, within the limits of the system, detects a preceding vehicle. It maintains a safe distance by automatically applying the brakes and accelerating. In slow-moving traffic and congestion, it governs braking and acceleration.	ERTRAC
Apportionment	Vehicle-related		A process whereby the elements of a system are sub-divided between the various items which comprise the system to provide individual targets (EN50126).	ARCADE PROJECT
Assessment	Operational-related		The undertaking of an investigation in order to arrive at a judgement, based on evidence, of the suitability of a product (EN50126)	ARCADE PROJECT
Attack	Other		Attempt to destroy, expose, alter, disable, steal or gain unauthorized access to or make unauthorized use of an asset	ISO/IEC 27000
Audit	Operational-related		A systematic and independent examination to determine whether the procedures specific to the requirements of a product comply with the planned arrangements, are implemented effectively and are suitable to achieve the specified objectives (EN50126).	ARCADE PROJECT
Automated Driving System	Vehicle-related	ADS	The hardware and software that are collectively capable of performing the entire DDT on a sustained basis, regardless of whether it is limited to a specific operational design domain (ODD); this term is used specifically to describe a level 3, 4, or 5 driving automation system.	SAE-J3016
Automation Level 0 (No Driving Automation)	Vehicle-related		The performance of the entire DDT by the driver, even when enhanced by active safety systems	SAE-J3016
Automation Level 1 (Driver Assistance)	Vehicle-related		The sustained and ODD-specific execution of either the lateral or the longitudinal vehicle motion control subtask of the DDT (but not both simultaneously) by a driving automation system with the expectation that the driver performs the remainder of the DDT.	SAE-J3016
Automation Level 2 (Partial Driving Automation)	Vehicle-related		The sustained and ODD-specific execution of both the lateral and longitudinal vehicle motion control subtasks of the DDT by a driving automation system with the expectation that the driver completes the OEDR subtask and supervises the driving automation system.	SAE-J3016
Automation Level 3 (Conditional Driving Automation)	Vehicle-related		The sustained and ODD-specific performance of the entire DDT by an ADS with the expectation that the DDT fallback-ready user is receptive to ADS-issued requests to intervene, as well as to DDT performance-relevant system failures in other vehicle systems, and will respond appropriately.	SAE-J3016

Term	Group	Common Abbreviation	Definition	Source
Automation Level 4 (High Driving Automation)	Vehicle-related		The sustained and ODD-specific performance of the entire DDT and DDT fallback by an ADS , without any expectation that a user will respond to a request to intervene.	SAE-J3016
Automation Level 5 (Full Driving Automation)	Vehicle-related		The sustained and unconditional (i.e., not ODD-specific) performance of the entire DDT and DDT fallback by an ADS without any expectation that a user will respond to a request to intervene.	SAE-J3016
Baseline	Other		reference to which the series of tests in a study are compared	DINSAE-91381
Closed testbed	Operational-related		test environment without public traffic	DINSAE-91381
Commissioning	Operational-related		A collective term for the activities undertaken to prepare a system or product prior to demonstrating that it meets its specified requirements (EN50126).	ARCADE PROJECT
Common Cause Failure	Operational-related		A failure which is the result of an event(s) which causes a coincidence of failure states of two or more components leading to a system failing to perform its required function (EN50126).	ARCADE PROJECT
Compliance	Operational-related		A demonstration that a characteristic or property of a product satisfies the stated requirements (EN50126).	ARCADE PROJECT
Concrete scenario	Operational-related		parameterised model of the time sequence of scenes (logical scenario) which begins with an initial scene and defined point in time; the behaviour of the main actor (vehicle under test) is not further specified.	DINSAE-91381
Control factors	Other		influential variables that are kept constant within a series of tests	DINSAE-91381
Controlled test environment	Infrastructure-related		setting under which variables external to the vehicle under test are determined	DINSAE-91381
Conventional driver	User-related		A driver who manually exercises in-vehicle braking, accelerating, steering, and transmission gear selection input devices in order to operate a vehicle.	SAE-J3016
Corner case	Operational-related		scenario in which two or more parameter values are each within the capabilities of the system, but together constitute a rare condition that challenges its capabilities	DINSAE-91381
Criticality	Other		Criticality is defined for every vehicle independent from the driver. Criticality is defined as temporal and/or spatial proximity to a situation from which an accident is not evitable. Higher criticality results in higher demands on the human and the Automated Driving Function.	PEGASUS PROJECT
Crossing Clearance Zone	Infrastructure-related		It is a zone defined in at-grade crossings, as the intersection between the ARTS lane and the crossing roads plus a buffer area that extends in the direction of the crossing road. If the crossing is protected with physical barriers, the buffer zone extends until these barriers. The main objective of the buffer zone is to prevent that an obstacle coming on the crossing road reaches the ARTS vehicle's emergency volume while the vehicle is not at rest, either using on-board or infrastructure-based sensors. Figure 10 shows an example of the ARTS crossing clearance zone (a) and the buffer zone (b) in one of the ARTS integration scenarios.	ARCADE PROJECT
Cyber physical model	Other		representation of objects using a combination of physical and virtual models for interaction with each other	DINSAE-91381
Cyber security	Other		Cybersecurity is the protection of connected systems including hardware, software and data from internal and external attacks carried by malicious entities with or without authorization.	HEADSTART PROJECT
Dependent Failure	Operational-related		The failure of a set of events, the probability of which cannot be expressed as the simple product of the unconditional probabilities of the individual events (EN50126).	ARCADE PROJECT
Derived measurement	Operational-related		measurement calculated from a direct measurement (e. g. by applying mathematical or statistical operations) or a combination of one or more direct or derived measurements	DINSAE-91381

Term	Group	Common Abbreviation	Definition	Source
Digital twin [of pilot site]	Other		digitalized version of pilot site	ProjectDef
Direct measurement	Other		measurement logged directly from a sensor, without further manipulations except linear transformations (e.g., m/s to kph)	DINSAE-91381
Dispatch [in driverless operation]	Infrastructure-related		To place an ADS-equipped vehicle into service in driverless operation by engaging the ADS.	SAE-J3016
Dispatching entity [driverless operation]	Infrastructure-related		An entity that dispatches an ADS-equipped vehicle(s) in driverless operation.	SAE-J3016
Distance to Stop Line	Infrastructure-related		Distance from the vehicle's front to the next stop line in the vehicle's planned path applying comfort deceleration and jerk values (based on ETSI TS 102 637-2).	ARCADE PROJECT
Down Time	Operational-related		The time interval during which a product is in a down state. (IEC 60050(191)).	ARCADE PROJECT
Driver support [driving automation system] feature	User-related		A general term for level 1 and level 2 driving automation system features.	SAE-J3016
Driver takeover	User-related		action by the driver to regain manual control of the vehicle	DINSAE-91381
Driverless operation [of an ADS-equipped vehicle]	User-related		Operation of an ADS-equipped vehicle in which either no on-board user is present, or in which on-board users are not drivers or fallback-ready users.	SAE-J3016
Driverless operation dispatcher	User-related		A user(s) who dispatches an ADS-equipped vehicle(s) in driverless operation.	SAE-J3016
Driving automation	Vehicle-related		The performance by hardware/software systems of part or all of the DDT on a sustained basis.	SAE-J3016
Driving automation system or technology	Vehicle-related		The hardware and software that are collectively capable of performing part or all of the DDT on a sustained basis; this term is used generically to describe any system capable of level 1-5 driving automation.	SAE-J3016
Dual-mode vehicle [ADS-equipped]	Vehicle-related		A type of ADS (automated driving system)-equipped vehicle designed for both driverless operation and operation by a conventional driver for complete trips.	SAE-J3016
Dynamic driving task	Operational-related	DDT	All of the real-time operational and tactical functions required to operate a vehicle in on-road traffic, excluding the strategic functions such as trip scheduling and selection of destinations and waypoints	SAE-J3016
Edge case	Operational-related		scenario in which the extreme values or even the very presence of one or more parameters results in a condition that challenges the capabilities of the system	DINSAE-91381
Ego-vehicle	Vehicle-related		The Ego-vehicle is the automated vehicle from whose perspective the traffic situation is viewed. The data recorded by the ego-vehicle through its sensors describes the traffic situation from its perspective relative to its own condition.	HEADSTART PROJECT
Emergency Braking Distance	Vehicle-related		The distance required by the ARTS vehicle to come to a complete stop at emergency deceleration, calculated along its planned path.	ARCADE PROJECT
Emergency Deceleration	Vehicle-related		Is the maximum deceleration that the ARTS vehicle can apply.	ARCADE PROJECT

Term	Group	Common Abbreviation	Definition	Source
Emergency Zone	Infrastructure-related		Is a zone composed of a zone centred on the ARTS vehicle whose dimensions are the ARTS vehicle's width and length + 0.5 m on each side and a zone surrounding the vehicle path of width the vehicle width + 0.5 [m] on each side or the lane width. Its length is the emergency braking distance, meaning that it depends on the current vehicle velocity. Any static obstacle detected in this zone must force the vehicle to stop at an emergency deceleration. The emergency zone is done through the use of on-board sensors and infrastructure sensors, if available.	ARCADE PROJECT
Event	Operational-related		influencing change of state or condition within a scenario	DINSAE-91381
External measurement	Operational-related		measurement provided by sensors outside of the log equipment used in the study	DINSAE-91381
Fail-Safe	Operational-related		Designed to return to a safe condition in the event of a failure or malfunction.	ARCADE PROJECT
Failure	Operational-related		A failure is any fault in the system that prevents a vehicle from completing its planned journey or stops a vehicle in the station or depot movement areas.	ARCADE PROJECT
Failure cause	Operational-related		The circumstances during design, manufacture or use which have led to a failure. (IEC 60050(1 91)).	ARCADE PROJECT
Failure mode	Operational-related		The predicted or observed results of a failure cause on a stated item in relation to the operating conditions at the time of the failure (EN50126).	ARCADE PROJECT
Failure rate	Operational-related		The limit, if this exists, of the ratio of the conditional probability that the instant of time, T, of a failure of a product falls within a given time interval (t, t+Jt) and the length of this interval, It, when It tends towards zero, given that the item is in an up state at the start of the time interval (EN50126).	ARCADE PROJECT
Fallback [dynamic driving task]	Operational-related		The response by the user to either perform the DDT or achieve a minimal risk condition after occurrence of a DDT performance-relevant system failure(s) or upon operational design domain (ODD) exit, or the response by an ADS to achieve minimal risk condition, given the same circumstances.	SAE-J3016
Fallback-ready user [DDT]	User-related		The user of a vehicle equipped with an engaged level 3 ADS feature who is able to operate the vehicle and is receptive to ADS-issued requests to intervene and to evident DDT performance-relevant system failures in the vehicle compelling him or her to perform the DDT fallback.	SAE-J3016
Fault mode	Operational-related		One of the possible states of a faulty product for a given required function. (IEC 60050(191)).	ARCADE PROJECT
Feature or application [driving automation system]	Vehicle-related		A level 1-5 driving automation system's design-specific functionality at a given level of driving automation within a particular ODD, if applicable.	SAE-J3016
Field operational test	Operational-related	FOT	study to evaluate functions or vehicles under typical operating conditions in uncontrolled environments encountered by the vehicle under test	DINSAE-91381
Front Collision Warning	Vehicle-related	FCW	The Front Collision Warning monitoring system uses a radar sensor to detect situations where the distance to the vehicle in front is critical and helps to reduce the vehicle's stopping distance. In dangerous situations, the system alerts the driver by means of visual and acoustic signals and/ or with a warning jolt of the brakes. Front Collision Warning operates independently of the ACC automatic distance control.	ERTRAC
Function	Operational-related		Implementation of a set of rules to achieve a specified goal	ARCADE PROJECT

Term	Group	Common Abbreviation	Definition	Source
Functional scenario	Operational-related		A functional scenario is a temporal sequence that describes one of the behaviours of a system during a specific use case, with a nominal scenario and alternative scenarios. It is described in a linguistic way or with a structured language. Functional scenarios are derived from driving functions. They are used to describe the use case at a high level (higher than logical and concrete scenarios).	HEADSTART PROJECT
Handover	Operational-related		controlled transition of the vehicle control from the system to the driver and vice versa	DINSAE-91381
Harm	Operational-related		Physical injury or damage to the health of persons	ISO 26262-1
Hazard	Operational-related		Source of potential harm	PAS 11281
Hazard log	Operational-related		The document in which all safety management activities, hazards identified, decisions made and solutions adopted are recorded or referenced. Also known as a “Safety Log”. (ENV 50129).	ARCADE PROJECT
Human driver	User-related		A user who performs in real-time part or all of the DDT and/or DDT fallback for a particular vehicle.	SAE-J3016
Influencing actor	User-related		scenario participant that either requires the vehicle under test to take action or limits its action	DINSAE-91381
Infrastructure Support levels for Automated Driving	Infrastructure-related	ISAD	ISAD levels can be assigned to parts of the network in order to give automated vehicles and their operators guidance on the “readiness” of the road network for the coming highway automation era. Infrastructure support levels are meant to describe road or motorway sections rather than whole road networks. The following levels are being developed in INFRAMIX project:	ARCADE PROJECT
Initial condition	Operational-related		state of the environment and vehicle under test at the beginning of a scenario	DINSAE-91381
Internal measurement	Operational-related		measurement provided by sensors of the system under test in the study	DINSAE-91381
Lane Change Assist	Vehicle-related	LCA	The system monitors the areas to the left and right of the car, including the blind spot detection, and up to 50 metres behind it and warns you of a potentially hazardous situation by means of flashing warning lights in the exterior mirrors.	ERTRAC
Lane Departure Warning	Vehicle-related	LDW	Lane Departure Warning helps to prevent accidents caused by unintentionally wandering out of lane, and represents a major safety gain on motorways and major trunk roads. If there is an indication that the vehicle is about to leave the lane unintentionally, the system alerts the driver visually and in some cases by means of a signal on the steering wheel.	ERTRAC
Lane Keeping Assist	Vehicle-related	LKA	Lane Assist automatically becomes active from a specific speed (normally from 50 km/h) and upwards. The system detects the lane markings and works out the position of the vehicle. If the car starts to drift off lane, the LKA takes corrective action. If the maximum action it can take is not enough to stay in lane, or the speed falls below 50 km/h, the LKA function warns the driver (e.g., with a vibration of the steering wheel). Then it is up to the driver to take correcting action.	ERTRAC

Term	Group	Common Abbreviation	Definition	Source
Lateral vehicle motion control	Vehicle-related		The DDT subtask comprising the activities necessary for the real-time, sustained regulation of the lateral component of vehicle motion	SAE-J3016
Logical scenario	Operational-related		beginning with an initial scene, a model of the time sequence of scenes whose parameters are defined as ranges; at a defined point in time, the behaviour of the main actor (vehicle under test) is not further specified	DINSAE-91381
Logitudinal vehicle motion control	Vehicle-related		The DDT subtask comprising the activities necessary for the real-time, sustained regulation of the longitudinal component of vehicle motion	SAE-J3016
Maneuver	Operational-related		physical movement of an actor in a scenario	DINSAE-91381
Metrics	Operational-related		algorithm to calculate an indicator based on measurements applied to a concrete scenario	DINSAE-91381
Minimal risk condition	Operational-related	MRC	A condition to which a user or an ADS may bring a vehicle after performing the DDT fallback in order to reduce the risk of a crash when a given trip cannot or should not be completed.	SAE-J3016
Mission	Operational-related		An objective description of the fundamental task performed by a system (EN50126).	ARCADE PROJECT
Mission Profile	Operational-related		Outline of the expected range and variation in the mission with respect to parameters such as time, loading, speed, distance, stops, tunnels, etc., in the operational phases of the lifecycle (EN50126).	ARCADE PROJECT
Mixed traffic environment	Infrastructure-related		Traffic environment in which AVs are mixed with other non-equipped traffic participants such as pedestrians, cyclists, powered two-wheelers, and other driven vehicles	InterACT PROJECT
Monitor driving automation system performance	Operational-related		The activities and/or automated routines for evaluating whether the driving automation system is performing part or all of the DDT appropriately.	SAE-J3016
Monitor the driving environment	Operational-related		The activities and/or automated routines that accomplish real-time roadway environmental object and event detection, recognition, classification, and response preparation (excluding actual response), as needed to operate a vehicle.	SAE-J3016
Monitor the user	Operational-related		The activities and/or automated routines designed to assess whether and to what degree the user is performing the role specified for him/her.	SAE-J3016
Monitor vehicle performance [for DDT performance-relevant system failures]	Operational-related		The activities and/or automated routines that accomplish real-time evaluation of the vehicle performance, and response preparation, as needed to operate a vehicle.	SAE-J3016
Naturalistic driving study	Operational-related		unobtrusive observation of human drivers in uncontrolled test environments	DINSAE-91381
Near crash	Operational-related		event requiring a rapid, evasive maneuver to avoid a collision	DINSAE-91381
Object and event detection and response	Other	OEDR	The subtasks of the DDT that include monitoring the driving environment (detecting, recognizing, and classifying objects and events and preparing to respond as needed) and executing an appropriate response to such objects and events (i.e., as needed to complete the DDT and/or DDT fallback).	SAE-J3016
Object fidelity	Other		quality of representation of a real-world subject's relevant characteristics by a virtual or physical model	DINSAE-91381

Term	Group	Common Abbreviation	Definition	Source
Obstacle	Infrastructure-related		Any object present in the environment and not belonging to the Frame, Scope or Regulation layers, which should be protected from harm (other road users, domestic animals and property) or capable of creating hazard to the ARTS and/or the ARTS' end users.	ARCADE PROJECT
Obstacle Detection Zone	Other		Is a zone that includes the safety zone plus a front zone with at least a half circle zone of radius the length the emergency braking distance. All the potential obstacles must be detected and tracked in the obstacle detection zone, in order to calculate a collision risk by regarding the ARTS vehicle planned path and the obstacle predicted trajectory. The collision risk must be assessed in order to adapt the velocity, warn pedestrians/bicyclists in a dangerous trajectory or make an emergency braking. The collision risk calculation shall take into account large objects in the environment, located near the ARTS lane, which can hide road users, which may become potential obstacles. The obstacle detection zone observation is done through the use of on-board sensors and infrastructure sensors, if available. In case of segregation, obstacle detection zone and safety zone are restricted to the segregation limits (continuous barriers and crossing barriers).	ARCADE PROJECT
Open testbed	Operational-related		test environment with public traffic	DINSAE-91381
Operate [a motor vehicle]	Operational-related		The activities performed by a (human) driver (with or without support from one or more level 1 or 2 driving automation features) or by an ADS (level 3-5) to perform the entire DDT for a given vehicle during a trip.	SAE-J3016
Operational design domain	Operational-related	ODD	Operating conditions under which a given driving automation system or feature thereof is specifically designed to function, including, but not limited to, environmental, geographical, and time-of-day restrictions, and/or the requisite presence or absence of certain traffic or roadway characteristics.	SAE-J3016
Other road user	User-related		All possible road users from the perspective of the ego-vehicle (the AV) i.e., pedestrians, bicyclists, motorcyclists, vehicles, automated vehicles	InterACT PROJECT
Park Assist	Vehicle-related	PA	Park Assist automatically steers the car into parallel and bay parking spaces, and also out of parallel parking spaces. The system assists the driver by automatically carrying out the optimum steering movements in order to reverse-park on the ideal line. The measurement of the parking space, the allocation of the starting position and the steering movements are automatically undertaken by the Park Assist: all the driver has to do is to operate the accelerator and the brake. This means that the driver retains control of the car at all times.	ERTRAC
Park Distance Control	Vehicle-related	PDC	The Park Distance Control supports the driver to manoeuvre into tight spaces and reduce stress by informing him of the distance from obstacles by means of acoustic or, depending on vehicle, optical signals.	ERTRAC
Passenger	User-related		A user in a vehicle who has no role in the operation of that vehicle.	SAE-J3016
Physical model	Other		tangible representation of a real-world object	DINSAE-91381
Pilot test	Operational-related		study to evaluate prototype functions or vehicles under typical operating conditions in uncontrolled environments encountered by the vehicle under test	DINSAE-91381
Platoon	Vehicle-related		A group of two or more automated cooperative vehicles in line, maintaining a close distance, typically such a distance to reduce fuel consumption by air drag, to increase traffic safety by use of additional ADAS-technology, and to improve traffic throughput because vehicles are driving closer together and take up less space on the road.	ENSEMBLE PROJECT

Term	Group	Common Abbreviation	Definition	Source
Positioning	Operational-related		The acknowledgment of the spatial position of an asset in time, involving in autonomous vehicles relative positioning (for obstacle avoidance or precise guidance with respect to the road markings) and absolute positioning (for retrieving from the digital map the information needed for the navigation).	HEADSTART PROJECT
Receptivity [of the user]	User-related		An aspect of consciousness characterized by a person's ability to reliably and appropriately focus his/her attention in response to a stimulus.	SAE-J3016
Remote driver	User-related		A driver who is not seated in a position to manually exercise in-vehicle braking, accelerating, steering, and transmission gear selection input devices (if any) but is able to operate the vehicle.	SAE-J3016
Repair	Operational-related		That part of a corrective maintenance in which manual actions are performed on a item. (IEC 60050(191))	ARCADE PROJECT
Replay scenario	Operational-related		recorded, unmodified, real-world data representing the experienced test	DINSAE-91381
Request to intervene	Operational-related		Notification by an ADS to a fallback-ready user indicating that s/he should promptly perform the DDT fallback, which may entail resuming manual operation of the vehicle (i.e., becoming a driver again), or achieving a minimal risk condition if the vehicle is not drivable.	SAE-J3016
Restoration	Operational-related		That event when an item regains the ability to perform a required function after a fault. (IEC 60050(191)).	ARCADE PROJECT
Resulting condition	Operational-related		state of the environment and vehicle under test at the end of a scenario	DINSAE-91381
Risk	Operational-related		The probable rate of occurrence of a hazard causing harm and the degree of severity of the harm (EN50126).	ARCADE PROJECT
Risk Assessment	Operational-related		The determination of the value of a risk related to a concrete situation of a hazard.	ARCADE PROJECT
Safe State	Operational-related		Condition of an ARTS vehicle where it does not present an impending hazard.	ARCADE PROJECT
Safety	Operational-related		This is freedom from unacceptable or absence of unreasonable risk of physical injury or of damage to the health of people, either directly, or indirectly as a result of damage to property or to the environment.	HEADSTART PROJECT / IEC 61508
Safety Authority	Operational-related		Often a national government body responsible for setting or agreeing the safety requirements for a ARTS and ensuring that the ARTS complies with the requirements (derived from EN50126).	ARCADE PROJECT
Safety Case	Operational-related		The documented demonstration that the product complies with the specified safety requirements (EN50126).	ARCADE PROJECT
Safety critical event	Operational-related	SCE	event with increased collision risk that might lead to a near crash or a crash	DINSAE-91381
Safety Integrity	Operational-related		The likelihood of a system satisfactorily performing the required safety functions under all the stated conditions within a stated penod of time (EN50126).	ARCADE PROJECT
Safety Zone	Operational-related		Is a zone that has the same shape as the emergency zone but is larger and longer at front. Its width is the lane width. Its length is the emergency braking distance + a buffer distance of 5 [m]. The presence of any obstacle in this zone must force the vehicle to decelerate to prevent that an obstacle reaches the emergency zone while the vehicle is not at rest. The safety zone is done through the use of on-board sensors and infrastructure sensors, if available. In case of segregation, obstacle detection zone and safety zone are restricted to the segregation limits (continuous barriers and crossing barriers).	ARCADE PROJECT
Scenario	Operational-related		abstraction and general description of a temporal and spatial traffic constellation without any specification of the parameters	DINSAE-91381
Scenario parameter	Operational-related		A scenario parameter is a value used to describe the characteristics of a scenario (e.g., minimum TTC, average speed, minimum distance and trajectory).	PEGASUS PROJECT

Term	Group	Common Abbreviation	Definition	Source
Scene	Operational-related		snapshot that includes the moving and non-moving elements of the traffic environment, the self-representation of all actors and observers and the relations between those elements	DINSAE-91381
Security	Operational-related		State of relative freedom from threat or harm caused by deliberate, unwanted, hostile or malicious acts	PAS 1885 / PAS 11281
Security incident	Operational-related		Event or events during which the security of an asset, organization or person is, or might be, compromised, either accidentally or deliberately	PAS 1885 / PAS 11281
Severity	Operational-related		The severity of the accident describes the injuries to the vehicle occupants and other road users and damage to the vehicle (from material damage to fatal accident)	HEADSTART PROJECT / PEGASUS PROJECT
Situation	Operational-related		One specific level or a combination of more specific levels of situational variables. rain, dark, one passenger in vehicle, motorway, … (either each for itself, or the combination)	ARCADE PROJECT
Station Clearance Zone	Infrastructure-related		It is a zone defined by the length of the edge of the station adjacent to the ARTS lane and a width such that it guarantees that there are no hazards for the end-users during the ARTS vehicle docking and undocking manoeuvres or in case an ARTS vehicle passes the station. Its objective is to replace the safety role of the station doors in ARTS stations not equipped with doors. The station clearance zone is part of the emergency zone.	ARCADE PROJECT
Supervise [driving automation performance]	Operational-related		The driver activities, performed while operating a vehicle with an engaged level 1 or 2 driving automation system feature, to monitor that feature's performance, respond to inappropriate actions taken by the feature, and to otherwise complete the DDT.	SAE-J3016
Supporting actor	User-related		required scenario participant that does not directly influence the vehicle under test but limits the action of others	DINSAE-91381
Sustained operation [of a vehicle]	Operational-related		Performance of part or all of the DDT both between and across external events, including responding to external events and continuing performance of part or all of the DDT in the absence of external events.	SAE-J3016
System	Other		Set of components or subsystems that relates at least a sensor, a controller and an actuator with one another. Note 1 to entry: the related sensor or actuator can be included in the system, or can be external to the system.	ISO 26262-1
System failure [DDT performance-relevant]	Operational-related		A malfunction in a driving automation system and/or other vehicle system that prevents the driving automation system from reliably performing the portion of the DDT on a sustained basis, including the complete DDT, that it would otherwise perform.	SAE-J3016
System takeover	Operational-related		temporary assumption of driving control by the vehicle	DINSAE-91381
Systematic Failures	Operational-related		Failures due to errors in any safety lifecycle activity, within any phase, which cause it to fail under some particular combination of inputs or under some particular environmental condition (EN50126).	ARCADE PROJECT
Test case	Operational-related		The set of conditions that are applied to test a function or system	ENABLEs 3 PROJECT
Test Scenario	Operational-related		Test setup in which scenarios are triggered in order to collect data specific to this scenario event something that happens in a specific period of time which is individuated combining (preprocessed) measures according to predefined rules. crash, near-crash, overtaking manoeuvre, strong deceleration	ARCADE PROJECT
Threat	Operational-related		Potential cause of an unwanted incident, which may result in harm to a system, individual or organization	ISO/IEC 27032
Threat agent	User-related		Person or organisation that can pose threats to cyber security	PAS 11281

Term	Group	Common Abbreviation	Definition	Source
Tolerable Risk	Operational-related		The maximum level of risk of a product that is acceptable to the Authority. The Authority is responsible for agreeing the risk acceptance criteria and the risk acceptance levels with the Safety Regulatory Authority (SRA). Usually, it is the SRA or the RA by agreement with the SRA that defines risk acceptance levels. Risk acceptance levels currently depend on the prevailing national legislation or national/other regulations. In many countries risk acceptance levels have not yet been established and are still in progress and/or under consideration.	ARCADE PROJECT
Treatment phase	Operational-related		period of testing during which the variables/system under study are manipulated	DINSAE-91381
Trip	Operational-related		The traversal of an entire travel pathway by a vehicle from the point of origin to a destination.	SAE-J3016
Type-approval	Operational-related		The procedure whereby an approval authority certifies that a type of vehicle, system, component or separate technical unit satisfies the relevant administrative provisions and technical requirements.	UN Regulation 2018/858
Uncontrolled test environment	Operational-related	UTE	setting under which all variables external to the vehicle under test are not determined	DINSAE-91381
Unreasonable risk	Operational-related		Risk judged to be unacceptable in a certain context according to valid societal moral concepts	ISO 26262-1
Usage specification	Operational-related		A particular level of driving automation within a particular ODD.	SAE-J3016
Use Case	Operational-related	UC	A specific event in which a system is expected to behave according to a specified function car following	ARCADE PROJECT
Validation	Operational-related		Confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use have been fulfilled (EN50126).	ARCADE PROJECT
Vehicle	Vehicle-related		A machine designed to provide conveyance on public streets, roads, and highways.	SAE-J3016
Vehicle under test	Vehicle-related	VUT	scenario participant whose behavior is of primary interest	DINSAE-91381
Vehicle-to-everything communication	Infrastructure-related	V2X	The passing of information from a vehicle to any entity (vehicles, infrastructure, etc.) that may affect the vehicle, and vice versa	HEADSTART PROJECT / SaferTec PROJECT
Verification	Operational-related		Confirmation by examination and provision of objective evidence that the specified requirements have been fulfilled (EN50126).	ARCADE PROJECT
Virtual model	Operational-related		software representation of a real-world object	DINSAE-91381
Vulnerability	Other		Weakness that can be exploited by one or more threats	ISO/IEC 27000

Appendix III – Questionnaires and interviews (preliminary versions)

This section includes the first draft of the questionnaires to evaluate the **needs and wants** of the travellers and stakeholders (i.e., their expectations and their *a priori* acceptance). The long versions of the questionnaires and interviews aim not exceed 30 question items.

The following table presents the instruments / tools suggested per user/stakeholder type.

Table 14: Synthesis of survey targets, campaign, instruments, moment, administration and tools.

User/ Stakeholder	Campaign	Instrument	When	Administration	Tool
Traveller (passenger/ driver)	Needs / wants & *a priori* acceptance	Surveys (long)	Before the implementation of the experiments	Online via invitations	Typeform, surveymonkey, socsurvey, etc.
	Acceptance *a posteriori*	Short questionnaire	On-site during the automated service experiments	Asked by personnel entering stops or the PT vehicle – contextually appropriate with high face validity	Same as above via a tablet or mobile phone, QR code
OEM, Operators, authorities, infrastructure operators, Tier 1 service providers	Needs/wants & acceptance	Interview	Before the implementation of the experiments	Face to face	Hard copy/ tablet/ recordings
	Needs/wants & acceptance	Interview	On-site during the automated service experiments	Face to face	Hard copy/ tablet/ recordings

The following surveys and interview templates were created with data minimisation in mind. They are, of course, preliminary and they will be further refined as the project progresses. In addition, the questionnaires will be further adapted when the UCs are available as well as adapted to the vehicles used at each pilot site. The decision upon using any visualisation to support the questions will be made in the next version.

Travellers

Needs & Wants & Acceptance (Long Survey – Before the demonstration)

SHORT INTRO PARAGRAPH

Introducing the project, the survey, mention anonymity, mention duration of completion and mention contact person. Logos here.

The survey shall be available in every pilot site's native language(s) and English.

Travelling preferences and experience

1. Please complete this section about your current travelling habits.

For each activity, give the frequency, the classification of the different means of transport used and an overview for each of one of their general user experiences.

For	Frequency	Mode of transport	…and, in general, the experience is…
Work (school/University)	❍Daily ❍Weekly ❍Monthly ❍Few times per year ❍Never/Rarely	Car Motorcycle/scooter/moped Public transport Bicycle, roller, etc. Walking	
Shopping and errands	❍Daily ❍Weekly ❍Monthly ❍Few times per year ❍Never/Rarely	Car Motorcycle/scooter/moped Public transport Bicycle, roller, etc. Walking	
Leisure	❍Daily ❍Weekly ❍Monthly ❍Few times per year ❍Never/Rarely	Car Motorcycle/scooter/moped Public transport Bicycle, roller, etc. Walking	

2. Do you own a vehicle with the following advanced driver assistance systems? (ONLY for drivers)

With a short definition of each advanced driver assistance systems.

Advanced driver assistance systems		If "yes", do you use it regularly?
Adaptive Cruise Control (ACC)	Yes / No	Yes / No
Autonomous Emergency Brake	Yes / No	Yes / No
Lane Departure Warning	Yes / No	Yes / No
Road Sign Recognition	Yes / No	Yes / No
Parking Assistance	Yes / No	Yes / No
Other (please state)	Yes / No	Yes / No

3. I have driven/ travelled with an autonomous...

With a definition of the term "autonomous".

Mode of Transport	…and the experience was…	NA
Train/Metro		❍
Bus/ Shuttle		❍
Private passenger car		❍
Other passenger car (taxi, sharing, pooling)		❍
Other (please state)		❍

Expectations, Needs & Wants related to autonomous travelling experience

4. **For you, which are the most IMPORTANT reasons for a GOOD travelling experience?** (please SELECT in order of IMPORTANCE, 1 for the most importance, 2 for the next most important, etc.).

Reasons	**Importance [1 to 13]** *drop down menu*	**N/A**
To avoid delays		
To offer good connection with other transport modes		
To avoid traffic jams		
To be comfortable and pleasant		
To feel safe and secure		
To be cheaper		
To be good to the environment		
To be fast with less stops		
The stop (or parking space) to be near my work/ residence		
There is room to sit and it is not crowded		
To do not have to search for parking space		
There is always an operator/personnel present to assist me		
Other (please state)		

5. **You would select an autonomous alternative (if it was available) for the following reasons**
(please SELECT in order of IMPORTANCE, 1 for the most importance, 2 for the next most important, etc.).

Reasons	**Importance [1 to 12]** *drop down menu*
I will be able to engage to other activities during the trips	
I will have better connection with other transport modes (e.g., between bus and train)	
I will encounter no more delays	
It will be cheaper	
I do not want to have the control of the vehicle (*ONLY where relevant*)	
There will be less accidents because the human errors will be eliminated	
It will be good to the environment	
It will cover areas and parts of my journey that they are not covered until now	
I will trust in the [autonomous vehicle] more than humans	
The journey will be more comfortable	
The journey will be safer	
The journey will be faster	
The data I share to do this journey are secure	
Other (please state)	

6. **I think the JOURNEY with one of the following AUTONOMOUS TRANSPORT MODES to be…**

Mode of Transport	
Autonomous Passenger car	Pleasant---------------------------------------Unpleasant Relaxing--Stressful Comfortable-------------------------------Uncomfortable Safe--Dangerous Easy--Difficult

	Useful---Useless
Autonomous Train/Metro	Pleasant---Unpleasant Relaxing--Stressful Comfortable--------------------------------Uncomfortable Safe---Dangerous Easy---Difficult Useful---Useless
Autonomous Bus/ Shuttle	Pleasant---Unpleasant Relaxing--Stressful Comfortable--------------------------------Uncomfortable Safe---Dangerous Easy---Difficult Useful---Useless
Autonomous Private passenger car	Pleasant---Unpleasant Relaxing--Stressful Comfortable--------------------------------Uncomfortable Safe---Dangerous Easy---Difficult Useful---Useless
Autonomous Other passenger car (taxi, sharing, pooling)	Pleasant---Unpleasant Relaxing--Stressful Comfortable--------------------------------Uncomfortable Safe---Dangerous Easy---Difficult Useful---Useless

7. **Regarding the following propositions, indicate your degree of agreement** *[9-point Likert scale]*.

a. I think I will use an autonomous mobility service if it is shared.
b. I think I will use an autonomous mobility service if it is individual.
c. I think I will use an autonomous mobility service if it takes the expressways.
d. I think I will use an autonomous mobility service if it uses dedicated lanes.

8. **I think I will use an autonomous mobility service when there is:** *[Multiple choice]*

☐ Sun
☐ Rain
☐ Fog
☐ Snow
☐ Ice
☐ Cold

9. **Indicate the time slot(s) where you think an autonomous mobility service would be useful:** *[timeline with start and end cursors where the respondent can indicate several slots]*

10. **Indicate the type of environment where you think the service would be useful:**

Responses	**Importance [1 to 4]** *drag and drop*
Urban	
Peri-urban	
Rural	
Confined area (e.g., university, hospital, airport, etc.)	

11. You would take an autonomous transportation mode mostly for...

Mode of Transport	
Autonomous Passenger car	❍Commuting ❍Business meetings ❍Leisure ❍Shopping and errands ❍School/ University ❍Family and friends
Autonomous Train/Metro	❍Commuting ❍Business meetings ❍Leisure ❍Shopping and errands ❍School/ University ❍Family and friends
Autonomous Bus/ Shuttle	❍Commuting ❍Business meetings ❍Leisure ❍Shopping and errands ❍School/ University ❍Family and friends
Autonomous Private passenger car	❍Commuting ❍Business meetings ❍Leisure ❍Shopping and errands ❍School/ University ❍Family and friends
Autonomous Other passenger car (taxi, sharing, pooling)	❍Commuting ❍Business meetings ❍Leisure ❍Shopping and errands ❍School/ University ❍Family and friends
Other (please state)	❍Commuting ❍Business meetings ❍Leisure ❍Shopping and errands ❍School/ University ❍Family and friends

12. You prefer ... *[9-point Likert scale]*

a. … order your transport via an application
b. … order your transport at a dedicated terminal on public roads
c. … do not order and wait at a collection point with fixed passage times

13. If an order service was set up, you would prefer that the service notify you of its arrival ... *[9-point Likert scale]*

a. … directly on your mobile phone
b. … via a display on a dedicated terminal on public roads

14. For a first use of the service, you would prefer…

Responses	**Importance [1 to 4]** *drag and drop*
Nothing	
A tutorial on a dedicated terminal	
A tutorial on the mobile phone or available on the internet	
Training carried out by the transporter	
A paper booklet	

15. **You prefer…** *[9-point Likert scale]*
    a. … pay with your usual urban transport card
    b. … pay using a mobile application
    c. … pay directly in the vehicle
16. Identification when boarding the vehicle ensures the safety of all passengers: only identified passengers can board. Identification can be done using a transport card or a bar code available on the mobile application, for example. **When you get into the vehicle, you prefer** ... *[two proposals, only one choice]*
    - Log in
    - Do not identify yourself
17. **What are the reasons for your choice?** *[9-point Likert scale]*

    Previous answer: do not identify yourself
    a. Keep my anonymity
    b. Ability to defraud
    c. Do not complicate the management of the reservation

    Previous answer: identify yourself

    How would you like to identify yourself?

    a. With my usual transport card
    b. With a digit code received by text message
    c. With a barcode received via the mobile application
    d. With an identifier assigned when I register on the mobile application

18. **When the vehicle arrives, I prefer:** *[only one choice]*
    - Let the doors open automatically
    - Press a button
19. **For the service to start, I prefer:** *[only one choice]*
    - Let it start automatically
    - Press a button to start it
20. **If the service is shared, I would like...** *[9-point Likert scale]*
    a. A button is available to make the service wait and allow other users to use it (e.g., as in elevators)
    b. A button is available to close the doors more quickly (e.g., in elevators)
21. **When the service arrives at its destination, I prefer:** *[only one choice]*
    - Let the doors open automatically
    - Press a button to open the doors
22. **I would like to be able to evaluate the service after each use (e.g., via a satisfaction questionnaire)?** *[9-point Likert scale]*

***A priori* acceptance**

23. **For each of the following statements, can you indicate your degree of agreement** *[9-point Likert]*
    1. I think an [vehicle/service] will become an important part of the existing public transport system
    2. I think using an [vehicle/service] in my day-to-day commuting is better and more convenient than using my existing form of travel

3. I think an [vehicle/service] would be more efficient/faster than existing forms of public transport
4. I think an [vehicle/service] would be easy to understand how to use
5. It would not take me long to learn how to use an [vehicle/service]
6. The people around me think that I should use an [vehicle/service]
7. I think I am more likely to use an [vehicle/service] if my friends and family used it
8. If it were affordable, I would use an [vehicle/service]

Technology savviness

24. Do you install software yourself, or do you have someone else do it for you?

❍I install it myself ❍Someone else does it for me ❍It depends on the software

25. What level of knowledge about autonomous vehicles is best for you?

❍Advanced (e.g., I actively contribute to the development of this technology)

❍Intermediate (e.g., the subject interests me but I do not know its technical functions)

❍Beginner (e.g., I just heard about Google Car or Tesla)

❍Novice (e.g., I do not know this area at all)

26. Would you like to test your knowledge on automation?

The Society of Automotive Engineers (SAE) defines 6 levels of driving automation ranging from 0 (fully manual) to 5 (fully autonomous). Please drag each of the 6 SAE level boxes (left side) and place it over the correct description boxes (right side). Each left side box corresponds to ONLY ONE right side box.

Background information

Year of Birth

(answer drop down with Years)

Gender

❍ Male ❍ Female ❍Other ❍Prefer not to say

The annual income of my household is approximately (please SELECT your nearest estimate - optional)

❍Under €12,000 ❍€12,000-24,000 ❍€25,000-36,000 ❍€37,000-60,000 ❍€61,000-90,000 ❍ over €90,000

Disability

Household structure *[drop-down list]*

Education *[drop-down list]*

Employment *[drop-down list]*

Residential situation *[drop-down list]*

Geographical area

❍ Urban ❍ Peri-urban ❍Rural

Thank you for your time!

Acceptance (short survey – during the demonstration)

A. Contextual information

1. Indicate the day and the time of your journey *[drop-down list]*

2. Select the major reason of your journey *[drop-down list]*

3. Indicate, in minutes, the duration of your journey *[open question]*

4. Did you encounter any problems during your trip? Yes / No

5. If yes, which problem(s) *[multiple choices]*

B. Acceptance

[degree of agreement on 9-point Likert scale]

6. Are you satisfied with the [vehicle/service]?
7. The [vehicle/service] is useful?
8. The [vehicle/service] is usable?
9. The [vehicle/service] is easy to learn?
10. The [vehicle/service] is reliable?
11. The [vehicle/service] is safe?
12. The [vehicle/service] correspond with my needs?
13. The [vehicle/service] is comfortable?
14. I intend to reuse the [vehicle/service]?
15. How likely would be to recommend the [vehicle/service] to a friend or colleague?

C. Background information

Year of Birth

(answer drop down with Years)

Gender

❍ Male ❍ Female ❍Other ❍Prefer not to say

The annual income of my household is approximately (please SELECT your nearest estimate - optional)

❍Under €12,000 ❍€12,000-24,000 ❍€25,000-36,000 ❍€37,000-60,000 ❍€61,000-90,000 ❍ over €90,000

Thank you for your time!

Stakeholders

This is a horizontal template, which we can further adapt to the specificities of each Pilot site and each stakeholder group.

Needs/Wants & Acceptance (interview – before)

SHORT INTRO PARAGRAPH

Introducing the project, the survey, mention anonymity, mention duration of completion and mention contact person. Logos here.

The interview will be conducted face to face or remotely and it is individual.

A. Background information

1. **Age** _____

2. **Gender**
❍ Male ❍ Female ❍ Other ❍ Do not want to say

3. **Stakeholder group** *(completed by the interviewer)*

❍Operator ❍Service provider ❍Tier 1 provider ❍Authority ❍Other (please state)

4. **Organization type (optional)**
❍ Governmental agency ❍ Non-governmental organization ❍ Industry/ Supplier ❍ Non-governmental organization Insurance company/ association ❍ Research/ Academia ❍ Other (please state)

5. **Number of employees**
❍ 1-100, ❍101-500, ❍501-1000, ❍1001-5000, ❍>5000

6. **Educational level**

❍ Elementary ❍Secondary ❍Higher ❍Postgraduate (MSc, PhD) ❍Other (please state)

7. **Area of expertise:** ____________________

8. **What is you working experience?**
❍≤ 5 years❍5-10 years ❍ >10 years

9. **How many years of experience do you have working in automation?**
❍No Experience ❍≤ 5 years❍5-10 years ❍ >10 years

B. The technologies/ Services

This section is relevant ONLY to the stakeholders bringing their technologies or services into the project.

10. **What is the technologies/services you are bringing into SHOW project?**

11. **How will your technologies/ services help the travelers? What is the target traveler group(s)?**

12. **Have you integrated/offered your technologies/ service(s) in other platform(s) and/or cities? If Yes, which?**

C. Previous Experience/Current Behaviour

With the following questions, we want to learn more about your previous experiences with integrating your technologies or services into another city/ platform, etc. *This will help us to understand better the requirements needed to successfully integrate them into SHOW.*

a) Previous Experience with other services/platforms/ vehicles (explicit knowledge)

13. Do you have any previous experience with automation in transportation?
Yes/no

14. If answered Yes in Q.13: What is your general experience with similar [depending on stakeholder group: technologies/ services/ implementations]? What does that practically mean for you?

15. What will be, for you, the advantage of offering your technologies/ services through SHOW?

b) Current Behaviour

16. What are the 3 most important aspects for a successful [depending on stakeholder group: integration/ exploitation/ implementation]? *Is licensing e.g. important?*

17. How do you believe we can ensure that your [depending on stakeholder group: integration/ exploitation/ implementation] requirements are met (if any)?

c) Previous Negative Experience (implicit knowledge)

18. Can you think of one particular NEGATIVE EXPERIENCE when you offered your technologies/ services that you recall as being very frustrating or aggravating? *(prompts for situation: time pressure, resources, costs, importance, alternatives)*

19. Can you provide a complete and detailed description?
a) Aim?
b) Integration/ implementation process?
c) Outcome? Shortcoming and caveats

d) Previous Positive Experience (implicit knowledge)

20. Can you think of one particular positive experience when you tried to integrate your service or offer through another platform that you recall as

being very satisfying or encouraging? *(prompts: time pressure, resources, costs, importance, alternatives)*

21. **Can you provide a complete and detailed description?**
    a. *Aim?*
    b. *Integration/ implementation process?*
    c. *Outcome? Shortcoming and caveats*

D. Constraints/Cost/Value

For the next questions, I want you to focus on the current SHOW project.

22. **What SHOW can offer to (you, your organization, city, to transportation, the environment, society, business)?**

23. **Which are your major concerns for the SHOW implementations and why?**

E. Risk/Impact

Finally, I want you to think about possible risks relating to SHOW.

24. **What are the major problems/challenges/risks you anticipate in the integration/ service/ implementation plans?**

Follow-up question:

   a. *Would that not be something you consider at the beginning, e.g. "by design"?*
   b. *Why is it a risk?*

25. **What is the most important impact you believe you can possibly achieve with your service if everything works out within the project?**

26. **Where do you like to be in your professional expertise in a few years down the line? (e.g., Do you like to be more involved in automation or other new areas and/or other services?) (expectations as professionals, as themselves)**

F. *A priori* acceptance

27. **For each of the following statements, can you indicate your degree of agreement** *(9-point Likert)*

a. Do you think an [vehicle/service] will become an important part of the existing public transport system.

b. Do you think using an [vehicle/service] in my day-to-day commuting is better and more convenient than using my existing form of travel.

c. Do you think an [vehicle/service] would be more efficient/faster than existing forms of public transport.

d. Do you think an [vehicle/service] would be easy to understand how to use.

e. It would not take long to learn how to use an [vehicle/service].

f. The people around you think that you should use an [vehicle/service].

g. Do you think you are more likely to use an [vehicle/service] if your friends and family used it.

h. If it were affordable, you would use an [vehicle/service].

Thank you for your time!

Needs/Wants & Acceptance (interview – during the demonstration)

A. Background information

1. **Age _____**

2. **Gender**
❍ Male ❍ Female ❍ Other ❍ Do not want to say

3. **Stakeholder group (completed by the interviewer)**

❍Operator ❍Service provider ❍Tier 1 provider ❍Authority ❍Other (please state)

4. **Organization type (optional)**
❍ Governmental agency ❍ Non-governmental organization ❍ Industry/ Supplier ❍ Non-governmental organization Insurance company/ association ❍ Research/ Academia ❍ Other (please state)

5. **Number of employees**
❍ 1-100, ❍101-500, ❍501-1000, ❍1001-5000, ❍>5000

6. **Educational level**

❍ Elementary ❍Secondary ❍Higher ❍Postgraduate (MSc, PhD) ❍Other (please state)

7. **Area of expertise: ____________________**

8. **What is you working experience?**
❍≤ 5 years❍5-10 years ❍ >10 years

9. **How many years of experience do you have working in automation?**
❍No Experience ❍≤ 5 years❍5-10 years ❍ >10 years

B. Experience with SHOW and technologies

Mode of Transport	The acceptance scale		
[vehicle/service]	1 Useful	|__|__|__|__|__|__|	Useless
	2 Pleasant	|__|__|__|__|__|__|	Unpleasent
	3 Bad	|__|__|__|__|__|__|	Good
	4 Nice	|__|__|__|__|__|__|	Annoying
	5 Effective	|__|__|__|__|__|__|	Superfluous
	6 Irritating	|__|__|__|__|__|__|	Likeable
	7 Assisting	|__|__|__|__|__|__|	Worthless
	8 Undesirable	|__|__|__|__|__|__|	Desirable
	9 Raising Alertness	|__|__|__|__|__|__|	Sleep-inducing

10. **What was your BEST experience from the SHOW project demonstrations?**

11. **What was your WORST experience from the SHOW project demonstrations?**

if the stakeholder has not actively participated in the project, but they were invited only to demonstrations, then the above question is re-phrased below.

12. **What you liked MOST about SHOW project technologies/ services/ implementations?**

13. **What you liked LEAST about SHOW project technologies/ services/ implementations?**

G. Constraints/Cost/Value

For the next questions, I want you to focus on the current SHOW project.

14. **What SHOW offered you (you, your organization, city, to transportation, the environment, society, business)?**

15. **Which are your major concerns after the SHOW implementations and why?**

H. Risk/Impact

Finally, I want you to think about possible risks relating to SHOW.

16. **What are the major problems/challenges/risks that were not anticipated in the integration/ service/ implementation plans?**

Follow-up question:

  a. *Why It was not anticipated as a risk?*

17. **What is the most important impact you believe you will achieve with your service after the end of the project with the knowledge and know-how you obtained during the lifetime of the project?**

18. **Where do you like to be in your professional expertise in a few years down the line? (e.g., Do you like to be more involved in automation or other new areas and/or other services?) (expectations as professionals, as themselves)**

Thank you for your time!

Appendix IV – Keywords used in Social Media mining and ML algorithms

N°	Keywords
1	Cooperative and Connected Automated/Autonomous Vehicles – CCAV
2	Cooperative and Connected Automated Mobility – CCAM
3	Connected and Automated Driving - CAD
4	Automated Driving - AD
5	highly automated road passenger service - HARPS
6	Automation in road transport
7	Automated/autonomous vehicles – AV
8	Automated mobility
9	Shared Cooperative and Connected Automated Mobility
10	Autonomous Shuttles
11	Urban automation
12	Public Transport Automation/ Automated public transport
13	Automated fleets
14	Automated Demand Response Transport
15	Automated Mobility as a Service – Mobility as a Service in/and Automation
16	Robo-taxis
17	Automated Logistics – Automated Logistics as a Service
18	First – Last mile and/in automation
19	Automation as a Service
20	User acceptance
21	Legal aspects of automated/autonomous vehicles
22	Cooperative Intelligent Transport Systems – C-ITS and/in automation
23	Authorisation for automated/autonomous vehicles/ automated mobility
24	Business scenarios for automated/autonomous vehicles/ automated mobility
25	Ethical aspects/dilemmas in automated/autonomous vehicles/ automated mobility
26	Artificial intelligence in automated/autonomous vehicles/ automated mobility
27	Tele-operation in automation – Remote operation in automation
28	Mixed passenger – cargo automated mobility
29	Platooning and automation
30	Inclusive automated transport
31	Mixed traffic and automation
32	Dedicated lanes and automation
33	Training in automation
34	Skills in automation
35	Automation and employment
36	Automation soft measures
37	Incentives for automated transport/mobility
38	Energy saving and automation/ automated transport/mobility
39	Road safety and automation/ automated transport/mobility
40	Emissions and automation/ automated transport/mobility
41	Traffic/transport efficiency and automation/ automated transport/mobility
42	Handover strategies and automation/ automated transport/mobility
43	Driving behavior and automation/mobility
44	Vulnerable road users and automation/mobility
45	Freight transport and automation/mobility
46	CCAV integration in SUMP (Sustainable Urban Mobility Planning)
47	Real life demonstration of automated fleets
48	Traffic management and automation
49	Cooperative, connected, automated & autonomous mobility
50	Autonomous Vehicles Operating Design Domain (ODD)
51	User Experience in automated & autonomous mobility
52	Automated Driving System
53	Adaptive Cruise Control
54	Automated Bus
55	Automated Truck
56	Automated Valet
57	Automatic Train
58	Cooperative ACC
59	Driverless Operation
60	Driving Automation
61	Automated Vehicle
62	Driving Automation Performance
63	Traffic Jam Assist
64	V2X
65	V2I
66	Automated vehicles

67	V2V
68	V2VRU
69	Vulnerable road users (VRU)
70	MaaS
71	Laa
72	DRT
73	Aggregator as a Service (AaaS)
74	Business models
75	Operating models
76	Business models for SMEs, start-ups, new entries
77	Impact analysis
78	Validation of business models
79	Mobility Service Canvas
80	Cost Benefit Analysis (CBA)
81	Total Cost of Ownership (TCO)
82	Cost Efficiency Analysis (CEA)