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SHared automation Operating models for Worldwide adoption

SHOW

Grant Agreement Number: 875530

D9.2: Pilot experimental plans, KPIs definition & impact assessment framework for pre-demo evaluation

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Legal Disclaimer

Executive Summary

The SHOW project aims to support the migration path towards effective and persuasive sustainable urban transport through technical solutions, business models and priority scenarios for impact assessment, by deploying shared, connected, electrified fleets of automated vehicles in coordinated Public Transport (PT), Demand Responsive Transport (DRT), Mobility as a Service (MaaS) and Logistics as a Service (LaaS) operational chains in real-life urban demonstrations.

One important part of the SHOW ecosystem evaluation framework is the detailed framework of the evaluation of the pre-demonstrations and demonstrations and the experimental plans. Deliverable 9.2 is the updated version of the common parametric evaluation framework for SHOW demonstrations and includes a description of the methodological approach for the pre-demonstration evaluations. New here is experimental plans for the pre-demonstrations, but also the impact analysis framework and its detailed description of how to perform it.

In SHOW, a methodology has been created for this, denoted M^{3}ICA (multi-impact, multi-criteria, and multi-actor). It allows for consistent analysis and evaluation of pilots and simulations within the ecosystem of electric connected automated vehicles (e-CAV). Specifically, for the pre-demonstration and demonstrations data collections, the Field opErational teSt support methodology (FESTA) is used as the starting point for setting up the framework. It describes how data collected will be used for the impact analysis, including baseline data along with dimension of measurement of the KPIs (per vehicle, per service…) and the aggregation rule (sum or average). Finally, the comparability is discussed cross site in chapter 7.4 as well. The preparation of the demonstration site evaluations is based on the FESTA stepwise procedure. This procedure is also used as the outline of this document, with headings for: Systems and services identification, Use Cases, Research Questions, Evaluation Methods, Capturing and monitoring tools.

The experimental design has its starting point in the identified use cases described in deliverable D1.2: SHOW Use Cases. The experimental plan encompasses clear definitions of research questions (for each demonstration site), liaison to KPIs defined in A9.4 "Impact assessment framework, tools & KPIs definition", objective measurement tools and more subjective measuring tools (surveys and interviews/focus groups), to be used (fed by A9.2 "Capturing and monitoring tools"), timetables, but also allocation of responsibilities and definition of all operational conditions for the realisation of the demonstrations. All experimental plans adhere to a common parametric evaluation framework that is defined to reflect clear liaisons to the impact assessment framework of A9.4. Still, it will be parametric in the sense that not all use cases will be demonstrated and tested in all sites or not in the exact same configuration.

The main outcome of this deliverable is the evaluation framework including the experimental plans at pre-demonstrations and the method of the impact analysis, that will be used by the demonstration sites during the pre-demonstration activities. The main structure of the work starts with identifications of the target users, use cases and connected priority scenarios. Based on this, the research questions were formulated, to which the KPIs used for impact analysis were connected. When this was clear the design of the data collection was made, and tools were developed possible to use and test during the pre-demonstrations. Pre-demo should be done until all test cases for the demo-site has been successfully run through at least 10 times.

The framework will be updated to cover the full experimental design for the final demonstrations in D9.3 (M23). However already in this deliverable engagement

strategies are included. In addition, the work toward data collection with as less as possible bias is described, considering also the end users in focus for the pre-demonstration data collections.

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Table of Contents

List of Tables

List of Figures

Abbreviation List

Abbreviation	Definition
AaaS	Automation as a Service
AI	Artificial Intelligence
AV	Autonomous/Automated Vehicle
AVP	Automated Valet Parking
BAU	Business as usual
BRT	Bus Rapid Transit
B2C	Business to consumer
DRT	Demand Responsive Transport
CAV	Connected and Autonomous/Automated Vehicle
CCAM	Cooperative, Connected & Automated Mobility
CCAV	Cooperative Connected Automated Vehicle
DMP	Data Management Portal
e-CAV	Electric connected automated vehicles.
FESTA	Field operational test support methodology
GDPR	General Data Protection Regulation
LaaS	Logistics as a Service
MaaS	Mobility as a service
MAMCA	Multi-Actor Multi-Criteria Analysis
M3ICA	Multi-Impact, Multi-Criteria, and Multi-Actor
OEM	Original Equipment Manufacturer
ODD	Operational Design Domain
PMR	Persons with Special Mobility Requirements
PT	Public transport
P2P	Peer-to-peer
SAV	Shared Avs
SoS	System of systems
SMU	Soft Mobility Users
SPACE	Shared Personalised Automated vEhicles, a UITP project that resulted in the definition of 13 “autonomous mobility scenarios”
SUMP	Sustainable Urban Mobility Planning
UC	Use Case
VEC	Vulnerable to Exclusion
WoZ	Wizard of Oz

WP9 Glossary

Terminology	Definition
Demonstration site	A city that demonstrates part of or a full set of systems/services possible in future sustainable cities. The abbreviation is Demo site.
Pre-Demonstration	First step toward the full Demonstration, used as a rehearsal (WP11).
Demonstration	Final demonstration used for final evaluation (WP12).
Demonstration plans	Description of what will be included in the Demonstration sites. The same as pilot plan but specific for a demonstration site.
Evaluation framework	This is the theoretical description of how the evaluation be done.
Experimental plan	Description of what, how and when the test cases will be evaluated (what data to collect, when and what tool to use).
Use Case	List of actions or event steps typically defining the interactions between a role (known in the Unified Modeling Language (UML) as an actor) and a system to achieve a goal. The actor can be a human or other external system.
Test case	The demonstration site specific Use Case.
Scenarios	The description of what will happen in the Test Case. Similar to a storyboard, that can be used to visualize a scenario as a sequence of scenes (being connected through actions or events)
M3ICA Scenarios	Scenarios that are defined in relation to the delineation of AV service types that are implemented across SHOW demonstration sites for the purpose of the holistic M3ICA method developed for the SHOW project.
Services	Systems that provide a public transport need such as PT, MaaS, LaaS, DRT.

1 Introduction

The SHOW project aims to support the migration path towards effective and persuasive sustainable urban transport through technical solutions, business models and priority scenarios for impact assessment, by deploying shared, connected, electrified fleets of automated vehicles in coordinated Public Transport (PT), Demand Responsive Transport (DRT), Mobility as a Service (MaaS) and Logistics as a Service (LaaS) operational chains in real-life urban demonstrations. The SHOWcasing of the Automated City of tomorrow is presented in Figure 1.

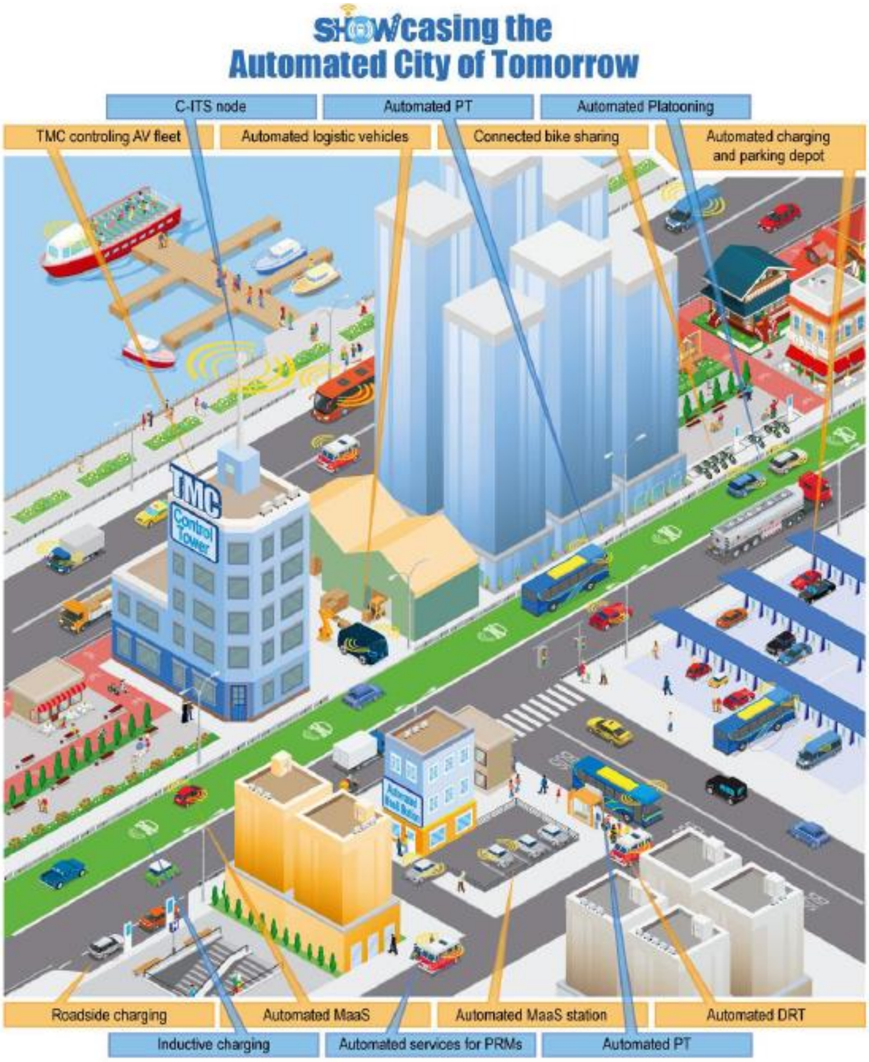

Figure 1: SHOWcasing the Automated city of tomorrow.

Each system mentioned above (e.g., PT, DRT) and presented in Figure 1 , is a system within the urban transport eco system and as such will be represented and evaluated. The ecosystem involves dynamic interactions among the different stakeholder groups (e.g., the fleet operator, the leader in a platoon and passengers) and therefore it’s not the same as the addition of its systems, rather something different.

SHOW aims to demonstrate and evaluate a complex System of Systems (SoS). The SHOW ecosystem includes systems and services such as: Traffic Management Control (TMC) controlling AV fleet, Advanced Logistic vehicles, Connected bike sharing, Automated charging and parking depot, Roadside charging, Automated MaaS, Automated Maas Stations, Automated DRT, see chapter 4.2.

To this end, the European Commission has initiated a discussion within the ITS Committee. The goal is to establish a European roadmap with short-term and long-term targets for testing and deployment of Cooperative, Connected and automated mobility (CCAM) [1]. CCAM initiatives focus to find possible frameworks to rely on.

At this point still comprehensive frameworks to be used for evaluations of such an ecosystem, with layers of safety, energy and environmental impact, societal impact, logistics and user experience, awareness and acceptance are not yet available. Especially taking into consideration several stakeholder perspectives, described in SHOW D1.1: "Ecosystem actors' needs, wants & priority users experience exploration tools". The list of stakeholders for SHOW consists of the following key groups (see chapter 6.3 for further information).

- Vehicle and other road users (passengers, other road users interacting with Avs in traffic, and AV (remote) operator)
- Public interest groups and associations
- Decision-making authorities or regulators
- Operators (e.g., public transport operators, private fleet operators)
- Mobility service providers
- Industry (e.g., AV manufacturers)

The SHOW project has eight identified objectives, among those # 5 and 6 are the main targeted in the evaluation framework, but the outcome of the evaluation results will be used to address more or less all other objectives.

1. To identify and specify priority urban automated mobility Use Cases (Ucs) that guarantee high user acceptance, true user demand and cost-efficiency under realistic operational conditions, respecting the legal, operational and ethical limitations.

2. To identify novel business roles and develop innovative business models and exploitable products/services for sustainable automated fleet operations in urban and peri-urban environments.

3. To develop an open, modular, and inclusive system architecture, and the enabling tools for it, supporting all Ucs and allowing cross-site, cross-vehicle and cross-operator data collection, analysis and meta services realisation.

4. To improve the necessary functionalities of all vehicle types (shuttles and pods, buses and cars) to allow the demonstration Ucs to be realized, taking into account the local physical and digital infrastructure (5G, G5, …), weather and traffic conditions, improving the vehicles' energy efficiency and safeguarding the safety of vulnerable and non-connected traffic participants through appropriated interfaces.

5. To deploy demonstration fleets, infrastructure elements and connected services (DRT, MaaS, LaaS, etc.) to realise and validate seamless, personalised and shared electric Cooperative Connected Automated Vehicle (CCAV) services for all travellers in real urban and peri-urban traffic

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[1] https://ec.europa.eu/transport/themes/its/c-its_en

environments across Europe and, through a vast international collaboration at global level.

6. To assess the impact of shared automated cooperative and electric fleets at city level through holistic impact assessment.

7. To transfer the outcomes through proof of alternative operational schemes and business models to replication sites across Europe and beyond.

8. To support evidence-based deployment of urban traffic automation, through replication guidelines, road-mapping, reskilling, and training schemes for the future workforce as well as through input to certification and standardization actions and policy recommendations.

One of the objectives of the SHOW project (#5) is to deploy demonstration fleets, infrastructure elements and connected services (DRT, MaaS, LaaS, etc.) to realise and validate seamless, personalized and shared electric CCAVs for all travellers in real urban and peri-urban traffic environments. Demonstrations will take place in 5 Mega Pilots and 6 Satellite sites. A Mega Pilot site is a site in a country where different cities or parts of a city are working together addressing the SHOW use cases. A satellite is a demonstration site that is more focused and is not covering all use cases. In total, demonstrations will take place in 17 cities across Europe. In Chapter 9 each Demonstration site is described together with the experimental plan for the pre-demonstrations. In addition, an overview of systems and services for all demonstration sites is presented in Chapter 4.

In addition, there are Follower Pilot sites that are used as replication sites but will not be covered by the evaluation framework in D9.2 as they will not typically follow it. Three sites are already identified and more will be identified during the project. They will adopt business models, selected technologies, and tools from SHOW to ensure a proper replication plan based upon one or more SHOW Pilot sites demonstration plans. The description of them will be included in the Follower sites multiplication plans and actions (D12.7 and D12.8 with a due date M44).

Several other project-wide objectives are also related to the evaluation framework. One objective is to identify and specify priority urban automated mobility use case that will be covered in the Pilot sites (#2). To allow the demonstration Ucs to be realized, necessary functionalities of all vehicle types to be used in SHOW demonstrations (shuttles and pods, buses, and cars) will be improved (#4). Another objective is related to the development of a big data collection platform and data management portal, being able to collect and analyse all demonstration sites data (#3). Data collected at the demonstration sites will also contribute to the objective of assessing the impact at city level of shared automated cooperative and electric fleets through a holistic impact assessment (#6).

Evaluation of such a complex system of system is a very demanding task. Already 50 years ago, the insight of a need for multifaceted approach for evaluations of, in this case, safe traffic was identified by researchers (Hughes, Newstead, Anund, Shu, & Falkmer, 2015). Different types of road safety strategies were developed like the three Es – Enforcement, Engineering and Education (Damon, 1958) or the User-Machine-environment, that was the starting point for the work by Haddon (1972). Haddon included phases of a crash in time (pre-crash, crash, and post-crash) and factors or components that affect crashes (e.g., drivers, vehicles, road environment, and social-economic environment), but did not include the broader physical environment and socio-economic environment components. It has been argued that a system approach is needed to understand what is good or bad and Peden et al. (2004) stated that "making a road traffic system less hazardous requires a "system approach" – understanding the system as a whole and the interaction between its elements, and identifying where there is potential for intervention".

Such reasoning is most likely relevant for other areas of impact than safety, and useful to consider also evaluating the complexity of the automated systems of tomorrow. Developments of Cooperative, Connected and Automated Mobility are happening fast and hold the promise of further increased safety and more inclusive mobility solutions. To be successful, however, there is a need to carefully assess the integration in both existing traffic and existing infrastructure.

To be able to understand and learn from the complexity of a system of systems like SHOW there is a need for an evaluation framework that provide a common methodology for all CCAV demonstrations, that makes it possible to harmonize the experimental procedures across all Demonstration sites. The evaluation framework for the demonstrations needs to guarantee that data is collected for the impact analysis, including also the simulations, hence a strong link to the KPIs and the measurements is needed, including a multi method approach aim to understand both the effects and the reason behind.

1.1 Purpose and structure of the document

The current deliverable is named D9.2: Pilot Experimental Plans, KPIs definition and impact assessment framework for pre-demo evaluations. This a follow up of D9.1: Evaluation Framework. A third update will be done in Month 22 with focus on the Final demonstration evaluations (D9.3: Pilot Experimental Plans, KPIs definition and impact assessment framework for final demonstration round), whilst it is not impossible that intermediate versions may emerge till then.

The purpose of this deliverable is to present a generic framework for the evaluation of the system and services integrated at the demonstration sites, including the experimental plans for the pre-demonstration at each site. The pre-demonstration is seen as the rehearsal of the demonstrations that will run for approximately 12 months.

This update (D9.2) includes the update of the consolidation of vehicles, users and environments to be included in the pre-demonstrations and real-life demonstrations. The update is aimed to get an overview of all demonstrations sites that will perform pre-demonstrations and evaluations.

In addition, D9.2 includes the impact assessment framework. The generic framework and its methodological approach for impact analysis using the demonstration evaluation results is described in Chapter 2. Chapter 3 provides an overview of the pre-demonstrations and real-life demonstrations that will take place in 5 Mega Pilots and 6 Satellite Pilots in 18 cities across Europe. The demonstrations will cover various geographical areas, city sizes, weather conditions, socioeconomic and cultural issues. The services and systems to be evaluated at the demonstration sites are defined and described in Chapter 4 and an overview of vehicles and infrastructure to be included in demonstrations at each site are provided. Use cases and a description of the target groups for the evaluation are provided in Chapter 5. Thereafter, research questions connected to the use case groups are given in Chapter 6. Chapter 7 describes the method employed for the evaluation to be performed at the demonstration sites across Europe covering key performance indicators (KPIs), study design, stakeholders and end users that will be in focus on the evaluations and in the impact analysis. Capturing and monitoring tools have been developed for this purpose as described in Chapter 8. Those cover a mix of qualitative (interviews) and quantitative measures (questionnaires and observations). Chapter 9 introduces the procedure to be followed by the demonstration sites when performing data acquisition during their pre-demonstrations. Regarding this, ethics, roles and responsibilities, data handling and approval processes are addressed. In Chapter 10, the experimental plans for each of the demonstration sites are presented in more detail. Chapter 11 provides the conclusion.

Ethical and privacy issues (see D3.4: SHOW Updated Ethics manual & Data Privacy Impact Assessment) will be instantiated herein in each demonstration site context. The framework will be common in the sense that it will target the same objectives and satisfy the same key impact assessment targets as defined in A9.4 and described in chapter 8.3.

As such, the framework and experimental plans will make evident from the beginning and through the association of the KPIs with demonstration cases (herein called test cases), which outcomes will emerge from each site, and which of them and to which extent they will be comparable. Still, the framework, used by the demonstration sites, will ensure that the key priority use cases and impacts targeted will be answered by all demonstration sites of the project.

The detailed pre-demonstration plans defined and associated carefully to the varying testing contexts – in particular the type of roads, the size of penetration, the automation readiness of the region/city, the tests' seasonality, and the type of vehicles involved. The experimental plan includes the description of the key end users, etc. – identifying the common and changing parameters in each case. This is used to define the impact assessment (WP13) and the projections done by simulations (WP10). This will again allow the definition of the level of the later consolidation and comparison of the outcomes and, finally, the derivation of both generic but also context-specific conclusion. The detailed description of the framework is described in chapter 2.

1.2 Intended Audience

This deliverable has two groups of intended audience: people outside the SHOW Consortium and SHOW partners working with the demonstrations and specifically the evaluations. The work described is intended to contribute to those working on CCAV specific evaluations and frameworks in general.

The deliverable is public and is seen as a deliverable where people from outside the project consortium, but with experience in the topic of automation, can get an overview of the framework for the evaluation of the SHOW ecosystem, and also a consolidated view on pre-demos and real-life demonstrations that will happen. At the same time, this deliverable aims to define the evaluation framework covering the details of the pre-demonstrations. The audience is therefore the project demonstration site partners that will use this for the planning of the oncoming pre-demonstrations.

1.3 Interrelations

The Evaluation Framework (D9.1 and its updates D9.2 and D9.3) is closely related to several activities, not only to the WP9 Pilot plans, tools, and eco-system engagement. In Figure 2, the main interrelationships between A9.1 and other WP/A are highlighted.

The methodological approach taken in this document is twofold. It presents both an evaluation framework and impact assessment framework.

The work in WP1 (A1.1, A1.2, A1.3) sets up the core of what to demonstrate in terms of Use Cases and how to assess stakeholder and AV user needs and acceptance. In addition, WP2 (A2.1) will provide input about existing models and best practices to make sure the focus is on innovations, that is also important for the selection of the final Ucs and scenarios to be evaluated. WP3 (A3.2) then provides the guidance for the demonstration sites to be able to follow and consider the requirements defined by the General Data Protection Regulation (GDPR), but also other legal and ethical regulations that need to be considered, when humans are involved in testing and demonstration activities. The demonstration sites will use different physical infrastructure and the work in WP8 (A8.1) will provide input about what to consider. Moreover, the evaluation framework of the SHOW ecosystem is not only about the performance of the single demonstration sites. To understand the full concept, there is a need to also use simulation to get the system perspective on the future city concept and this will be done in WP10/A10.1. The demonstration sites will be carefully described within the system architecture work in WP4 (A4.1) and before realisation of the pre-demonstrations and demonstrations, this will be the starting point for the technical validation process in WP11 (A11.1).

The realisation of the pre-demonstrations will be done in A11.3 and the realisation of the final demonstrations will be done in WP12.1-WP7, with a consolidation of the results done in A12.8, but also be fed into the big data collection platform in WP5 (A5.1) that will be used for result analysis and consolidation. The connection between A5.1 and the evaluation framework and the development of capturing and monitoring tools (A9.2) and the impact assessment framework in A9.4 is strong, and the activities depend on each other to make the evaluation of the SHOW ecosystem a success. The results from the demonstration sites will then be used for analysis of business models in WP2 (A2.3), for enhancement of user experience in WP7 (A7.3), for HMI development in WP7 (A7.4), for dynamic personalised services in WP6 (A6.5) and for impact analysis in WP13 (A13.1, A13.2, A13.3 and A13.5). All data collected will be included in the Data Management plan (D14.2 and its update D14.3).

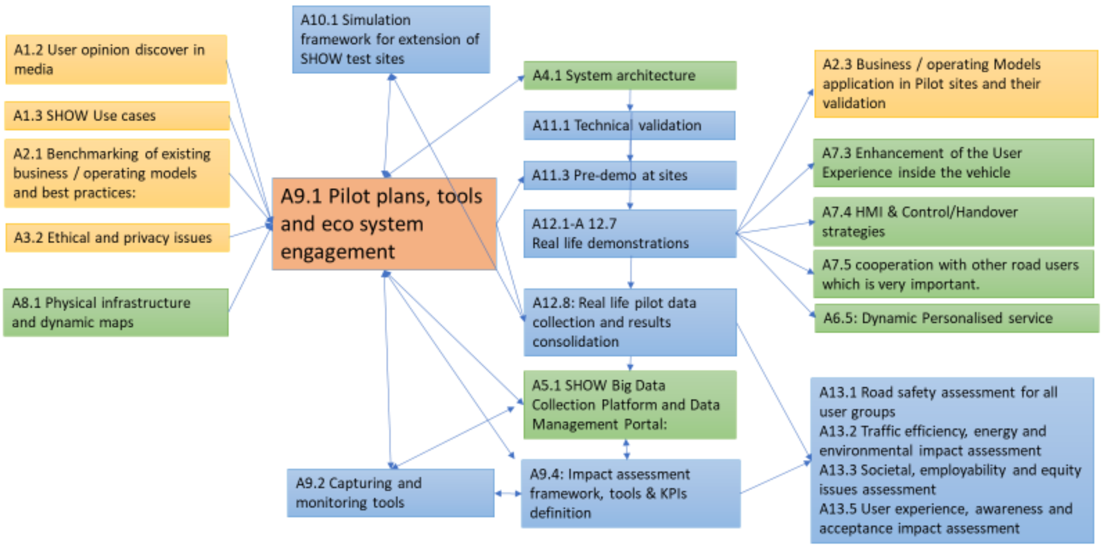

Figure 2: Interrelations between A9.1 (Amber) and other WP/A, different colour per SP (Yellow= SP1, Green=SP2 and Blue for SP3).

2 Methodological Approach

The methodological approach taken in this document is twofold. It presents both a **test and evaluation framework** and **impact assessment framework**. The former lays out the practical implementation of pilot plans, tools, and eco-system engagement (A9.1), as described in the first subsection, section 2.1. The latter prescribes a framework that facilitates the assessment of **specific** and **holistic** impacts, that are detailed in the next two subchapters, sections 2.2 and 2.3, respectively.

The test and evaluation framework considers the set-up, monitoring and data collection at the pilot level, based on the FESTA guidelines. The purpose is to set the foundation for the data collections that will take place at the pilot sites using the capturing and monitoring tools (A9.2), as detailed in the following chapters.

The generic evaluation methodology for the whole project and its layers is shown in Figure 3. The methodology encompasses several layers that to some degree are overlapping or interrelated. It starts with the investigation of the expectations of travellers and stakeholders and is completed with the final evaluation of the ecosystem (System of Systems; SoS). The results will contain the findings from the user tests (WP11 and WP12) (FESTA implemented methodology), the impact assessments (M3ICA methodology; WP13) and the simulations conducted within WP10.

The SHOW methodology has four main facets, as shown on the figure, from the top, in an anti-clockwise direction: The starting point is the Use Cases and their actors, research questions (RQs) and key performance indicators (KPIs), parametric methods and instruments, and scalable data exchange. More concretely, defining and implementing RQs and KPIs concerns this overall chapter, which is described in detailed, as this chapter develops.

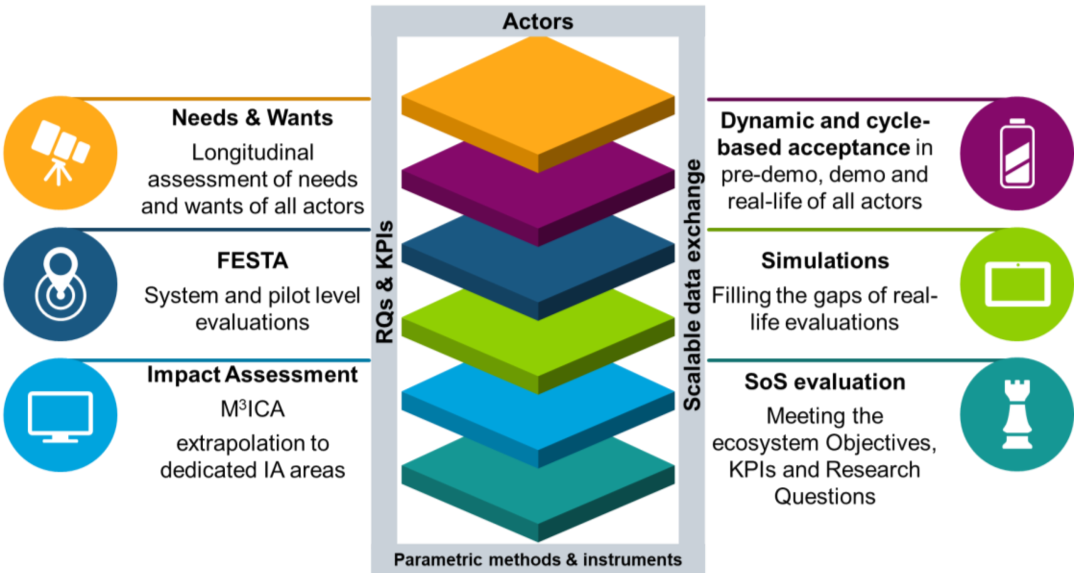

Figure 3: High-level description of the layers of the SHOW eco system evaluation framework.

2.1 Evaluation framework

The evaluation framework is defined to support data collections and evaluations both at demonstration sites and for simulations. A demonstration specific performance indicator framework is used, see also the ‘V-diagram’ in Figure 4. This work is mainly done in A9.1 – Plans for pilot evaluations. Data collections will be done under real life conditions in the demonstrations in relation to predefined Use Cases and research questions. The evaluation of demonstration-sites in SHOW implements the FESTA (Field 24ot24way24ed24 24ot24 24ot24way)[2] and the Trilateral Impact Assessment Framework [3]. The FESTA project developed a handbook on Field Operation Test (FOT) methodology to improve comparability and significance of results at national and European levels.

A FOT is defined as a study undertaken to evaluate a function, or functions, under normal operating conditions in road traffic environments typically encountered by the participants to identify real world effects and benefits. FOTs were introduced as an evaluation method for driver support systems and functions with the aim of proving that such systems can deliver real-world benefits. Although the FESTA methodology was originally developed for other types of functions than the transport systems and services evaluated in SHOW, the methodology provides a way of harmonising the preparations and evaluations across demonstration sites to facilitate a consolidated evaluation.

Figure 4 shows an adapted version of the FESTA methodology, i.e., the steps that will be carried out during the evaluations in SHOW presented as a V-diagram. The SHOW demonstration evaluation framework (D9.2) will focus on the preparation described on the left-hand side of the diagram. Chapters 4 to 9 of this deliverable will mirror the structure of the FESTA methodology, starting with systems and services identification, followed by use case identification, formulation of research questions, evaluation methods including KPIs and thereafter the specific capturing and monitoring tools for data collection at the demonstration sites.

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[2] FESTA handbook Introduction - FOT-Net WIKI (fot-net.eu) (date: 2021-01-04)

[3] https://connectedautomateddriving.eu/wp-content/uploads/2018/03/Trilateral_IA_Framework_April2018.pdf

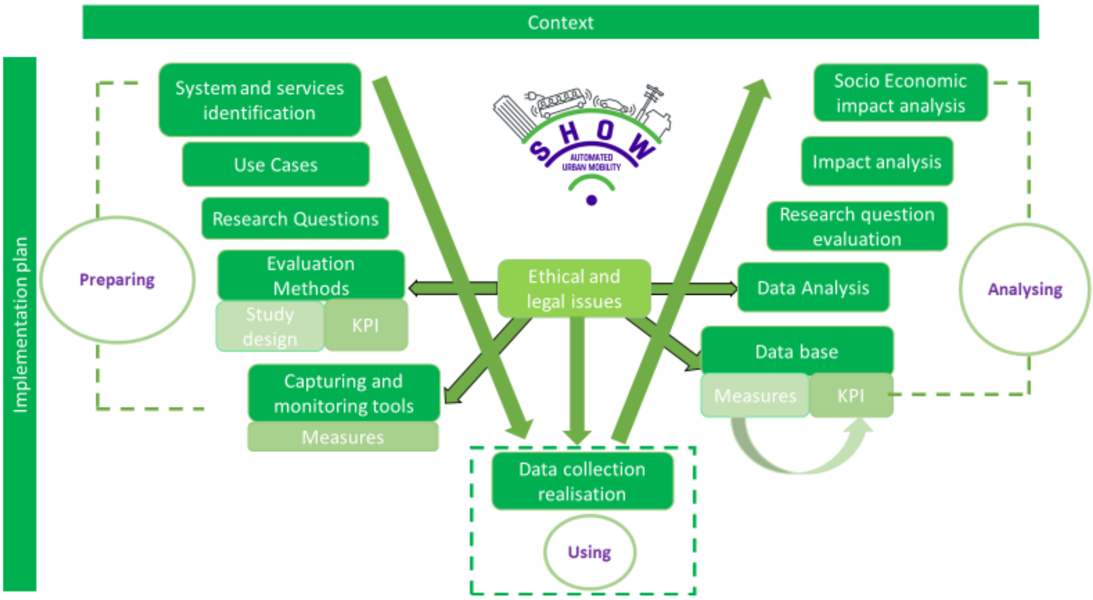


Figure 4: V-diagram modified from the FESTA handbook.

The evaluation approach also foresees simulations. They are done in WP10 – Operations simulation models' platform and tools, and will cover various kinds of simulations associated with urban mobility (see D10.1: Simulation scenarios and Tools). This includes traffic simulations on different levels, pedestrian simulation, public transport simulation and many other related simulations. Since it is not easy to combine so many different simulation methods under one roof, a classification of simulations was elaborated in WP10, which reflects the focus in SHOW.

As shown in Figure 5, the main distinction is made between "City/district level" simulations and "street level" simulations. The former is a more aggregated level with focus on larger areas, whereas the latter deals with individual movements of participants. The terms macro- and micro-simulation were deliberately not chosen as these are defined for traffic simulations and SHOW has a wider focus, which includes mobility of persons. On street level, simulations mainly cover three aspects: 1. Automated driving to simulate movements of automated vehicles, 2. Walking to simulate pedestrians and passengers, and 3. Taking a ride to simulate the behaviour of DRT and public transport.

The simulation methodology includes several stages and refinements. First, a small set of simulations will be carried out that covers all the main classifications of simulations as described above. These simulations will be linked to selected, concrete Pilot sites of SHOW. In a second round, the simulations will be refined and extended to a higher number of Pilot sites. The simulations will be aligned to the KPIs developed in WP9 and the simulation results will be fed to the impact assessment being conducted in WP13. More detailed information on the simulation framework will be found in deliverable D10.1.

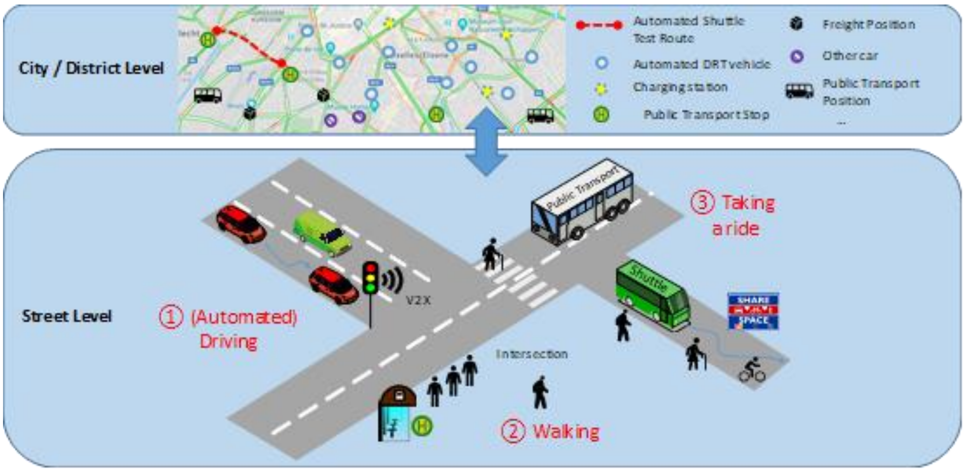


Figure 5: Classification of simulation activities in SHOW (according to D10.1).

2.2 Specific impact assessments within WP13

The overall SHOW eco-system impact assessment framework will include KPIs as calculated from the in-depth analyses from the different impact areas, and potentially non-processed KPIs collected from demonstration sites and simulations. As such, the overall impact analysis brings together the analyses done in the different activities of WP13:

- A13.1: Road safety
- A13.2: Traffic efficiency, energy, and environmental impact
- A13.3: Societal, employability and equality
- A13.4: Urban logistics
- A13.5: User experience, awareness and acceptance

The correspondence between the above impact areas and the holistic impact assessment performed in A13.6 is illustrated in Figure 6.

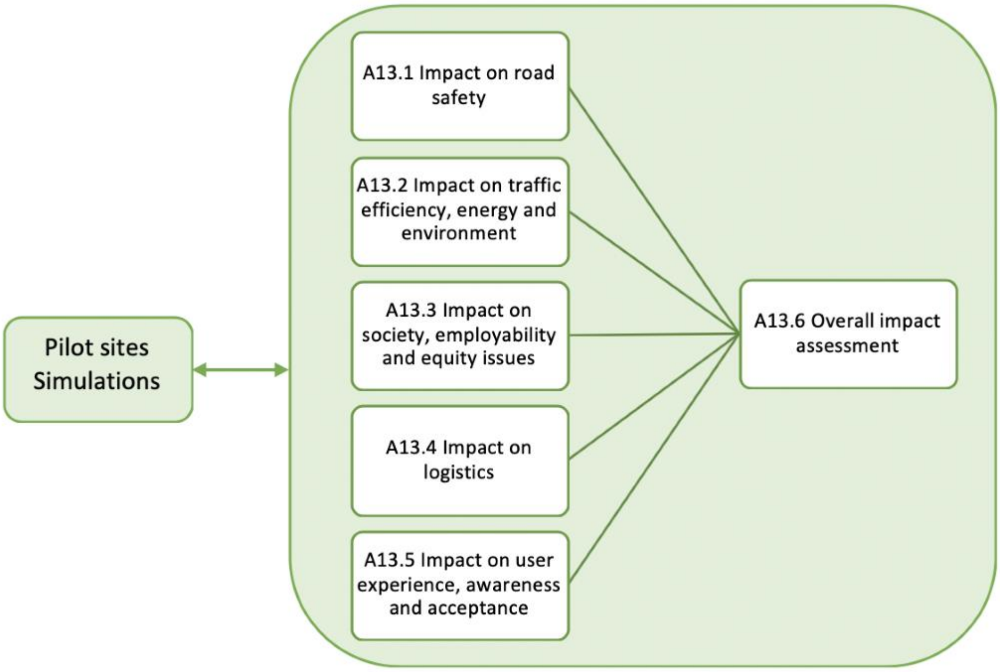


Figure 6: WP13 activities that perform specific and an overall impact assessment.

In the following subsections, specifications on the analysis for the activities 13.1-13.5 are discussed.

2.2.1 Road safety assessment for all user groups

Within task A13.1, in the first step, a review and investigation of the existing or simulated CCAV fleets with regard to their safety performance will be conducted and a more detailed description of the literature review can be found in the following paragraphs. The focus of literature will be given also from a perspective related to CCAV's impact on the road safety of all user groups. The data will be collected either from the pilots or from the simulation experiments. Utilizing the data derived from simulation tools and demo sites, results can be extracted related to findings from several different types of micro and macro simulation i.e., drivers, passengers, vulnerable road users, vehicles, PT, freight transport, network. With the purpose of producing an overall estimation of the impact that CCAVs will bring in the future on all user groups. The results aim to give insights exported from the developed assessment by providing the necessary data. All the steps of the proposed methodology (i.e., i) literature review, ii) methodology, ii) results) are analyzed in more detail in the following paragraphs.

NTUA leads this ongoing task A13.1 which consists one of the six actions of WP13. The beginning month of this action was deemed more appropriate by the partners to start earlier (prior to M30). Currently within this task, the necessary KPIs for the impact assessment as well as the data registry with regards to road safety were determined. These include the safety enhancement as well as road accidents and the number of conflicts per veh/km.

Literature Study

The literature review process aims to investigate findings related to the safety assessment methodologies across worldwide CCAV applications. In this review, previous knowledge obtained in the European projects of SAFETYCUBE and LEVITATE (within Horizon 2020 framework) is going to be exploited. The Decision Support Tool of SafetyCube (www.roadsafety-dss.eu) is going to be consulted for relevant risk factors, whereas the Policy Support Tool (PST) of LEVITATE (www.levitate-project.eu) and more specifically the impact assessment methodology followed is going to be strongly investigated and exploited. Especially, the impact assessment of the LEVITATE project is quite relevant since it was included and analysed wider impacts of CAVs through simulations. The relevance between SHOW and LEVITATE can be established as both project investigate connected and autonomous vehicles and assesses plenty of significant impacts through simulations. Specifically, the LEVITATE project focused on assessing the following CAVs impacts by using KPIs: i) Road safety, ii) Direct impacts, iii) Systemic impacts, and iv) Wider impacts. Therefore, this knowledge along with detailed methodological approach techniques can be directly exploited, whereas additions from recent literature can be introduced as well. By this, synergies would be created amongst the two projects throughout the various steps of the project (i.e., literature review, methodology, indicator analysis, results).

Methodology

Focusing on the methodology, the identification of the road safety KPIs was assisted and defined by interim discussions between WP9, 10 and 13 partners. These discussions included also aspects related to the simulations needed and the data collected in order for the corresponding partners to be aligned and on the same page. Furthermore, a first plan of the methodology for the impact assessment with regards to road safety was prepared. The first draft of the methodology contains the following steps:

- The first step is to connect the demonstration sites with the obtained KPIs. This will be accomplished by analysing the data, once they become available from simulations and pilots, so as to “cluster” critical and non-critical situations for each user group under different conditions (e.g., CCAV penetration rates, traffic and weather conditions, road geometry).
- At a later stage, the integration of the KPIs and data analytics to form a holistic road safety assessment protocol for all scenarios (as clusters of pilot sites and all the technical details are analyzed at step 2 in holistic impact assessment framework – Section 2.3.4) and user groups.
    - Estimation of a weighted score for KPIs per scenario for clustered pilot sites (or per each pilot site if it deems more appropriate .
    - Aggregation per scenario (or time/space if it deems more appropriate) as well as road user category.
    - Feature importance on KPIs to identify the most relevant for each user, scenario and match the KPIs with relevant stakeholders. Then, the stakeholders can exploit the extracted results.
    - Exploratory analysis and before-after designs to estimate the impact on road safety.
    - Extraction of a total score per scenario and road user based on the weighted scores for scenarios and road users.
- Validation of the safety assessment protocol on data from the real-world applications in SHOW.
- Consolidation of the safety assessment protocol for simulation calibration and development of deep learning models for prediction of events.

For each step of the aforementioned methodology, state-of-the-art statistical and machine learning algorithms are going to be utilized, in order to explain and predict the safety impacts of the SHOW use cases quantitatively. Finally, cross-pilot comparisons, as well as a comparison between the different scenarios, are going to take place in order to provide a holistic road safety assessment for all road users.

Results

Results of the safety assessment can also benefit the pilot implementation. The exported results of the road safety assessment will also assist demonstration sites by finding indicators or guidelines adapted to their needs in order to form proper decision-making policies and techniques with the total aim of road safety enhancement. By succeeding improved road safety levels in the demonstration sites, the higher public acceptance for CCAVs will be accomplished. Moreover, the results of this WP will be used to develop a database of critical and non-critical situations in terms of safety for usage either in simulative tests or for predicting critical events using deep learning and big data methods. Results will ultimately be used to create a report on the safety impacts of CCAVs worldwide as well as a database of representative critical events.

2.2.2 Traffic efficiency, energy and environmental impact assessment

The impact assessment for traffic efficiency, energy and the environment is based on two types of activities: pilots in the real world and simulations. The pilot tests reproduce actual interaction of CCAM concepts with traffic and environment in the real world that realistic CCAM impacts could be obtained. During the pilots, data will be collected to derive (mandatory, common and additional) KPIs regarding traffic efficiency (e.g. travel times, speeds), energy (energy use) and environment (typically vehicle emissions). Typically, these data are directly measured from vehicles. It does not only consider vehicle-related factors such as driveline dynamics, road frictions and aerodynamics, but also include randomness and heterogeneity in the operation of CCAM concepts such as shuttle bus waiting time at stops. Realistic operation of CCAM concepts could be revealed via pilots and deep insights into CCAM impacts could be achieved.

The simulations enable CCAM impact assessments to be conducted at a larger scale than the pilots and in scenarios which are difficult to be realized in pilots. Via simulations, impact assessment could be easily scaled up to a region or city level that benefits of CCAM concepts could accumulate and become significant. Well-facilitated environment or high market penetration rate could be ideally assumed in simulation in order to illustrate the maximum potential of tested CCAM concepts. Different types of simulations are available, from microscopic (each vehicle modelled separately) to macroscopic (traffic flows on a link are modelled without modelling each vehicle separately). The more detailed the simulation, the smaller the road network and number of vehicles that can be simulated, considering computation efficiency. Depending on the type of CCAM concept tested, one or the other is more suitable for analysis, as different choices of travellers are affected (e.g. mode choice, mileage, route choice, following and lane change behaviour). Simulation models vary in the extent to which they can model certain choices.

Literature Study

Traffic efficiency, energy and environment are crucial areas to be investigated when a new mobility system is introduced in transportation systems. Evaluations of the changes in traffic efficiency, energy and environment are able to provide insights into the interaction between the introduced mobility system and existing transportation system, revealing the cost and benefits of new system applications. These insights are beneficial for policy makers and road operators in making decisions on future transportation systems, and also beneficial for car manufactories to redesign/refine their vehicle driving systems.

The overall impact assessment follows the general FESTA-V procedures. System functions, use cases, research questions, performance indicators and data measurements are defined before the data acquisition in field tests, and data analysis, hypotheses testing, impact assessment and cost-benefit analysis are conducted after field tests. Impact assessment in A13.2 is a combined work of research questions, performance indicators, data analysis, hypotheses testing and impact assessment, based on the use cases defined in D1.2 and impact assessment scenarios defined in WP9. Additional insights will come from the WP10 simulation results regarding traffic efficiency, energy and environment.

Methodology

Impact assessments of traffic efficiency, energy and environmental impact will be conducted at three levels, being vehicle level, street level and city level. These three evaluation levels are categorized by different data resources, modelling tools and evaluation scopes at individual vehicle, road bottleneck and city network. Vehicle level impact assessment is highly correlated to the diverse vehicle pilots in SHOW demo sites, while the impact assessments at the street level and city level are correlated to traffic simulations in WP10. Research questions, hypotheses and KPIs are designed independently for all three levels to investigate the impacts of a new mobility concept.

Pilot-based impact assessment

Vehicle-level impacts assessment focuses on the operational characteristics of automated driving systems in reactions to various traffic scenarios. Characteristics such as average speed, acceleration variance and stopping manoeuvres are to be exanimated and they are measurable in real-world pilots. The main research question to be answered by the vehicle-level impact assessment is "Does the pilot vehicle operate efficiently with low energy use and emissions on the pilot route?" and corresponding KPIs are listed below:

- Average speed of pilot vehicles
- Acceleration variance of pilot vehicles
- Number of hard braking events
- Number of non-scheduled stops*
- Number of scheduled stops*
- Service reliability, measured as punctuality for vehicles and passengers
- Number of passengers in pilot vehicle
- Kilometres travelled in pilot vehicle
- Energy use per kilometre of vehicle
- Emissions of a pilot vehicle (CO_2, PM, Nox)

Note: a scheduled stop refers to the vehicle stops for picking up and dropping off passengers, as well as that of fixed-route service at bus stops. The vehicle stops other than scheduled stops are non-scheduled stops. The non-scheduled stop includes the stops for stop signs, traffic lights and traffic congestion or crossing traffic, etc.

These KPIs require direct measurements of vehicle speed, acceleration, distance travelled and passenger number with time stamps and GPS locations. The data needs to be aggregated to the level of part of a trip, namely between two scheduled stops. The data aggregation (KPI calculation) between two scheduled stops should exclude the influence of the scheduled stop frequency in different vehicle pilots and make the KPI comparable across the demo sites. Between two scheduled stops, we focus on the duration that the vehicle has been in normal operation status, i.e. excluding the acceleration and deceleration phases near the scheduled stops. In the illustration below, the blue range is what we consider for calculating KPIs.

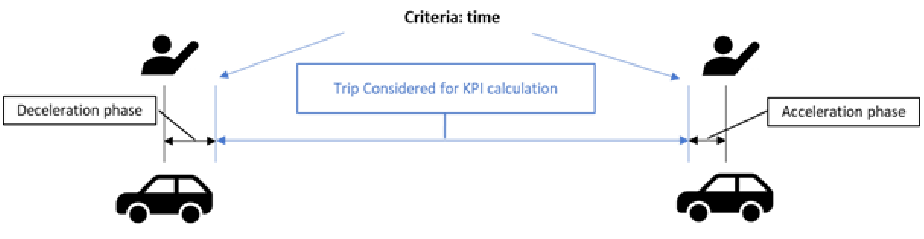


Figure 7: Measurement of Time between Acceleration and Deceleration Phase.

The criteria to identify a normal operation could depend on time (e.g. peak vs. off-peak period). Before calculating the KPIs for the part of a trip between two scheduled stops, the average time needed for a tested vehicle to accelerate from zero to expected operational speed and to decelerate from expected operational speed to standstill should be measured/calculated. The measurement data within the acceleration and deceleration phases should be excluded from calculating the KPIs.

The KPIs will be quantitatively analyzed in the following steps:

- Step 1: descriptive statistics of all KPIs for all sites (cross-site evaluations)
- Step 2: data are split up by impact assessment scenarios and situational variables where deemed interesting
- Step 3: explanation analysis by correlation graphs between two or three Pis and investigate specific pilot's circumstances (situational variables, description of pilot)
- Step 4: (optional) sensitivity analysis, depending on data quality.

Simulation-based impact assessment

Impact assessment at street level and city level aim to investigate the collective flow characteristics in an environment of mixed automated driving and conventional vehicles. Due to the lack of information about conventional vehicles, impact assessments at these levels are often conducted in a traffic simulation environment. Street-level impact assessment scopes at road segments and intersections and characteristics such as segment throughputs and intersection delay are investigated by modelling individual objects and their interactions. City-level impact assessment aims for the impacts on transportation systems such as modal split and network flow performance. Simulation-based impact assessments are designed to explore the impacts in extended traffic scenarios with controlled experimental variables and large-scale road networks that are often infeasible in vehicle pilots.

Research questions of street-level assessment are:

- **Traffic efficiency**: how do the pilot vehicles impact traffic flow performance at different vehicle market penetration rates?
- **Energy**: how does the introduction of pilot vehicles impact the average vehicle energy use at different vehicle market penetration rates?
- **Environment**: how does the introduction of pilot vehicles impact the vehicle emissions at different vehicle market penetration rates?

The KPIs of street-level assessment are:

- Average vehicle speed per vehicle type
- Average travel time delay per vehicle type
- Number of vehicle stops per vehicle type
- Number of hard braking events in traffic
- Total vehicle delays in an intersection
- Average energy use per kilometre per vehicle type
- Average vehicle emissions per kilometre per vehicle type (CO_2, PM, Nox)

Data needed to calculate the street-level KPIs includes simulated individual vehicle trajectories (i.e. position, speed, acceleration with timestamps) and estimated energy use and vehicle emissions based on that. The simulated and estimated data should be sampled at a frequency of an hour and they will be aggregated to an average value per vehicle type.

Research questions and KPIs of city-level assessment are:

- **Traffic efficiency**: how does the new mobility system impact the overall network performance?

- **Energy**: how does the introduction of the new mobility system change the overall energy consumption of vehicles?
- **Environment**: how does the introduction of the new mobility system impact vehicle emission, air quality and traffic noise?

The KPIs of street-level assessment are:

- Total travel time in network per vehicle type
- The modal split in number of trips or distance travelled
- Total number of kilometres travelled in a network, per mode of transport and/or trip purpose
- Average travel time delay over the entire network
- Average vehicle speed in a network
- Number of trips in the network, per mode and/or trip purpose
- Total amount of vehicle energy use
- Total amount of CO_2 emissions
- Concentrations of pollutants (e.g. Nox) along roads
- Noise levels along roads

KPIs at city-level assessment require inputs of simulated trips of individual travellers in time and space and estimated energy use, CO_2 emission, concentration and traffic noise (subjecting to the modelling capability of simulation tools). The sampling frequency is one hour and the KPIs are calculated for each vehicle type, transportation mode or trip purpose.

Quantitative analysis of simulation-based impact assessment KPIs will be performed for each simulation activity to describe the impact of particular simulation variables. Comparisons of different simulations will be challenging since simulation experiments are designed for various goal/research questions by the site owner/partner. The analysis of a particular simulation is expected to provide additional insights into one or several factors of traffic efficiency, energy and environmental impacts. These factors will be categorized and discussed in three simulation scenarios defined in WP 10: (1) simulation of automated shuttles on fixed route; (2) DRT-simulation and (3) simulation of public transport stops. The scenario of public transport stop simulation will be excluded from traffic efficiency impact assessment since vehicle movements within a public transport terminal are not within the scope of traffic flow.

Results

The output of traffic efficiency, energy and environmental impact assessment has two parts: (1) cross-site evaluation and comparison of vehicle demonstrations and (2) factor analysis from efficiency, energy and emission aspects in typical SHOW impact assessment scenarios. The quantitative method will be used to analyse the large amount of pilot and simulation data to achieve statistical results. Correlation and explanatory analysis will be conducted for the cross-site evaluation and factor analysis, followed by discussions and general conclusions. Subjecting to the data availability and quality, sensitivity analysis of efficiency, energy and environmental factor is optional.

2.2.3 Societal, employability and equity issues assessment

The approach within A13.3 is going to focus on the development of a dedicated analysis to assess the scope and magnitude of the impact of CCAVs on mobility related occupations. Our aim is to produce a dedicated study that will provide a vision and strategy for the EU mobility ecosystem to adapt its value chain to effectively respond to the impacts of automation on jobs and employment.

Literature Study

The following references are used as a basis for the societal, employability and equity impact assessment:

- Ecorys*:* Study on exploring the possible employment implications of connected and automated driving. *https://www.ecorys.com/sites/default/files/2021-03/CAD_Employment_Impacts_Main_Report.pdf*
- Delphi study*: http://theijes.com/papers/v3-i4/Version-4/B03404008013.pdf*
- Overview of the jobs associated to public transit: *http://istas.net/descargas/guia%20movilidad%20200.pdf*

Methodology

The impact assessment will extrapolate the ideas generated in the pilot sites. For example, if the pilot sites can show that 1 shuttle will generate or replace X amount of jobs, this will be used to generate a quantified estimate of job impact that can be scaled out to other cities. Initially the pilots will be looked at independently, and if some common trends are identified between the different sites (Eg. Economic environment), some cross pilot assessment can be made. The different business models used in the different demo sites may also give an indication of different levels of job loss or gain, and will be taken into account when the extrapolation is done.

The interviews done with the stakeholders in the pilot sites can also include a few relevant job loss/gain questions to feed into the assessment. E.g., shuttle producers can be asked about job creation numbers.

The main KPI of the simulations sites that is relevant is **how many people using automated vehicles, and how many vehicles are deployed**. This will inform the deployed capacity which will inform the job gain/loss based on the pilot sites.

Results

The impact assessment will predominantly use the findings from the demonstration sites/simulations to extrapolate an understanding of job loss/gain that can be transferred to any city that is implementing a CAV programme.

Furthermore, the qualitative assessment of job types that will be impacted will ascertain outlier professions that CAVs will impact that may not be taken into consideration within the demo sites. This will be generated from the Delphi study. We will also review and liaise with SKILLFUL deliverables and partners to build from the work already done. For instance, Deliverable D1.1: Future scenarios on skills and competences required by the Transport sector in the short, mid and long-term, and Deliverable D3.1: Proposed future training curricula and courses for the Transport sector. This will inform us on the current state of the art of knowledge in the areas of job opportunities and equity issues.

The objective is then to produce a Delphi study, by conducting 2-3 rounds of set interviews (30+) with relevant experts and stakeholders to assess the scope and magnitude of the societal, employability and equity issues associated with CCAVs. This can include discussions with a few select stakeholders outside of the mobility sector in more mature industries (e.g. Manufacturing) where crossover of ideas may be identified to inform a better scenario. We will also work to setup an online workshop based on results of the Delphi and KPIs.

We also aim to present and discuss the findings from the interviews to further specify likely future scenarios with select interviewees, but also to discuss some of the outliers which may have been cut out in the initial interview rounds.

Though the Fuzzy Delphi Method will be used to reduce the ambiguity, diversity, and discrepancy of the opinions among the experts, we may also employ a sensitivity/uncertainty analysis to reduce the same uncertainty within the data from the pilot sites. This will be dependent on the amount of data received, to be determined if useful at a later date.

2.2.4 Impact assessment on logistics

The impact assessment of intelligent or automated logistics services performance is a complex process that is required to point out the service type, the stakeholders involved and their engagement level, as well as the application/demo sites' particularities and objectives (expected outcomes).

For the availability of various aspects and decision making, the logistics indexes are more convenient for the proposed logistics assessment framework because the indexes are able to capture these different aspects and to provide a full outline of the status of the systems and support decision making.

Therefore, the index-based assessment approach is designed, and various specific evaluation criteria and indicators are considered. This activity refers to an impact assessment framework that consists of three indexes: logistics sustainability index, logistics maturity index and logistics transferability index. In particular, such a framework allows different logistics systems to be assessed. For example, the impact assessment on Automated Logistics as a Service (AlaaS) is modeled, developed, and tested during the project demo cases of Trikala, Karlsruhe, Carinthia, Brno, and Gothenburg. For this purpose, the developed assessment methodology is designed in order to point out the implementation of the automated logistics services during the demo cases, showing impacts at a different level, including sustainability of the application (business, social and environmental), maturity as for innovation (Logistics 4.0 paradigm) and transferability.

After that, the assessment framework has various components that are the following:

1. Impact areas
2. Stakeholders involved
3. Objectives and Use Cases
4. Performance indicators
5. Demo Sites (pilot cities)
6. Indexes

Furthermore, as mentioned before, the three indexes are implemented in the assessment and evaluation procedure of the impact assessment framework during the project demo cases; the highlighted indexes are:

- The Logistics Sustainability Index refers to an integrated assessment method to quantify the sustainability performance indicators of the freight transport and/or logistics based on various criteria.
- The Logistics Maturity Index is looking for the maturity models that are tools for being defined to understand the logistics sector, by using indicators, concerning measuring, comparing, describing, or determining a path or roadmap of the highlighted issue.

- The Logistics Transferability Index is responsible for the knowledge and experience exchanging between one application that has been applied in one time and/or one zone, and another.

Literature Study

a. Logistics Sustainability Index

The concept of sustainable logistics stems from the idea that urban freight transport and city logistics can contribute enormously to reducing congestion and emissions in city centres. Logistics solutions and measures can be evaluated on the basis of their specific objectives or expected effects (Novelog, 2016). The assessment of their impact is usually undertaken using a multicriteria approach (e.g. Macharis et al., 2014) or an economic assessment like cost-benefit analysis (e.g. Holmgren, 2019).

An evaluation framework to assess sustainability of city logistics have been proposed initially by Nathanail et al. (2016), following a multicriteria approach, and then further developed in Nathanail et al. (2018). The framework is based on 7 impact areas, namely: Economy and energy, Environment, Society, Policy and measure maturity, Social acceptance and User uptake. For these seven areas 26 related criteria and 140 indicators are identified (Nathanail et al. 2018). The approach considers the involvement of different stakeholder categories, so it can be considered a multi-stakeholder multi-criteria decision making framework.

An integrated performance index, the Logistics Sustainability Index, can be estimated, which can be adapted to different type of logistics solutions and has been tested and used in Sulpiter (2017), Comi et al. (2020) and Nathanail et al. (2021). This index will be used also for the impact assessment of SHOW logistics solutions.

b. Logistics Maturity Index

The Logistics Maturity Index is used to describe the comprehensive digitalisation and networking of all logistics objects in an autonomous, logistical system. The calculation method is based on the Fraunhofer IFF's stage model of Industry 4.0. The model consists of five stages: standards (stage 1), big data (stage 2), smart data (stage 3), dark factory (stage 4), industrial ecosystem (stage 5). In the beginning, the general business case information is requested. Then the data for determining the degree of maturity are collected by using multiple-choice questions.

The adoption of Industry 4.0 technologies becomes significantly important for organisations in order to optimise the production processes and organisational structures. However, some organisations may have various difficulties to implement a significant plan that would be a path for getting technological business and service providing concerning Industry 4.0 concept. The Industry 4.0 concept has also brought some uncertainties for logistics service providers and freight transport suppliers concerning supply chain management, and processing; so that, the technology implementation strategies and operational adaptation are quite critical to obtain more intelligent, efficient, and sustainable logistics services. For this reason, the Industry 4.0 applications would be assessed and searched by a developed maturity model concerning logistics services and freight transport (Facchini et al., 2019).

According to Facchini et al. (2019), the term "maturity" refers to a "state of being complete, perfect, or ready". Based on this definition, a maturity model would be an assessment tool for the Logistics 4.0 implementation concerning measurement, description and definition, and a guideline for further applications. The maturity model is designed and developed consisting of various parameters that provide an approach from immaturity process to maturity process considering more effective and qualitative processing; so that, the maturity would be obtained as qualitative or quantitative with a discrete or continuous manner. For this purpose, the maturity models would be adopted to assess the state of logistics service or a logistics service provider, in accordance with various indications by maturity models in order to obtain sufficient outcomes concerning the beginning of the technology implementation on the logistics services processes. As an example of the maturity index processing, the maturity model would have a continuous approach that provides maximum flexibility since it leads to improving the efficiency of a logistics process and/or on various impact areas asymptotically aligned with the logistics sector objectives pursued. The capability maturity model integration adopts predefined sets of multiple process areas to define an improvement path. Each logistics improvement on the process would be mentioned by maturity levels, each one of the levels requires a set of defined process areas. The index approach involves a structured and systematic path to reach a certain level of maturity. The achievement of a level ensures the necessary maturity for moving to the next level.

The logistics-related maturity levels would be highlighted as follows: the first level, which is "ignoring of the technology" identifies the absence of any Logistics 4.0 capability, and the fifth level, which refers to the integration of the technology, identifies the full implementation of Logistics 4.0 solutions; so that, all logistics maturity levels would be (orderly) "Ignoring – Defining – Adopting – Managing – Integrated".

After that, the evaluation areas in the logistics sector are required to be defined concerning each Logistics 4.0 dimension that would be highlighted such as management, the flow of the material, and the flow of the information. The data collection for the logistics maturity index would be done by a questionnaire concerning various questions based on the use of technology, automation level, logistics processing, environmental and socio-economic improving, etc. After the data collection process (done by questionnaire), the weighting of the logistics evaluation areas would be evaluated.

The data collection and weighting continue with the next step which is the quantification of each result according to the weighted average of all maturity index parameters within the related dimensions. Therefore, a numerical interval was assigned to each maturity level according to the criteria defined before. The results collected by the questionnaires would allow the achievement of the predesigned objectives as the evaluation of the maturity level for Logistics 4.0 related implementations. As the last step of the maturity index process, questions of the questionnaire would be analysed by qualitative and quantitative as indicating assigned numbers to be highlighted concerning the perception of their importance or critical points.

The last step of the evaluation consisted of the overall estimation of the weighted average of all maturity items/questions.

Tubis et al. (2021) proposes a scheme for Logistics Maturity Modeling. For such study, a developed logistics maturity assessment method processes a risk management, and an assessment procedure, which is formulated, includes a two-stage analysis process: (1) A detailed assessment based on a 5 defined evaluation area assessment, and (2) an overall assessment based on the maturity indicator for operational risk management of Maturity Level. For this case, the maturity index assessment process is shown below:

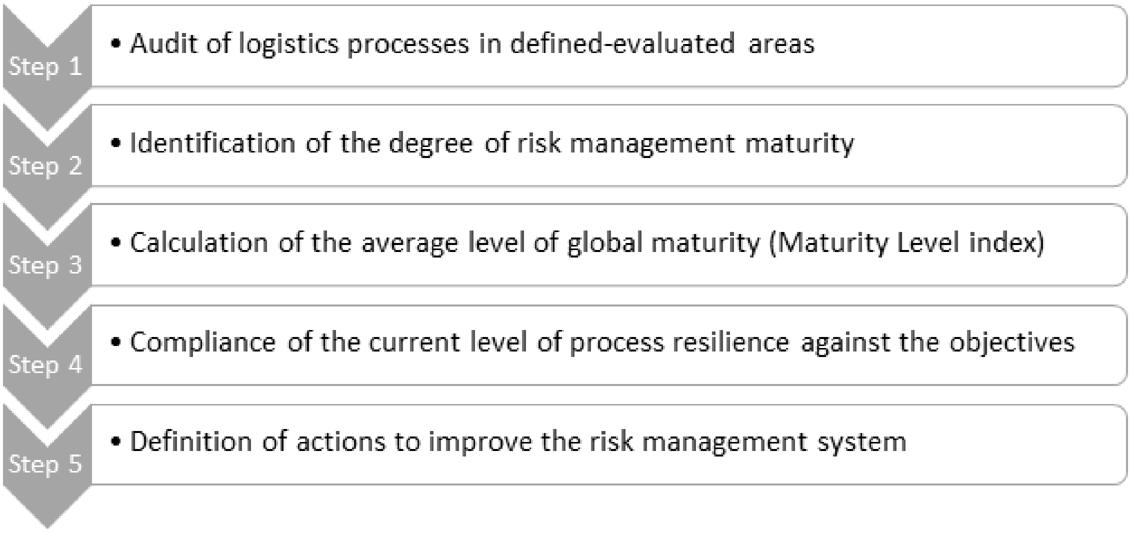


Figure 8: Maturity index assessment process (from Tubis et al., 2021).

In Behrendt et al. (2018) the term Logistics 4.0 is considered as a reference to provide a comprehensive automated networking of all logistics processing in a service provider. Additionally, Logistics 4.0 includes production process, logistics transports, service planning such as loading/unloading, appointments to pick-up, etc.

Accordingly, the Logistics 4.0 stage model would have the following four stages: Standards (data collection), Networking (communication), Logistics as a Service, and Logistics 4.0.

c. *Logistics Transferrability Index*

The Logistics Transferability Index involves a multi-step analysis process to qualitatively give a dimension to the propension of the logistics automated application to be successfully transferred in other urban contexts and according to what conditions. The first step concerns the detailed description and characterisation of the receptor city, the second consists of a benchmarking analysis of eventual similar context, the third deals with the definition of the automated applications that can be valid of the receptor city including a general assessment on specific criteria identified by the city itself.

The Logistics Transferability Assessment interests a policy-knowledge exchange between similar sites across Europe. As Marsden and Stead (2011) state: "examples from elsewhere are often seen by politicians and civil servants as a quick, cheap and/or simple means to solve their policy problem without reinventing the wheel where solutions to problems already exist". Furthermore, logistics transferability refers to a logistics-related procedure or service policy-knowledge, about logistics management, transport, procedure, digitalization, etc., exchange to provide an aspect for problems of the service to enhance the logistics service conditions in another site and/or time. The main concept of logistics transferability is "exchange the solutions-based policy-knowledge that would be efficient, sustainable, and problem-solver for new technology implementation between one successful implementation to other concerning characters of the sites and potential barriers".

In particular, one site wishes to implement new technology or procedure of logistics service, which should be assessed concerning various criteria, to increase the active situation by taking into account another successful implementation based on particular features and similarities with analysing difficulties.

The Transferability Index approach requires various assessment processes considering implementation, evaluation and assessment in order to provide a sufficient policy-knowledge transfer from the origin site to the destination site as city-to-city, municipality-to-municipality, region-to-region, etc. To do this, various assessment methods (measures, solutions, etc.) would be developed concerning transfer-practices between similar sites, and highlighting the possible barriers that would affect the policy-transfer process; so that, the characteristics of both origin-destination sites are required to be analysed.

In the literature, Dolowitz and Marsh (1996) highlight seven main questions to be asked for the policy transfer process as follow:

1. What is transferred?
2. Why do actors engage in policy transfer?
3. Who are the key actors involved in the policy transfer process?
4. From where are lessons drawn?
5. What are the different degrees of transfer?
6. What restricts or facilitates the policy transfer process?
7. How is the process of policy transfer related to policy ‘‘success’’ or policy ‘‘failure’’?

After that, the study from Macario and Marques (2008) develops a transferability assessment framework for sustainable urban mobility measures; moreover, the method is taken into account for the designing of an assessment framework for the Urban Logistics Transferability in the TURBLOG project (EU FP7 project). This mentioned TURBLOG project refers to a logical framework for urban logistics transferability as represented below (Andrea Campagna, Discussion Paper of LIMIT4WEDA, 2013):

- Step 1 – Diagnostic of the problems,
- Step 2 – Characterisation of the city,
- Step 3 – Analysis of the city context and implications of problems identified,
- Step 4 – Look around for similar contexts,
- Step 5 – Selecting examples of source urban contexts,
- Step 6 – Identify measures with the potential for transferring,
- Step 7 – Packaging and dimensioning the measures for transferring,
- Step 8 – Ex-ante assessment of measures to transfer,
- Step 9 – Identify the need for adjustment,
- Step 10 – Implement measures and steer results.

The study from Kijewska and Iwan (2019) refers to an implementation process that would be analysed according to three approaches that are: creation (developing completely new solutions from scratch), transfer (direct copying of practically proven solutions), and adaptation (transferring practically proven solutions while making changes that mainly depend on the implementation environment).

For the logistics policy transfer and adaptation, the policy is needed to be sampled and modelled based on the similarities between sites and a set of assessment methods that would be analysing the logistics policy by using the in-depth evaluation method considering different indicators and parameters. The logistics process policy implementation requires several measures that would be applied before-during-after the implementation to monitoring current situations and conditions in the sites. This analysis targets to highlight the problems-solutions and characteristics of both sample and implementation sites to provide a better well-adapted policy that has a set of potential solutions for logistics-related problems (Kijewska and Iwan, 2019).

The approach requires a workshop with stakeholders from the receiver city to discuss the potential of transferability, success factors and barriers of the measures identified in the package(s) of step 7. If it’s not possible to organize a workshop, interviews should be carried out with responsible policy-makers and/or logistic experts in the city.

Methodology

a. *Logistics Sustainability Index*

The Logistics Sustainability Index (LSI) is based on a Multi-Criteria Decision Analysis technique, and is calculated according to a five steps process (adapted from Sulpiter, 2017):

1. *Application*: Specification of demo case with main performance characteristics;
2. *Impact areas*: Selection of the impact areas (e.g. economy and energy, environment, transport and mobility, society, policy and measure maturity, social acceptance and user uptake) depend on the objectives of the stakeholders;
3. *Performance indicators*: Selection of the indicators for each impact area, measurement methods and data collection sources (direct, indirect, estimation, quantitative, qualitative);
4. *Weighting*: Estimation of weights for combining the criteria through e.g. Analytical Hierarchy Process (AHP) method. Such a task foresees the involvement of stakeholders of the demo case;
5. *Index*: Normalisation and harmonisation of the measurements of indicators and calculation of the overall index.

The index is calculated before the implementation (ex-ante) and after the implementation (ex-post) in order to compare the benefits obtained globally. Therefore, the LSI may thus evaluate one or more impact areas jointly and becomes useful when a comparison between the current status and a potential scenario is required, or when two potential scenarios have to be compared.

Given an impact area (e.g. energy consumption, pollutant emission), the related LSI_i is computed as follows (Novelog, 2016, Comi et al., 2020):

$$LSI_i = \sum_m I_m w_m$$

where $\boldsymbol{I_m}$ is the normalised value of indicators ***m*** with a minus or plus sign, according to its contribution to the sustainability (i.e. positive if the benefit, negative if costs); ***Wm*** is the weight given to the impact area indicator/metric ***m*** which can be estimated for example using AHP or a Delphi approach.

$$LSI = \sum_i LSI_i w_i$$

Where w_i are the weights of the impact areas, computed in step 4.

b. *Logistics Maturity Index*

For the sake of clarity and completeness of the approach, the approach by Facchini et al., 2019 will be taken as a reference. The Maturity Index MI is calculated as a weighted average of all maturity items/questions in accordance with the following equation:

$$M_D = \frac{\sum_{i=1}^{n} M_{DIi} * g_{DIi}}{\sum_{i=1}^{n} g_{DIi}}$$

Where:

M = maturity, D = dimension, i = item,

g = weighting factor, n = number of maturity items

c. *Logistics Transferability Index*

After a preliminary literature review to highlight existing of logistics transferability processing, the proposed logistics transferability assessment considers the following steps:

1. **Characterisation of the Site (cities, regions, etc.)** refers to have an overview of the city that would be interested in the transfer of the logistics policy concerning population, density, area, socio-economic situations, etc.,
2. **Analysing the Urban Logistics Problems** highlights the problems related to logistics such as traffic-load, a lack of the parking area for loading/loading, etc.,
3. **Analysing of the Logistics Stakeholders** aims to identify operational responsible persons considering customers, senders, receivers, drivers, carriers, managers, etc.,
4. **Searching of the Similarities and Risks/Barriers** targets to define the similarities between reference and implementation sites with also mentioning possible policy-transfer barriers or risks,
5. **Identification of the Impact Areas and Indicators** focuses on the definition of the impact areas, such as environment, safety, efficiency, and performance indicators, to measure the policy efficiency and monitoring, that are related to logistics processing and policy transferability,
6. **Measures and Sources** are used to have an analysis for the reference site and implementation site based on problems measurements,
7. **Assessments and Evaluation** analysis the theoretically-transferred policy and its potential outcomes concerning impact areas and performance indicators, and
8. **Sources-Destination City Similarity Level Analysis** is the last step of the logistics transferability process that works out to compare the transferability index consisting of applicability of one successful logistics policy, from source site to the determined implementation site.

Similarly to the LSI, the LTI will be a weighted mean:

$$LTI = \sum_i I_i w_i$$

where $\boldsymbol{I_i}$ is the normalised value of indicator **I** and $\boldsymbol{w_i}$ is the weight given to the impact area indicator/metric ***m*** estimated for example using AHP or a Delphi approach.

Results

The output of the index-based logistics impact assessment is then three quantitative indices representing the performance of the services in sustainability, transferability, and maturity.

2.2.5 User experience, awareness and acceptance impact assessment

Within A13.5, appropriate methods for user experience research will be selected from a methods toolbox. The detailed approach for the user research will largely depend on the results that will be accomplished in SHOW from the beginning of the activity. Potential methods are user workshops, mobility diaries, online surveys, (telephone-)

interviews, participating observations, usability / UX–- testing of devices, Social media content analysis or a discrete choice experiment. These methods can be used to derive closer insights from a user perspective, e.g. with regards to the mobility systems in the test sites. User experience, awareness and acceptance is materialised in WP12 pilots but is also tackled in an iterative way in the context of A1.1 in order to feed (apart from the specific SHOW pilots results) an important side result of the project which is the shared CCAV stakeholders' needs and wants.

The KPIs retrieved from the user assessment will mainly understand users' concerns and describe the user'' willingness to use the deployed solutions. As such, they will mainly be useful to show the potential of the new offers to shift modes from motorised individual transport to public transport offers. This information can as well be used to extrapolate the usage of the new offers to bigger regions. As well, they will describe the attitudes of users and as such they can help in improving the offers.

Literature Study

The impact assessment on user experience, awareness and acceptance will mainly be based on the evaluation framework for the pilots developed in WP9. Other research projects and publications on the subject of autonomous DRT shuttles, e.g. those with participation of DLR at different demonstration sites in Germany, will provide additional input for elaborating the methodology in A13.5. A detailed literature study will follow with further development of the A13.5 methodology.

Methodology

In A13.5, a post-demo evaluation of user experience, awareness and acceptance will be carried out, replicating the travellers' extended questionnaire, the acceptance questionnaire and interviews from before (T1) and during (T2) the demo phase. Results from T1 and T2 will be used as a reference against which the evolution in the KPIs will be assessed. This activity will start at the beginning of 2022 and will end with the submission of the deliverable D13.5 in August 2023.

A13.5 will use and assess the following KPIs, defined in WP9:

- Traveller acceptance
- User reliability perception
- User safety perception
- Travel comfort
- Perceived usefulness
- Willingness to pay
- Willingness to share a ride

Further KPIs may be defined in the course of refining the methodology of A13.5.

Relevant data for analysis of the KPIs will be collected by engaging with users at the demo sites. For this purpose, the questionnaires and interviews developed in WP1 will be used and, if necessary, the wording of questions and measurement scales will be modified to fit with the post-demo phase. To ensure that the results are comparable across the different points in time, the questionnaires and interviews will be kept as close as possible to the versions used at T1 and T2.

A cross-site comparison regarding the KPIs stated above will be carried out.

The need for additional site-specific activities, such as user interviews or on-site behavioural observations, will be determined in parallel with the beginning of the demo phase in 2022. These activities will be planned according to the development of the specific CCAV services and use cases at the demo sites.

Results

The impact assessment will yield both qualitative and quantitative data that will be used assess any adaptations in users' attitudes and behaviour over the course of the demo phase. The exact type of data analysis will be specified along with further specification of the data collection method and, hence, the type and measurement level of the ensuing data.

2.3 Holistic impact assessment framework

The goal of the holistic impact assessment framework is to assess the impacts of automation in different scenarios (as described later) by subjective stakeholder analysis, as well as objective measurements based on pilots and simulations. For this purpose, we introduce the M3ICA framework which brings together these different components. Within WP13, as described in the previous section, detailed impact assessments are performed for specific impact areas. The detailed impact assessment will aggregate KPIs from demonstrations and simulations to draw conclusions on a specific impact area. If the detailed impact assessment results in an impact index, this will further be incorporated in the M3ICA scoring. The scope of the detailed impact assessments will be on scenario level, with individual pilot sites grouped by scenario, as will be that of the holistic impact assessment.

2.3.1 Introducing and justifying the M3ICA

Real-world demonstrations and simulations of AV services are becoming more advanced and applied in more cities across the world (Barnard et al., 2016; Stocker & Shaheen, 2019). This trend is made even more evident by the SHOW project. As a result, impacts from a mobility system where aVs play a greater role can be better understood (Elvik et al., 2019; May et al., 2020). Therefore, a holistic impact assessment framework should incorporate objective data and measurements from real-world demonstrations.

AV services and operational models are increasingly being tested on wider scale, longer-lasting pilots. These pilots are based on more concrete scenarios describing aVs' integration into city transportation system (Litman, 2020; Narayanan et al., 2020). Consequently, concrete scenarios that support robust comparative analysis are a requirement for this framework.

Authorities increasingly aim to consider the interests, concerns, and insights of stakeholders (Cohen et al., 2018; Graf & Sonnberger, 2020; Legacy et al., 2019). As a result, a holistic framework needs to embed viewpoints from stakeholders or actors in relation to criteria that they use to measure the performance of scenarios.

In this deliverable, we introduce a SHOW-induced holistic impact assessment framework, that\integrates impacts, scenarios, stakeholders and their performance criteria. Therefore, it is defined as the Multi -Impact, -Criteria, and Actor (M3ICA) framework. Succinctly put, the M3ICA incorporates both quantitative indicators or key performance indicators from pilots and simulations as well as subjective criteria weighed by stakeholders for a comparative analysis of AV service scenarios.

2.3.2 An overview of the M3ICA steps

The M3ICA can be summarised in 6 steps, which are presented in Figure 9. The steps are elaborated on in depth in the next section, where they will be applied to the SHOW ecosystem of demonstrations and simulations.

1. Stakeholders (or actors) are identified (1a), and AV service impact criteria are defined (1b) which are in turn weighed by the relevant stakeholders (1c).

2. Autonomous mobility service scenarios are defined based on pilot demonstrations.
3. Based on literature of AV deployment impacts key criteria and their respective KPIs can be positioned in terms of their deployment effects.
4. Relevant project demos and simulations are identified and mapped to the scenarios. This enables the definition of KPIs (step 5) that can be collected.
5. KPIs are defined within the different impact criteria in accordance with demonstration sites and simulations.
6. The overall analysis is conducted that allows a comparison of the scenarios in relation to impact criteria and KPIs from demo-sites and simulations. Results can be enhanced by conducting a sensitivity analysis.

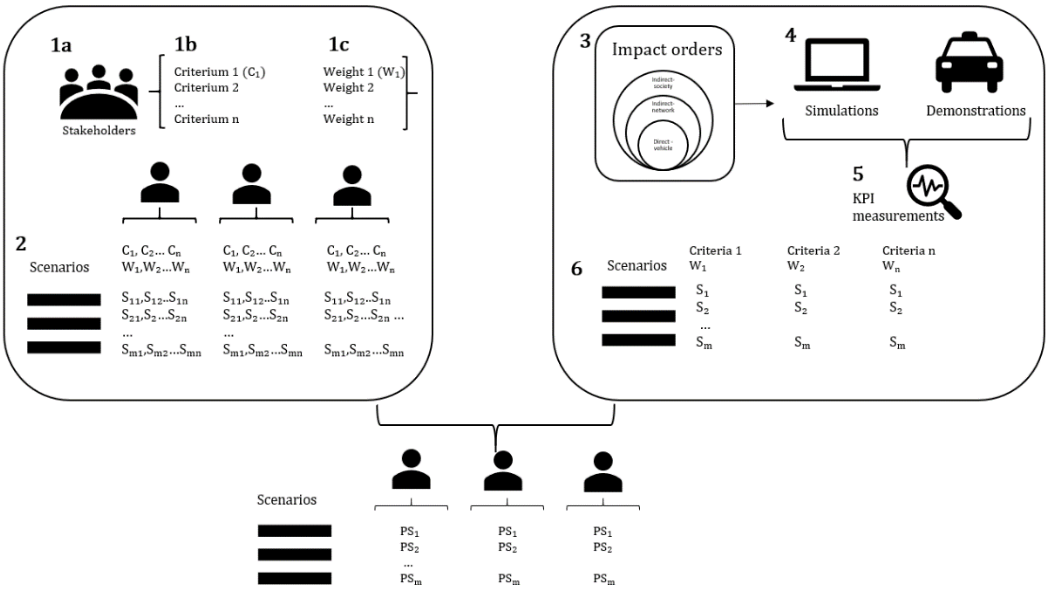


Figure 9: The M3ICA methodology incorporating the pre- and real-life demonstration evaluation framework.

2.3.3 M3ICA step 1: stakeholders' assessment of impact criteria

In the first step, stakeholder groups and impact criteria will be determined, and the impact criteria will be defined. After mapping the relevant criteria to the different stakeholder groups, the criteria are given a general weight, independent of the deployment scenarios. In step 2, discussed in the next section, the scenarios will be taken into consideration. The first 2 steps of the M3ICA methodology are founded on the Multi-Actor Multi-Criteria Analysis (MAMCA), which form the basis of the subjective evaluation.

The MAMCA is an approach where stakeholders are involved from the beginning of the entire exercise, there is no need to achieve a consensus among stakeholders, and results are more transparent, allowing for meaningful discussion (Lebeau et al., 2018; Macharis et al., 2009, 2012; Milan et al., 2015; Sun et al., 2015). The primary outcome of MAMCA is a visualisation of the heterogeneity in evaluations of criteria, which can support further analysis and the co-creation of future policy positions. MAMCA has been applied in a multitude of studies in transport and mobility research (Macharis et al., 2012). More recently it has been applied to investigate stakeholder assessment of autonomous mobility scenarios (Feys et al., 2020). A stated limitation and future research priority of Fey'' et al. (2020) application of MAMCA on autonomous mobility deployment scenarios is the need to quantify indicators in scenarios for which the M3ICA aims to resolve.

In the following subsections, the identification of stakeholders, criteria as well as the weighing method are described conceptually. A detailed framework for **the practical implementation** of the sub-steps 1 and, in step 6 for the overall analysis (subsection 2.3.8) will be forthcoming in D9.3. Concisely, that framework will prescribe how stakeholders would be organised for their weighing of criteria and assessment of criteria in relation to scenarios. An approach would be facilitating remote and/or live workshops with the support of the interactive MAMCA website interface. Individual workshops can be organised at the mega-site level, where stakeholders who may be linked to specific pilot sites can be pooled. Multiple representatives per stakeholder group will better validate the weighing of criteria and the evaluation of scenarios for each scenario. The identification and participation of stakeholder representatives can be organised by liaising with demo-site representatives.

2.3.3.1 Step 1a: identifying stakeholders

The overall process of this sub-step is shown in Figure 10. This provides the basis for the understanding broad categories of stakeholders, defining them, developing an exhaustive list, and the selection of specific stakeholders (and classification into broad groups) for a specific application of the M3ICA.

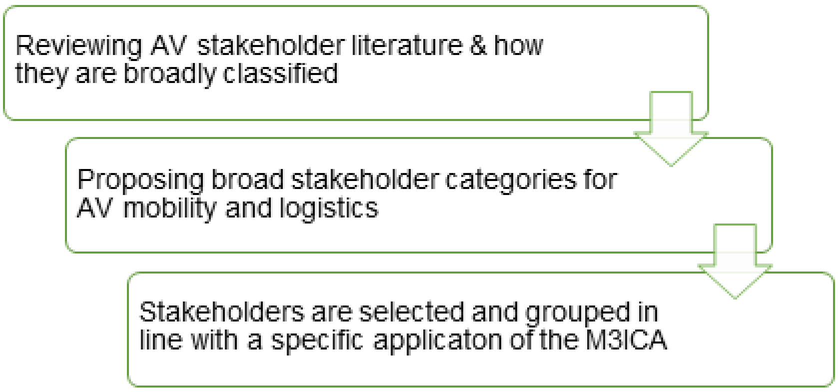


Figure 10: Overview of steps taken to define stakeholders that would participate in the overall M3ICA evaluation.

The primary outcome of this sub-step is the identification of discrete stakeholder groups, for the purpose of the M3ICA analysis, is the evaluation criteria by them, in relation to scenarios. Macharis & Baudry (2018) define stakeholders as "people or group of people who may affect or may be affected by the consequences" from a decision taken on policy. Stakeholders can be identified in terms of their ownership or control of services, or lack of (Esztergár-Kiss & Tettamanti, 2019). Additionally, stakeholders can be thought about in terms of their roles and capability in influencing policy and government actions (Shibayama et al., 2020).

To identify stakeholders, relevant literature on (autonomous) mobility and logistics was consulted. That overview was complemented by the classification of stakeholder groups defined in D1.1 (pg. 15-16) which are overviewed in Table 2, together with the defined stakeholder groups for autonomous and urban logistics stakeholder groups defined for the purpose of the M3ICA holistic impact analysis.

Table 1: Stakeholder groups identified from literature on autonomous mobility.

Pettigrew & Cronin (2019)	Cohen & Cavoli (2019)	Shibayama et al. (2020)	Drive2theFuture–- Markvica et al. (2020)	Fey'' et al. (2020)
• Government • Research • Private • Advocacy	• Industry (manufacturers, transport providers, insures, legal, etc.) • Central government departments • Local authorities • Think tanks • Charities & campaign organisations • Researchers & research funders • Regulators	• Public authorities • Infrastructure and service providers • Large employers and schools • Interest groups, NGOs, business support organisations • General public	• Vehicle user • (Remote) operator • Regulator • Road user • Industry	• Users • Public transport operators • Public transport authorities • Mobility service providers

Based on the stakeholder categories that were reviewed from literature, as overviewed in Table 1 above, and from clusters from the SHOW ecosystem, the broad classifications were defined for SHOW and AV mobility. As listed out in Table 2, these stakeholders that were defined, with the goal of operationalising the subjective analysis of the M3ICA framework are overviewed and are matched to ecosystem stakeholders, as defined in SHOW deliverable D1.1, and their relation to passenger mobility and urban logistics.

Members of M3ICA stakeholders are identified by pilot-site leaders, stakeholders can also be complemented from the SHOW's Stakeholders Forum (A15.2) as described in D1.1 for the purpose of the SHOW ecosystem stakeholder surveys.

Table 2: M3ICA stakeholder groups in relation to SHOW stakeholder clusters.

Defined M3ICA stakeholder groups	SHOW stakeholder ecosystem clusters (as described in D1.1)	Passenger mobility	Urban logistics
Vehicle and other road users (passengers, other road users interacting with aVs in traffic, and AV (remote) operator)	Passengers and other road users encompassing Vulnerable to Exclusion (VEC)	✓	
Public interest groups and associations	Umbrella associations; research & academia;	✓	✓
Decision-making authorities or regulators	Road operators, Authorities (Cities, Municipalities, Ministries) & policy makers	✓	✓
Operators (e.g., public transport operators, & private fleet operators)	Original Equipment Manufacturers (OEMs) and transport/mobility operators Tier 1 suppliers, telecom operators, technology providers, Small or Medium Enterprises (SMEs);	✓	✓
Mobility service providers		✓	
Industry (e.g., AV manufacturers)		✓	✓
Delivery senders	-		✓
Delivery receivers	-		✓
Delivery service providers	-		✓

2.3.3.2 Step 1b: Defining criteria

In this subsection, criteria are defined for the SHOW's demonstration ecosystem. As such, broad impact areas from SHOW's evaluative needs (defined in WP13) are further refined in relation to AV impact literature. As introduced, the M3ICA integrates underlying methods from the MAMCA (Macharis et al., 2012). MAMCA literature provides guidelines of how criteria can be developed based on real-world applications of the approach. In MAMCA, criteria can be derived by two main ways that provides the same result: a "hierarchical criteria tree". For the purposes of MAMCA, criteria are for "the evaluation are the goals and objectives of the stakeholders" (Macharis & Baudry, 2018). One approach to define criteria, based on the objectives of the analysis, is to define them in view of academic literature that concerns the subject, and in this case, for autonomous mobility. Stakeholders can also be involved in this process for their feedback and agreement of criteria, though the practitioner leads the process (Macharis et al., 2012).

For the purpose of the M3ICA, criteria would be largely be identical across all stakeholder groups. This will mean that the output from the analysis can be comparative between stakeholders and this allows for greater insights. When a criterion is not relevant to a stakeholder group then the criterion can be left out for them. MAMCA has been applied in research for autonomous mobility and examples of criteria can be consulted in Fey'' et al. (2020) and the Drive2theFuture's project D6.1 [4]. Since the M3ICA is specifically applied in a well-defined context of the SHOW project, the selection of criteria would be streamlined. Stakeholders, however, could be involved in criteria validation and amendment (Macharis et al., 2012), especially earlier in the M3ICA's application. Feedback from stakeholders involved earlier in the process could potentially allow for a greater consensus of chosen criteria and therefore less disagreement of a pre-defined selection (Macharis et al., 2012). As stakeholders provide their feedback, then the predefined criteria list would be improved and after time the need to revise the list would lessen. The overall approach taken is summarised in the following figure.

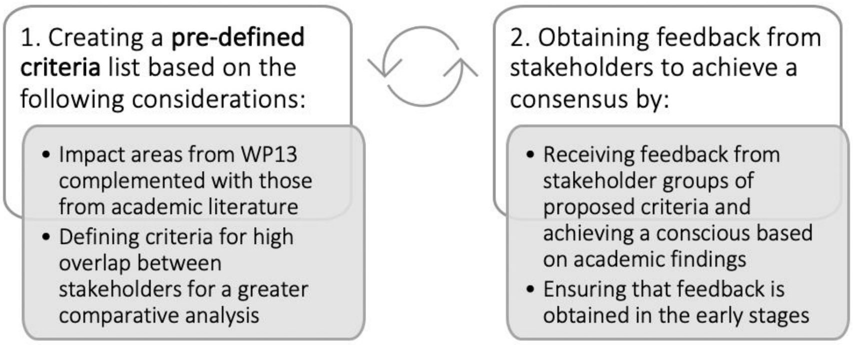


Figure 11: Overview of approach taken to define criteria in the M3ICA's application in1 the SHOW project.

Criteria were identified following reviewing impacts that are of specific focus in WP13. They are further then complemented with criteria from academic literature to ensure a comprehensive outcome. Proposed criteria and the source are overviewed in Figure 12.

[4] http://www.drive2thefuture.eu/dissemination/public-deliverables

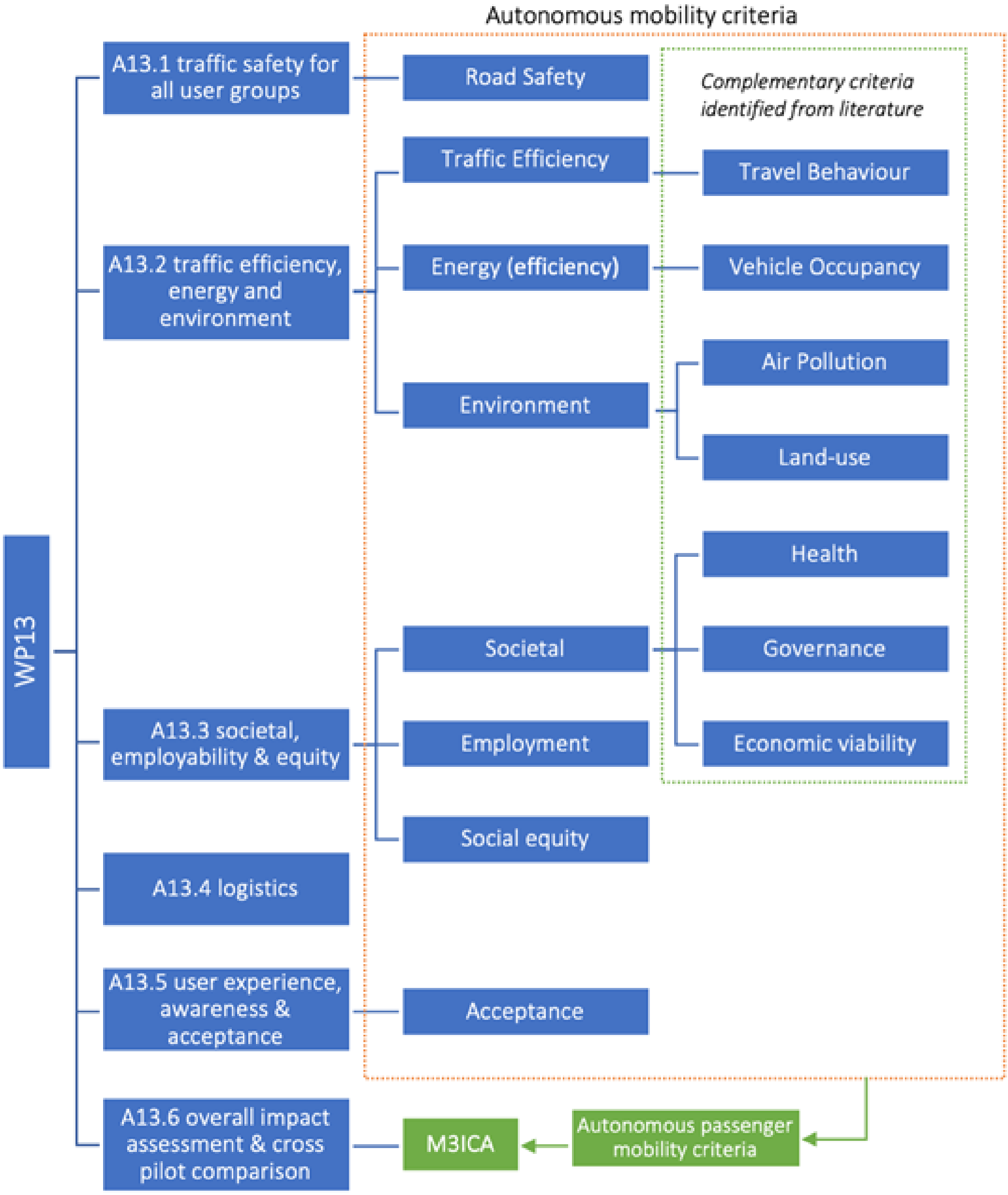


Figure 12: An overview of the relationship between WP13 activities and criteria derived internally and from literature.

2.3.3.3 Step 1c: Weighing criteria

In this last sub-step, stakeholders will weigh the predefined criteria as defined in step 1b, uses existing weighing methods, and as reviewed by Macharis et al. (2012), that can be advanced by either three multi-attribute weight measurements methods based on a citied work (Wang and Yang) that appraised their effectiveness. Namely, those methods are, Saaty's analytic hierarchy process (AHP), Edwar''s simple multi-attribute rating technique (SMART), and the Anderso''s functional measurement (FM).

The SMART approach is often preferred due to the fact that it is considered a more intuitive weighing method. SMART is based on the "addictive value function model" that allocates direct scores and weights to scenarios and criteria, respectively (Barfod, 2018). In recent literature, where MAMCA was applied in an AV context, the SMART approach was used as the weighing method, justified for its "transparent use" (Feys et al., 2020). Huang et al. (2020) also allude to the clarity of the approach. They found that SMART is the most understandable for the stakeholders based on first-hand experience from workshops implementing this approach.

Regardless of the chosen method, in this step, each stakeholder group will attribute a weight w_i to a criterion c_i for all i in $\{1, \dots, n_s\}$ with n_S being the number of criteria to be weighed by stakeholder group S. Practically, the weighing of criteria would be done in workshops organised for stakeholder representatives that are linked to one or more pilot sites. In those workshops the interactive online MAMCA interface will be used by stakeholder representatives to provide a weight to a criterion. A detailed procedure for stakeholders weighing will follow in D9.3.

2.3.4 M3ICA step 2: defining and scoring scenarios

The second step of the M3ICA framework is essentially the second step of the MAMCA approach. For MAMCA, this is the final stage of the analysis. In that final stage, weighted criteria are assigned a performance score by stakeholders for each scenario. In this section, scenarios are defined in relation to the delineation of AV service types that are implemented in the SHOW project. There is an advantage to generalise future AV operation models as scenarios, over the more technically defined forecasts since they are more adaptable and can easily incorporate more flexible conceptualisations of future AV services (Nogués et al., 2020). Firstly, SHOW's activities aim to be integrated into existing public mobility systems. Secondly, AV services being demonstrated would be part of shared and connected fleets. The overall aim is to reduce private car use and solving first and last-mile gaps in urban public transportation systems. The results can also be analysed per demo-site, therefore by disaggregating results that would be organised into M3ICA scenarios.

The goal of developing M3ICA scenarios is to test various AV operation configurations within a predefined scope. The definition of the scenarios is supported by the SPACE use cases as well as the SHOW use cases. The SPACE project defined 13 "autonomous mobility scenarios" in consideration of "operational environments" (UITP, 2020). The SHOW use cases sprouted from the SPACE use cases and the AV services have been mapped accordingly. According to the SHOW project objectives, AV services should attain broad acceptance from citizens, induce a high level of genuine demand, and be financially viable, under realistic operation conditions. These objectives provided the basis for the development of SHOW Use Cases that account for the diversity of business models, vehicle types (e.g., shuttles, pods, buses and cars), traffic conditions, build environment, and passenger characteristics in future AV scenarios. The SHOW Use Cases (WP1.3) and business models (WP2.3) are implemented in Demonstration of demo-sites (WP12) and Simulations (WP10), which, according to D1.2 are explicitly matched to SPACE Use Cases.

In view of the approaches to derive scenarios in MAMCA literature, and the context of the M3ICA's application for the SHOW project, scenarios are developed on clustering pre-defined SPACE's autonomous mobility scenarios, which led to the SHOW use cases, and are guided by literature. They are grouped since having a manageable number of scenarios is an important factor. This is due to the fact that the assignment of performance scores of criteria is done for each scenario. Scenarios should be optimally chosen but should be differentiable, as they would need to be as distinct from each other as possible. This will ensure a comparative analysis and yield meaningful results.

The overall goal in this clustering exercise would be for scenarios to effectively represent the variation among SPACE's scenarios and SHOW's Use Cases. This is further substantiated by how AV services have been investigated and classified in academic literature. Literature that deals with AV scenarios was consulted and their findings are overviewed in Table 3.

Narayanan et al. (2020) define components of shared aVs (SAV), and make a distinction based on the sharing system, its integration with the transport system, and booking type. Even though they do not define scenarios, components can allow more flexibility in conceptualising AV services that are yet to be realised. Fey'' et al. (2020) applied MAMCA to allow stakeholders to assess scenarios that were defined by the SPACE project and include a BAU which would allow stakeholders to better ground their evaluations to yet to be fully realised AV services. In the Drive2theFuture (2020) study, the MAMCA approach was also applied for both AV passenger transport and cargo scenarios and included a scenario of privately-owned aVs. Lastly, Stocker & Shaheen (2019) define in more detail, comparing to reviewed sources, business operation scenarios of aVs, however, provide a unique insight to the possibility of peer-to-peer (P2P) shared services which can be compared to privately owned car-sharing cooperatives.

Based on considerations from literature, the SPACE and SHOW use cases, the following scenarios are defined for shared autonomous passenger services.

- **Feeder services to multimodal & PT hubs.** As defined by Narayanan et al. (2020), the integration of SAVs to the transport system is an important factor. In the corresponding SPACE scenarios, the purpose of the operation of aVs in this scenario is to facilitate transfer of passengers that can continue their journey on traditional PT services.
- **Shared point-to-point services.** SAVs can provide a service detached from a fixed route or primarily purpose. Passengers can be picked up and dropped off in locations of their choosing, though it may be possible that these points are fixed and may require a short walk. What is unique with defined private point-to-point service is that passengers would share the vehicle, such as ridesharing services (Stocker & Shaheen, 2019).
- **Mass transit AV services.** SAVs could essentially become a new form of PT, replacing human driven buses. What is unique within this scenario is that more passengers are transported, unlike the point-to-point service and dedicated services that rely on shuttles or pods.
- **Private point-to-point services.** Unlike shared point-to-point vehicles, a private service will mean that the ride will be not be shared to other passengers who may have needed to take the same journey. Two SPACE scenarios overlap with this definition: premium robo-taxis and car-sharing, similar to Narayanan et al. (2020)'s 'booking type' dichotomy. The difference would be the type of reservation, if it would be on-demand as with the case of robo-taxis, or reservation based, as in the case of car-sharing, when the vehicle can be used during an allocated time.
- **Business as usual.** Following Fey'' et al. (2020) use of a BaU, a BaU scenario could better allow stakeholders to evaluate the scenarios in relation to a situation familiar to them, which is the current transport system without AV services. More precisely, a BaU can be defined as traditional PT being well developed and integrated with other sustainable modes, such as car sharing, cycling, and walking.

Table 3: Automation scenarios as defined in literature.

Narayanan et al. (2020)	Feys et al. (2020)	Drive2theFuture D6.1 (2020)	Stocker & Shaheen (2019)
Components of SAV scenarios • Sharing system o Mixed system o Ride sharing o Car sharing • Integration type o Special cases o Integrated (PT-SAV) system o Independent • Booking type o On-demand o Reservation-based	• Business as usual (BAU) • First/last mile feeder service to public transport stations • On-demand point-to-point service • Premium robo-taxis • Autonomous car-sharing • Bus Rapid Transit (BRT)	• Privately owned automated car (min level • Privately owned connected and cooperative private cards • Automated ride sharing • First/last mile feeder • Mass rapid transit	• Business–to–Consumer (B2C) with single owner–operator • B2C with different entities owning and operating, • Peer–to–Peer (P2P) with third–party operator • P2P with decentralized operations • Hybrid ownership with same entity operating • Hybrid ownership with third–party operator.

Table 4: Proposed M3ICA scenarios in relation to SPACE scenarios, SHOW Use Cases and Demo-sites.

M3ICA scenario	SPACE Use Cases	SHOW Use Cases	SHOW Demo-sites
Driverless shuttle for first/last mile	1) First/last mile feeder to PT station	1.1, 1.2, 1.3, 1.6, 1.8, 1.9, 1.10, 3.2	**Graz**: Suburban train station to shopping centre; **Rouen**: Interface to bus line; **Tampere**: Feeder services from suburban residential are to the tramline; **Linkoping**: DRT between trunk lines & AV pods in University and residential area. **Gothenburg:** Feeder service from a PT station to an urban science park & residential area **Carinthia:** public transport feeder
	2) Area based service and feeder to PT station	1.1, 1.2, 1.3, 1.6, 1.10, 3.1	**Salzburg**: Connection of peri-urban area to city centre; **Linkoping**: Area based on demand shuttles service; **Madrid**: Shuttles connecting new automated PT (bus) to metro station **Linköping**: AV pods for last/ first miles for children between school and the PT.
	6) Special service (campus, business park, hospital)	1.1, 1.2, 1.3, 1.5, 1.6, 1.7, 2.1, 2.2, 3.1, 3.2	**Karlsruhe:** Mixed passenger-cargo vehicles single day demo–- (capsule exchange) (L4/5); **Turin**: Flexible special service with automated DRT & private cars serving hospital campus.

M3ICA scenario	SPACE Use Cases	SHOW Use Cases	SHOW Demo-sites
	13) Pop-Up Shuttle transport	2.2, 3.2	**Graz**: four relevant demos planned at major events, plus specific events-based transportation
Door-to-door delivery of persons and goods	3) Premium shared point to-point service	1.5, 1.6, 1.7, 1.8, 2.1, 2.2, 3.1, 3.2	**Aachen**: Ring feeder service.
	4) Shared point-to-point service	1.5, 1.6 1.7, 1.8, 2.1, 2.2, 3.1, 3.2	**Franklin** suburb; **Brno**: DRT service for areas currently partly served, with low volume of demand
Mass transit with driverless buses	5) Local bus service	1.1, 1.2, 1.3, 1.5, 1.6, 1.7, 1.10	**Copenhagen**: Replacing normal PT by automated DRT (level 4); **Trikala:** Replace current downtown PT line (by automated shuttles)
	7) Bus Rapid Transit (BRT)	1.1, 1.2, 1.3. 1.5, 1.6, 1.7	**Copenhagen**: Automated BRT at level 4 at a business district.
	12) Intercity travel	UC1, 2, 3	**Austria, Germany and Sweden**: relevant corridors between different cities of the Pilots as well as urban and peri-urban areas are supported.
Shared on-demand Robotaxis	9) Premium–- Robo-taxis	1.1, 1.2. 1.5, 1.6, 1,7, 1.8, 3.1, 3.2	**Rouen**: 4 robo-taxis.; **Brno**: 1 robo-taxi for long distance commuting and interface to DRT.; **Karlsruhe**: 1 Shuttle and 1 automated vehicle with remote supervision and remote control in case of critical situations
	10) Car-sharing	1.1, 1.2, 1.3, 1.5, 1,6, 1.8, 1.10	**Rouen**: Robo-taxis, used also as MaaS fleet for car-sharing.; **Karlsruhe & Aachen**: Connected MaaS fleets of 2 cars in each, linked to automated DRT; **Madrid:** 2 MaaS cars to supplement automated PT/DRT; **Trikala:** 2 MaaS car fleet, interfacing automated DRT services; **Turin:** Connected MaaS car interfacing DRT.

2.3.5 M3ICA step 3: defining impact levels

From this step on, the MAMCA approach is applied as defined in the first two steps. The subjective analysis is now complemented by an objective analysis from step 3 until 5. One of the core features of the M3ICA framework is this integration of quantitative impact indicators or KPIs measured in demo-sites and simulations.

To define the impact levels in step 3, a literature review was conducted from which AV deployment impacts were delineated. Commonly used automation impact frameworks were identified that aid in conceptualising impact delineations as linkages and hierarchies. Impact categories from reviewed literature are summarised as follows and their categorisations and hierarchies are overviewed in Figure 13.

A bibliometric analysis of all AV literature up to 2018 by Rashidi et al. (2020) observed an overrepresentation of narrow and direct impact studies that focused on the technological development of AVs (i.e., software and hardware needs) and their interactions with infrastructure and traffic. They remark a lack of studies that focus on wider implications of AV technology, namely on the transportation system, a trend also commented by Litman (2020) and Legacy et al. (2019). As such, references that present a start-of-the-art review of autonomous mobility and additionally provided a synthesis of the broader implications of autonomous mobility stand out (Milakis et al., 2017; Narayanan et al., 2020b; Rashidi et al., 2020). Here, various thematic categories are organised in subchapters that focus on a wider impact category.

Narayana''s et al. (2020b) state-of-the-art review employed a systematic approach, gathering sources of literature that support an increasingly comprehensive analysis of holistic impacts. They provide a dedicated chapter of impacts that overviews seven impact categories, each with more narrowly defined impact types. Also, Milakis et al. (2017), provide a comprehensive literature review and proposes wider impacts categories and groups them into first, second, and third impacts orders. These are further conceptualised into layers in the 'ripple effect model' (Milakis et al., 2017). According to the authors, the model "describes the sequentially spreading of events".

Another framework specifically developed to understand the spatial and temporal dimensions of impacts, was developed by Smith et al. (2018). That framework was also incorporated in Innama''s et al. (2018) AV impact assessment in the "Trilateral Impact Assessment Framework for Automation in Road Transportation" (TIAF). Smith et al. (2018) first introduce the distinction between direct and indirect impacts.

A next reference that presents a framework of impacts and their interactions, is Levitate, an ongoing project investigating the "Societal Level Impacts of Connected and Automated Vehicles" (Elvik et al., 2019). Levitate developed a "taxonomy of impacts and models of their interrelations". An outcome is a listing of impact areas arising from the direct operation of aVs, transport system-wide impacts resulting from service and operation models, and then what they term as wider impacts, which are societal impacts resulting from changes in the transport system.

Lastly, Taiebat et al. (2018) present a "critical review" of the implications of aVs, beyond improvements to mobility and safety. Even though they draw more attention to environmental and energy impacts, they present an overview "influencing mechanisms" based on the characteristics from, starting with, the vehicle, then transport system, followed by the urban system, and finally, society. As a level increases then interactions increase in terms of complexity, uncertainty, and influence. A more precise characterisation of impacts, taking account of uncertainty in predictions, taking better account of travel behaviour in wider impact models, and the interaction of modelling across levels of impacts remain a challenge for researchers (Taiebat et al., 2018).

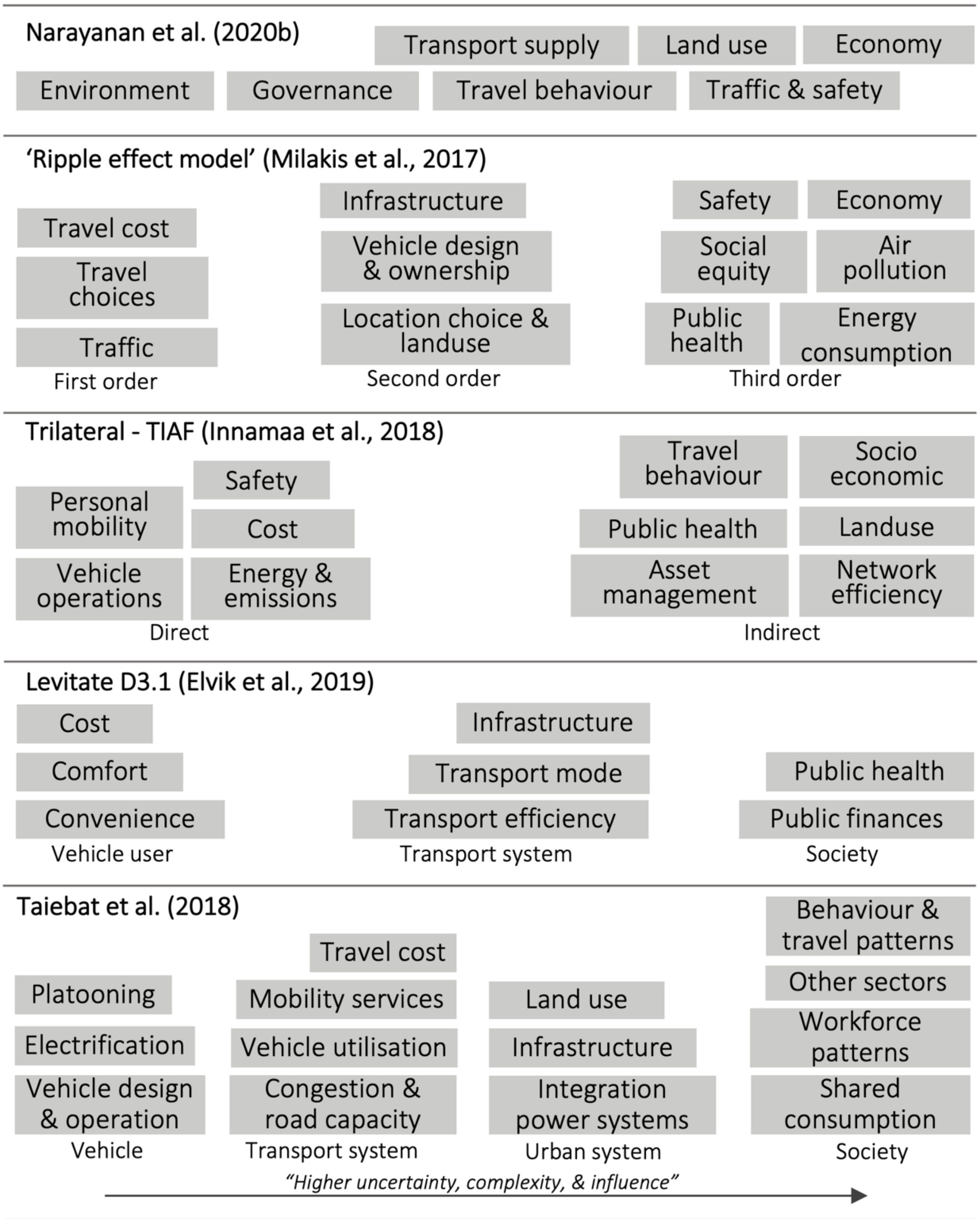


Figure 13: A comparison of impact categories reviewed from literature.

Based on the review, a hierarchy that conceptualises impacts as three levels was defined, which is similar to Milakis et al.'s (2017) spheres of influence (see Figure 14). The lower the impact level then the lower the spatial resolution, following Smit''s et al. (2018) AV Benefits Framework. According to that framework, the spatial resolution begins at the level of the person or vehicle, then the transport network, and finally beyond the transport system. The overall scoring or evaluation of criteria or KPIs by stakeholders were then structured in the form of levels. This allows the understanding and weighing of impact criteria or KPIs to grouped in relation to impact levels.

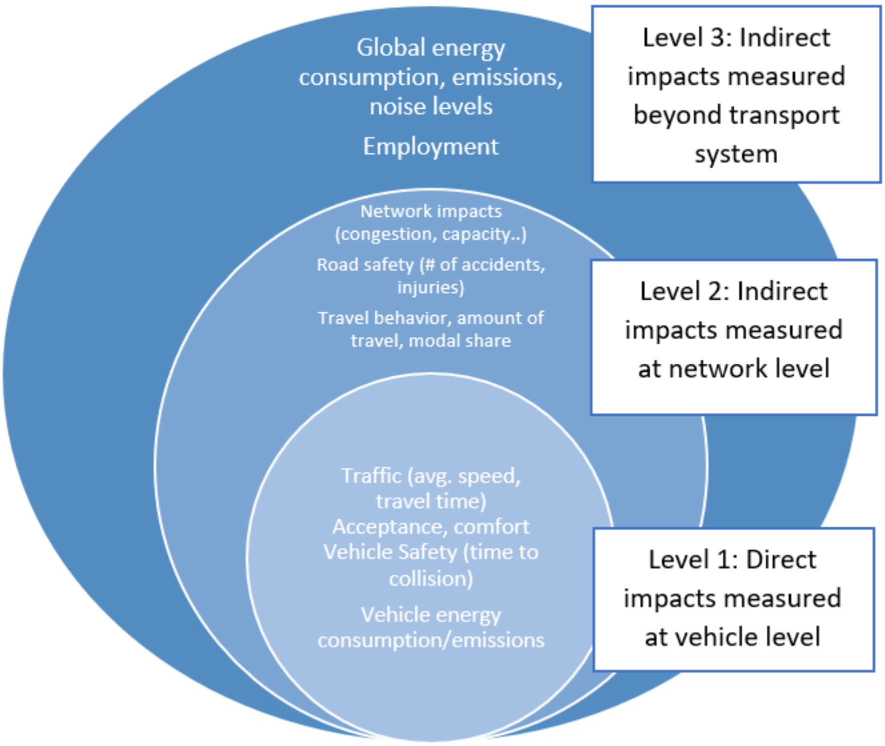


Figure 14: M3ICA impact hierarchy proposition.

2.3.6 M3ICA step 4: setting up the demonstration and simulation evaluation

As data and measurements from demonstration sites and simulations are crucial input for the M3ICA, an appropriate evaluation framework is chosen in this step. For the SHOW application of the M3ICA, the FESTA approach is followed as described in section 2.1. However, in another application the evaluation framework could be independently determined.

2.3.7 M3ICA step 5: applying KPIs in demonstration sites and simulation

The sources that were identified in step 3 primarily led to the definition of KPIs that resulted in an extensive listing. A first draft was defined based on relevant literature. As part of the impact assessment framework work package (WP13), the SHOW partners responsible for the different impact areas provided feedback on this first draft.

A more exhaustive list was compiled based on this input. In a last phase, to ensure feasibility for the demonstration sites, only the desired KPIs for the impact assessment of each area were withheld in an essential list.

The measures needed for the KPIs will be collected either through measurements (automatic or semi-automating logging), observations at the demonstration site, simulations or user surveys.

Next, KPIs were matched to use cases and research questions (RQ) to ensure all AV systems and service activities are adequately covered by a holistic collection of KPIs. Three main overlapping categories of KPIs were defined for:

- Demonstration sites (44 in total)
- Simulations (30 in total)
- Surveys (7 in total)
- Post-processing (12 in total)
- Overall SHOW project targets (27 in total)

The final KPI list covers and goes beyond the KPIs listed in the grant agreement. Maintaining the initial list from the GA was crucial as these KPIs reflect the objectives and dimensions of the project.

KPIs will be applied to the demonstrations and simulations which are linked to the impact scenarios defined in step 2. Measurement units and tools are also specified for KPIs. Supported by the literature review (step 3), KPIs are defined that aim to holistically assess impacts of systems and services within the area of AV and represents the holistic impact criteria defined in step 1b.

Table 5: KPIs for demonstration-sites, surveys and simulations.

Broader category	KPI #	Impact	RQ or target	Demo-sites	Simulation	Surveys	Post-	Project
Grant Agreement KPIs								
Road Safety	A1	Safety Enhancement	What is the safety enhancement induced by AV services when compared to the existing (public) transport services?. Target is >10% 7(as PT/ DRT urban accidents are scarce)	✓	✓	–	–	✓
Traffic, Energy, Environment	A2	Single vehicle km travelled	35% increase compared to before pilots	–	✓	–	–	✓
	A3	Increase in average vehicle occupancy	At least 25% in low density areas	✓	–	–	–	✓
	A4	PT quality of service enhancement	20% in area coverage and 10% in time-to-target	–	✓	–	–	✓
	A5	Reduction in CO2	90% for CO2 at city level	–	✓	–	–	✓
	A6	Reduction in noise level	30% reduction in noise levels	–	✓	–	–	✓
	A7	Reduction in energy consumption	20% for passenger transport, 40% for freight	–	✓	–	–	✓
	A8	Reduction in	10% reduction	–	✓	–	–	✓

Broader category	KPI #	Impact	RQ or target	Demo-sites	Simulation	Surveys	Post-	Project
		energy consumption						
Societal	A9	Number of passengers	Minimum 1500000 passengers	✓	–	–	–	✓
	A10	Person km travelled	>20% person kilometres travelled by special groups (in total, 5% for each sub-group)	✓	–	–	–	✓
	A11	Empty vehicle km	Empty haulage 20% or lower	✓	–	–	–	✓
	A12	Operative cost	At least a reduction of 20% before-after Pilots	✓	–	–	–	✓
Logistics	A13	Ratio of average load	Load factors of vehicles up to 70%	✓	–	–	–	✓
	A14	Number of cargo transported	Minimum 350000 containers	✓	–	–	–	✓
User Acceptance	A15	Traveller acceptance	Traveller acceptance rating (1-9 scale) over 7 (mean value)	✓	–	✓	–	✓
Project Success	A16	Number of uCs success	> 11 (out of 22)	–	–	–	✓	✓
	A17	Realisation of each UC	Realisation of uCs > 70%	–	–	–	✓	✓
	A18	Business models	> 5	–	–	–	✓	✓
	A19	SMEs using SHOW marketplace	> 3 internal, 15 external	–	–	–	✓	✓
	A20	MoUs for services sustainability created	> 15	–	–	–	✓	✓
	A21	Business models-local synergies	> 3	–	–	–	✓	✓
	A22	SHOW deployed fleets	> 50 vehicles in at least 10 cities	–	–	–	✓	✓

Broader category	KPI #	Impact	RQ or target	Demo-sites	Simulation	Surveys	Post-	Project
	A23	Future AV fleets after SHOW	> 200 vehicles	–	–	–	✓	✓
	A24	Alternative infrastructure schemes	> 3 different schemes	–	–	–	✓	✓
Non-Grant Agreement KPIs								
Road Safety	B1	Road accidents (leading to human injury)	What is the number of accidents that caused even the slightest of injury during the operation of the AV?	✓	✓	–	–	–
	B2	Conflicts	What is the number of number of conflicts with other road users and infrastructure during the operation of the AV?	✓	✓	–	–	–
	B3	Illegal overtaking	How frequently do illegal overtakes occur?	✓	–	–	–	–
	B4	Traffic flow	Number of vehicles per km, record average and standard deviation over time or road length	✓	–	–	–	–
	B5	Lateral/longitudinal distances	Lateral/longitudinal distances between vehicles	✓	–	–	–	–
	B6	Lateral/longitudinal 58ot58ways	Lateral/longitudinal time distance between vehicles	✓	✓	–	–	–
Traffic, Energy, Environment	B7	Average speed	What is the average speed of pilot vehicles on the pilot route?	✓	–	–	–	–
	B8	Acceleration variance	How does the acceleration of pilot vehicle vary on the pilot route?	✓	–	–	–	–
	B9	Number of hard braking events per kilometre	What is the number of hard braking events per km?	✓	–	–	–	–
	B10	Non-scheduled number of stops per kilometre	How often does a pilot vehicle have to make a non-scheduled stop?	✓	–	–	–	–
	B11	Scheduled number of stops	How often does a pilot vehicle make a scheduled stop?	✓	–	–	–	–

Broader category	KPI #	Impact	RQ or target	Demo-sites	Simulation	Surveys	Post-	Project
		per kilometre						
	B12	Service reliability	How often did the pilot vehicle arrive/depart as scheduled?	√	–	–	–	–
	B13	Number of travellers	How many travellers in a pilot vehicle?	√	–	–	–	–
	B14	Kilometre s travelled	How many kilometres did the pilot vehicle travel?	√	–	–	–	–
	B15	Speed per vehicle type	How does the introduction of pilot vehicles impact the average speed for all vehicle types?	–	√	–	–	–
	B16	Average vehicle delay	How does the introduction of pilot vehicles impact the average vehicle delay for all vehicle types?	–	√	–	–	–
	B17	Vehicle stops	How does the introduction of pilot vehicles impact the number of stop in traffic?	–	√	–	–	–
	B19	Hard braking events in traffic	How does the introduction of pilot vehicles impact the number of hard braking event in traffic?	–	√	–	–	–
	B20	Total intersecti on delay	How does the introduction of pilot vehicles impact the vehicle delay on intersection?	–	√	–	–	–
	B21	Total network travel time per vehicle type	How does the introduction of the new mobility system affect the total network travel time?	–	√	–	–	–
	B21	Modal split	How does the introduction of the new mobility system affect the modal split ?	–	√	–	–	–
	B22	Total mileage	How does the introduction of the new mobility system affect the vehicle kilometres travelled per mode?	–	√	–	–	–
	B23	Total network delay	How does the introduction of the new mobility system affect the total network delay?	–	√	–	–	–
	B24	Average network speed	How does the introduction of the new mobility system affect the average network speed?	–	√	–	–	–
	B25	Number of trips	How does the introduction of the new mobility system affect the number of trips performed? (e.g. caused by induced demand)	–	√	–	–	–
	B26	Energy use	How does the introduction of the new mobility system change energy consumption of vehicles?	–	√	–	–	–

Broader category	KPI #	Impact	RQ or target	Demo-sites	Simulation	Surveys	Post-	Project
	B27	CO2, PM, nOx Emissions	How does the introduction of the new mobility system change the amount of vehicle emissions related to transport in the area of interest?	–	✓	–	–	–
	B28	Concentrations (air quality)	How does the introduction of the new mobility system affect the air quality in the area of interest?	–	✓	–	–	–
	B29	Noise	How does the introduction of the new mobility system affect the traffic noise in the area of interest?	–	✓	–	–	–
Societal, Employment	B30	Amount of travel	How would kilometres travelled by people in an area with shared AV services change?	–	✓	–	–	–
	B31	Shared mobility rate	What is the proportion of trips where the vehicle is shared between passengers not travelling together?	–	✓	–	–	–
	B32	Vehicle utilisation rate	What is the proportion of time that the AV is not parked and how was the vehicle being used when in motion?	✓	✓	–	–	–
	B33	Operative revenues	What is the revenue from the AV services?	✓	–	–	–	✓
	B34	Job loss	What would be the proportion of jobs and the type of jobs that would be lost because of AV services?	–	✓	–	–	–
	B35	Job gain	What would be the proportion of jobs and the type of jobs that would be gained because of AV services?	–	✓	–	–	–
Logistics	B36	Punctuality of deliveries	What is the proportion of deliveries and pick-up executed within the planned (scheduled) delivery time?	✓	–	–	–	–
	B37	Precision of deliveries	What is the proportion of packages reaching their destination without being lost, stolen or damaged?	✓	–	–	–	–
	B38	Customer satisfaction	What is the perceived satisfaction of customers with the AV delivery or pick-up service?	✓	–	–	–	–
	B39	Unit cost of delivery	What is the average unit cost of delivery/pick-up service (per km, per shipment, per vehicle)?	✓	–	–	–	–
	B40	Load factor patterns	What is the volume that is occupied by packages?	✓	–	–	–	–
	B41	Public acceptance	What is the public willingness to use the system and trust to the system?	✓	–	–	–	–

Broader category	KPI #	Impact	RQ or target	Demo-sites	Simulation	Surveys	Post-	Project
	B42	Willingness to pay for AV urban deliveries /logistics	What is the maximum (and average) additional price users are willing to pay for AV service?	√	–	–	–	–
	B43	Number of accidents on site	What is the number of accidents during the operation of the AV (including accidents that caused property damage, slight injury, severe injury, mortal consequences)?	√	–	–	–	–
	B44	Accidents in AV UFT facility	What is the number of damaged parcels caused by the accident during the operation of AV service?	√	–	–	–	–
	B45	Incidents of crime / theft in AV UFT facility	What is the number of incidents involving crime or theft of parcel or any part of the AV device during its operation?	√	–	–	–	–
	B46	Number of incidents involving vandalism in in AV UFT facility	What is the number of incidents caused by vandalism during the operation of AV service?	√	–	–	–	–
	B47	Loss and damage parcels in AV UFT facility	What is the number of loss and damaged parcels caused in AV UFT facility?	√	–	–	–	–
	B48	Fair and equal access to in AV UFT facility	What is the public perception of Fair and Equal access to the AV UFT facility?	√	–	–	–	–
User Acceptance	B49	User reliability perception	What is the perception by passengers of the travel reliability in AV transit services?	√	–	√	–	–
	B50	User safety perception	What is the perception by passengers of vehicle safety in AV transit services?	√	–	√	–	–
	B51	Travel comfort	What is the perception by passengers of travel comfort in AV transit services?	√	–	√	–	–
	B52	Perceived usefulness	What is the perception by passengers of usefulness of the journey in AV transit services?	√	–	√	–	–

Broader category	KPI #	Impact	RQ or target	Demo-sites	Simulation	Surveys	Post-	Project
	B53	Willingness to pay	What is the willingness to pay for AV services?	✓	–	✓	–	–
	B54	Willingness to share a ride	What is the user willingness and user factors to share a ride in an AV?	✓	–	✓	–	–
	B55	Use of automated driving functions	What is the proportion of KMs driven within the ODD that the vehicle uses non-operator guided automation?	✓	–	–	✓	–
Project Success	B56	External joint collaborations with Third parties	What is the number of external partnerships achieved during the number	–	–	–	✓	✓
	B57	Number of uCs obtaining financial support after project implementation	40% of uCs tested	–	–	–	✓	✓

2.3.8 M3ICA step 6: performing the overall analysis

The overall analysis will result in a subjective scoring from the MAMCA (step 1 and 2 in M3ICA) evaluation as well as a more objective data-driven scoring from the evaluation of the demonstrations and KPI collections. These two distinct scoring methods allows stakeholders and decisions-makers to comparatively analyse two sets of results. They can consider the perceptions and concerns of stakeholders while simultaneously considering the performance of scenarios from KPI data obtained from demonstrations and simulations.

In the next sections scoring methods are written down mathematically. The subjective scoring leads to a final performance score per scenario for each stakeholder group. The objective score results from an aggregation method which is either based on the specific impact methodology (per impact activity) as described in section 2.2 or objective KPIs that are not processed within a specific impact activity are aggregated on criterion level according to the aggregation method as described in section 2.3.8.1.

2.3.8.1 Data-driven scoring

As for the objective scoring, this can be determined once the values for the KPIs have been collected from the pilots or simulation sites. As each pilot fits within a certain scenario, the collection of KPI values within a criterion c_k leads to a $m \times n_{c_k}$ –matrix D_{c_k} for scenario a_i $(1 \leq i \leq m)$, and KPI j $(1 \leq j \leq n_{c_k})$:

$$D_{c_k} = \begin{pmatrix} KPI_{11} & \cdots & KPI_{1n_{c_k}} \\ \vdots & \ddots & \vdots \\ KPI_{m1} & \cdots & KPI_{mn_{c_k}} \end{pmatrix}$$

This can lead to a ranking of the different scenarios by applying an entropy method. For the M3ICA, we choose to apply the improved entropy method, the TOPSIS-RSR, as developed by Chen et al. (2015), used for the ranking of road safety measures. Here, the KPI weights could be either attributed by determining the entropy value of the indicators or weights can be attributed by the stakeholders (as discussed in section 2.3.2).

After the decision matrix is identified, each KPI is first transformed depending on the relation between the KPI and the criterion leading to a new matrix X_{c_k}. If a higher value of the KPI should lead to a higher criterion score, $x_{ij} := KPI_{ij}$. If a lower value of the KPI should lead to a higher criterion score (e.g. a lower value of the KPI road accidents should lead to a higher road safety score), $x_{ij} := 1 - KPI_{ij}$, if the KPI value is a relative number (e.g., representing a proportion), $x_{ij} := \frac{1}{KPI_{ij}}$ if the KPI is an absolute number. In the transformed decision matrix X_{c_k}, higher indicator values are better.

As the indicators have different attribute dimensions (e.g. scales or units). Normalization will make sure that all indicators have the same magnitude. As such, the Euclidian norm can be utilised.

$$y_{ij} = \frac{x_{ij}}{\sqrt{\sum_{l=1}^{m}(x_{kj})^2}}$$

With $i = 1, \dots, m$ and $j = 1, \dots, n_{c_k}$.

The new decision matrix Y_{c_k} can be multiplied with the diagonal weights-matrix V.

$$\begin{pmatrix} v_1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ - & \cdots & v_n \end{pmatrix}$$

The values v_j could be determined by the stakeholders or using an objective method. Considering we have already included stakeholders' views in steps 1 and 2, we choose to use an objective weighting method. The method selected is the Entropy method, which assigns weights to indicators by how much information they contribute to the sample (Kumar et al., 2021).

The first step is to calculate the standardized value p_{ij} of each KPI in each scenario

$$p_{ij} = \frac{y_{ij}}{\sum_{k=1}^{m} y_{kj}}$$

for $i = 1,2, \dots, m$; $j = 1,2, \dots, n_{c_k}$.The entropy value of the indicators can then be calculated using the standardized values:

$$E_j = -\frac{1}{\ln m}\sum_{i=1}^{m} p_{ij} \ln p_{ij}$$

The entropy value is in a [0,1] range, and represents the degree of differentiation of an indicator (Zhu et al., 2020). *The principle of the entropy method is that the higher the* *entropy value is, the more dispersed an indicator is, and more information can be derived from it. Thus, it would be assigned a higher weight. The weights of the indicators are then defined as follows*

$$v_j = \frac{1 - E_j}{\sum_{k=1}^{n_{c_k}} (1 - E_k)} \quad \text{for } j = 1,2,\dots,n_{c_k}$$

Applied on all indicators, the result is then a matrix of the KPI weights

$$V = \begin{pmatrix} v_1 & \cdots & 0 \\ \vdots & \ddots & \vdots \\ 0 & \cdots & v_n \end{pmatrix}$$

Next, the columns of the normalized decision matrix are multiplied with the associated weights and obtain the matrix

$$z_{ij} = y_{ij} v_{jj}$$

for $i = 1,2,\dots,m\,;\, j = 1,2,\dots,n_{c_k}$.

In a last step, the ranking of the scenarios is determined. First, the positive ideal solution $Z^+ = (z_1^+, z_2^+, \dots, z_n^+)$ and the negative ideal solution $Z^- = (z_1^-, z_2^-, \dots, z_n^-)$ are determined. The positive ideal solution is the set of maximum values of the positive indicators, while the opposite applies for the negative ideal solution.

$$z_j^+ = \max_{1 \le i \le m} z_{ij} \quad z_j^- = \min_{1 \le i \le m} z_{ij}\,, for\ j = 1,2,\dots,n_{c_k}$$

Next, the distance from each scenario to the positive ideal scenario and the negative ideal scenario is calculated under each criteria and scenario

$$D_i^+(C_k) = \sqrt{\sum_{j=1}^{n_{c_k}} (z_{ij} - z_j^+)^2} \;;\; D_i^-(C_k) = \sqrt{\sum_{j=1}^{n_{c_k}} (z_{ij} - z_j^-)^2}$$

for $i = 1,2,\dots,m\,;\, j = 1,2,\dots,n_{c_k}$.

Lastly, the closeness coefficient of each scenario is calculated. This relative closeness $F_i(C_k)$ to the ideal solution can be defined as

$$F_i(C_k) = \frac{D_i^-}{D_i^+ + D_i^-}$$

Now, the impact scenarios can be ranked according to the score C_i under each criteria C_k,, k = 1,2,…n, $i = 1,2,\dots,m$.

While this impact score only considers the quantitative measurements from pilots and simulations, we can integrate the subjective stakeholder by further aggregating from criteria to scenario per stakeholder. Using the criteria weights assigned by the stakeholders, we can aggregate the scores of each criteria to end up with a final score per scenario per stakeholder.

$$F_i = \sum_{l=1}^{k} (F_i(C_k) * CW_l)$$

2.3.9 Example of the Data-driven Calculation

As KPIs are collected from real-world demonstrations and simulations, they are linked to a particular criteria and scenario to allow for the objective scoring of a criteria. For this example, the criterion of traffic safety is one of criteria developed from the holistic impact framework defined within the M3ICA. The aim is to illustrate the objective scoring of autonomous mobility criteria based on KPIs that are gathered from pilot sites and simulations. To demonstrate this an example is found in Table 6. This example provides road safety KPIs for three scenarios using fictive data.

Table 6: Example safety criterion KPIs used in the M3ICA's objective scoring method.

Example KPI identifier & description		**Scenarios**		
		A1	A2	A3
KPI1	Number of accidents leading to a slight injury per 1000 km	5	2	3
KPI2	Number of conflicts with other road users and infrastructure per 1000 km	35	51	42
KPI3	Frequency of illegal overtaking per 1000 km	85	60	70
KPI4	Number of hard braking events in traffic per 1000 km	150	200	130

This example leads to the 3 x 4-matrix:

$$D = \begin{pmatrix} 5 & 35 & 85 & 150 \\ 2 & 51 & 60 & 200 \\ 3 & 42 & 70 & 130 \end{pmatrix}$$

A higher safety score will be achieved by a lower value of the KPI. Therefore, KPIs are changed into their multiplicative inverse and further normalized, leading to the matrix Y.

$$Y = \begin{pmatrix} 0.316 & 0.679 & 0.472 & 0.587 \\ 0.789 & 0.466 & 0.669 & 0.441 \\ 0.526 & 0.566 & 0.573 & 0.678 \end{pmatrix}$$

Determining the entropy weights for each KPI results in the weights $v_1 = 0.65, v_2 = 0.09, v_3 = 0.09, v_4 = 0.17$.

$$Y = \begin{pmatrix} 0.205 & 0.061 & 0.043 & 0.100 \\ 0.513 & 0.042 & 0.060 & 0.075 \\ 0.342 & 0.051 & 0.052 & 0.115 \end{pmatrix}$$

Upon multiplying these weights with the matrix Y, we find the positive ideal scenario to be $Z^{+} = (0.517, 0.058, 0.063, 0.113)$ and the negative ideal scenario $Z^{-} = (0.206, 0.039, 0.045, 0.074)$.

After determining the distance of each scenario to these ideal scenarios, the relative closeness coefficients give the following ranking: $c_1 = 0.089, c_2 = 0.877, c_3 = 0.455$.

Scenario 2 will in this case be objectively ranked as the best scenario in terms of road safety according to the collected KPIs. Further aggregation using the weights assigned by stakeholders to the criteria (road safety, traffic, energy…) in the MAMCA workshops provide a view of the scenarios' performance in all criteria in the view of each stakeholder.

2.3.10 Conclusions and next steps

The impact assessment framework defined in this chapter leads to an integrated evaluation of the CCAV impact scenarios based on the stakeholders' evaluation and a data-driven analysis. The stakeholder evaluation leads to a ranking of future automation scenarios for each stakeholder. Weights are given to the different impact criteria, but also scenarios are evaluated based on the impact criteria. The multi-actor view can show the overall evaluation for all stakeholder groups. The individual stakeholder overview shows in detail the appreciation of the scenarios in terms of the different impact criteria. That overview is shown on Figure 15 where the horizontal black line indicates the weight attributed to the respective impact area and the performance scores for the scenarios are given on the y-axis.

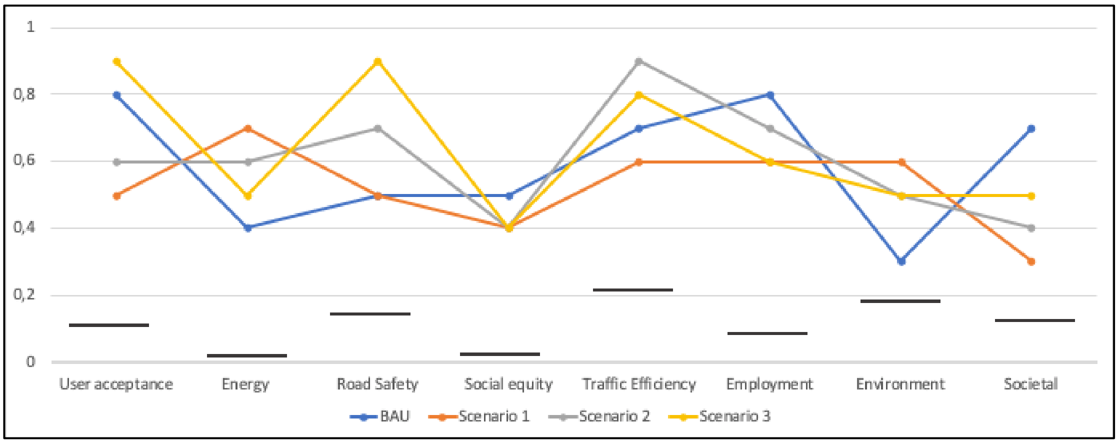


Figure 15: Subjective stakeholder view for a hypothetical stakeholder group.

In the M3ICA, this information will be aggregated with the objective scoring results for the different impact areas. If the different impact areas ranked in terms of their impact order, this figure can be put into a temporal perspective as illustrated in Figure 16.

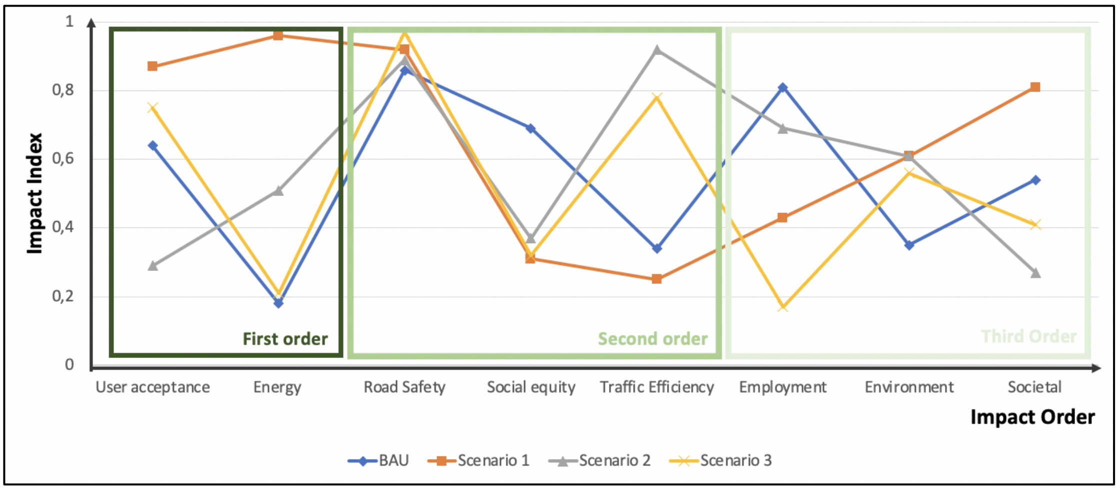


Figure 16: M3ICA impact assessment overview.

The final ranking of the impact scenarios gives an indication of what the impact will be in the different areas and in which order these can be expected. With this integrated assessment, the views of stakeholders, although subjective in nature, could buffer the limitations of relying on small-scale demonstrations of AV services and simulations that might have unknown parameters and assumptions. Additionally, M3ICA results will complement and embrace an in-depth analysis of various impact areas conducted in WP13 Activities 13.1 to 13.5.

The M3ICA approach can be further fine-tuned and validated during the pre-demonstrations. An adjusted methodology would then be justified and defined in D9.3. One possible revision concerns the weighing or prioritising of KPIs. Based on results from the pre-impact assessment (after the pre-demonstration) we will assess if the entropy method (that can be seen as a synthetic KPI weighing approach) provides sensible results. A possible solution to overcome issues of the entropy method is for the weighing (and thus prioritising) of KPIs by stakeholders or an expert panel. KPI weighing by stakeholders may be burdensome. Further, having all stakeholders involved may be problematic as they may not have the competency to assess the technical nature of KPIs. Therefore, a preferred approach can be the weighing of KPIs by an expert panel to avoid issues of having all stakeholders involved.

3 Pre-demonstration and real-life Demonstration sites – an overview

The SHOW project includes Mega Sites, Satellite Sites and Follower Sites, see Figure 17. In total 18 areas will be involved in Demonstrations activities. In Chapter 4, an overview of each demonstration site is presented. The aim is to provide an overview of what all demonstration sites bring together. Each demonstration site is clearer described, together with its experimental plan in chapter 9. Carinthia has recently replaced the original Vienna site, whereas Monheim is under amendment to replace the original Mannheim site. In addition, the Rennes site of the French Mega Site is also under replacement.

The **Mega Sites in SHOW** include the following countries and cities:

- France: Rouen (Rennes site which is under replacement)
- Spain: Madrid
- Austria: Graz, Salzburg, Carinthia (Pörtschach and Klagenfurt)
- Germany: Karlsruhe, Aachen and Monheim (Replacement of Mannheim)
- Sweden: Linköping and Gothenburg (replacing Kista)

The **Satellite Sites** include the following countries and cities:

- Finland: Tampere
- Denmark: Copenhagen
- Italy: Turin
- Greece: Trikala
- The Netherlands: Brainport, Eindhoven
- Czech Republic: Brno

In addition, three **followers** are identified that are not addressed in D9.2 but will be included in the updated version D9.3 in a dedicated manner, depending on the specific in-depth evaluation that will be held in their context.

- Belgium, Brussels.
- Greece, Thessaloniki.
- Switzerland, Geneva

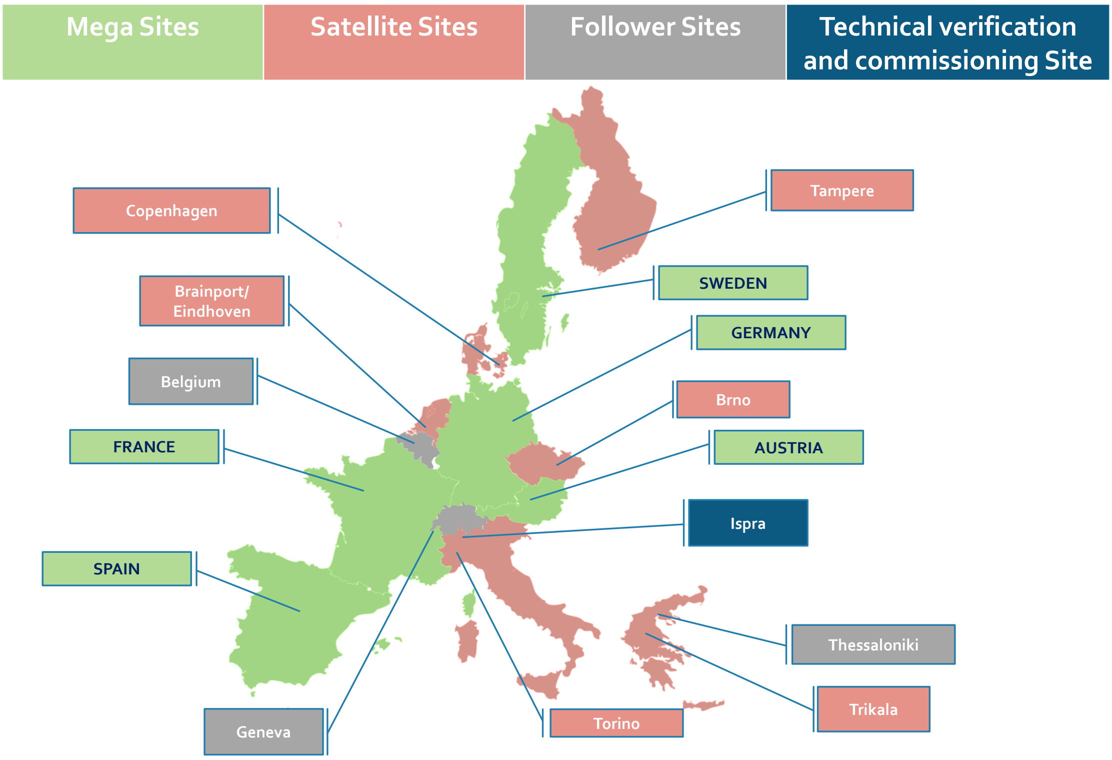


Figure 17: Mega Sites and Satellites in SHOW.

The SHOW demonstration plans and evaluations consists of 5 distinctive phases:

- **Licensing/Authorisation** where the respective permissions, if required, for real-life demonstrations will be acquired. This will be handled in WP3 Ethical and legal issues.
- **Technical verification & Commissioning** that will be held either in OEM labs or at the JRC site in Ispra. This will be done in WP11 Technical verification and pre-demo evaluations.
- **Pre-demonstration and its evaluations** that will be held in real traffic but with no passengers (only internal Consortium representatives from demo sites will participate in this phase). Those evaluations are rehearsals for the Demonstration. The planning work of the evaluations is done in WP 9 Pilot plans, tools and ecosystem engagement, and is the focus of this document (D9.2) and the realisation will take place in WP11 Technical verification and pre-demo evaluations.
- **Demonstration and its evaluations** are the final demonstrations that will take place at the demonstration sites. This will be done in WP12 Real-life Demonstrations, and the evaluation framework will be defined and described in WP 9 Pilot plans, tools, and ecosystem engagement. And here in the update of this deliverable (D9.3 with a due data of M22).
- **Post-demo services replication** with follower sites (existing and those connected during the project, including extra-European ones). This will be done in WP12 Real-life Demonstrations, and then, in turn in WP15 Dissemination, Training and Multiplication.

The pre-demonstrations and demonstrations will take place during roughly a time period of 24 months (not exactly the same period for all test sites though); the first months are for pre-demonstrations to secure the safe and reliable operation and commit relevant services in a modular manner, but also to evaluate the experimental plans and capturing and monitoring tools and provide the first pool of data required for the simulation activities of WP10. This will be followed by full-scale demonstrations aiming at 12 months pilot period at each demonstration site by average.

Hence, the pre-demonstrations are considered as “rehearsals” for the demonstrations in all aspects. The initial generic time plan for the period when the preparations, pre-demonstrations, demonstrations and post-demos is presented in Figure 18. Due to COVID-19, some delays might be expected. The final picture is not yet clear; the timeline is being continuously updated.

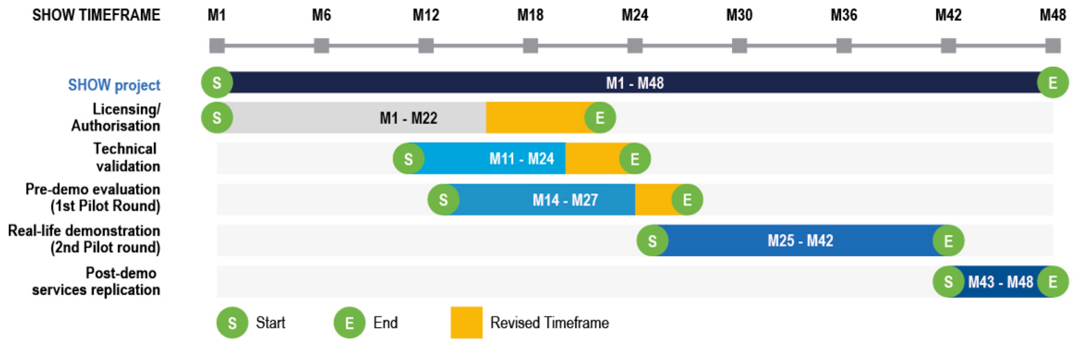


Figure 18: SHOW demonstration time plan with focus on Pre-Demonstrations and Demonstrations.

4 System and services identification – Demonstration plans

The demonstration plan describes what will be included at the different demonstration sites. It includes both systems and services and is the starting point for the Experimental plan describing the details on what to evaluate, what stakeholders to focus on, what research question to evaluate, using what tool and where to provide the data.

In Step 4 and Step 5 in the M3ICA analysis, see chapter 2.3.6 and 2.3.7, data collections in demonstrations and simulations will take place.

SHOW will cover a wide range of coordinated shared automated vehicle systems and services. At several demonstration sites, there are integrated MaaS services with automated, non-automated and multi-modal chains, and the connected automated fleets operation is being integrated at the actual city TMC where a remote-control tower is also operating (in most cases), including interfaces to other car sharing solutions, e-bike and bike rental, etc. Feeder services to peri-urban and low-density urban areas also take place with automated fleets operating fully autonomously or (for longer distances between the urban and peri-urban area) utilizing urban platoons.

The demonstration sites will support a mix of both fixed time-table solutions and on-demand solutions with flexible bus stops along the roadside. Connected MaaS solutions will integrate not only motorized solutions but also prioritized infrastructure for pedestrians and cyclists. The technical aspects of these automated functions and systems will be described below in a consolidated way to provide an overview of what will be included at the demonstrations sites and hence possible to evaluate the effects of.

4.1 Systems

4.1.1 Vehicles

SHOW will utilize an overall fleet of over 70 aVs of all types (buses, shuttles, pods, cars) operated as PT, DRT or as MaaS/ LaaS. They are on SAE L4 or L5 and based on existing vehicle concepts that are being further elaborated (TRL7) as well as on novel concepts (of initial TRL5-6); that are brought to TRL8 (i.e. automated cargo vehicle of UNIGENOVA). All test vehicles to be used at Mega and Satellite sites are presented in Table 7.

Table 7: Vehicles per site.

Country	City/Site	Vehicles	
France	Rouen	5 i-Cristal (Shuttle) + 1 backup tbd. 4 Renault Zoe (Robo-taxi)	 
France	*Rennes (to be replaced)*	*6 shuttles*	
Spain	Madrid–- Villaverde	1 IRIZAR–- i2eBus – (Coach Electric L3)	
Spain	Madrid–- EMT depot (Carabanchel)	2 TECNOBUS–- EMT–- Gulliver (Electric Minibus L2) 2 Renault–- TECNALIA–- Twizzy (Passenger car – L2)	 
Austria	Graz	1 Ford Fusion (Passenger car) 1 Kia e-Soul (Passenger car)	 
Austria	Salzburg	1 EasyMile EZ10, Gen 3 (Shuttle) 1 PT bus/shuttle (tbd)	

Country	City/Site	Vehicles	
Austria	Carinthia (Pörtschach and Klagenfurt)	2 Navya ArmaDL4 (Shuttle) 1 AV vehicle (tbd)	
Germany	Karlsruhe	2 EasyMile EZ10, gen 2 (AV Shuttles) Audi Q5 (AV Passenger car) 1 modular vehicle from DLR	
Germany	Aachen	1 automated passenger vehicle, 2 non-automated passenger vehicles–- retrofitted for ADF / V2V testing. 2 shuttles	
Germany	Monheim (replacement of Mannheim)	5 Shuttles. EM 10 Gen 2.	
Sweden	Linköping	1 Navya Autonomous DL4 (Shuttle) 1 EasyMile EZ10 gen 2 (Shuttle) 1 more EM will be ready for the final Demonstration (1 January 2022).	
Sweden	Gothenburg replacement for Kista	2 Navya Arma shuttles 1 vehicle to be added for the demonstration in 2022	

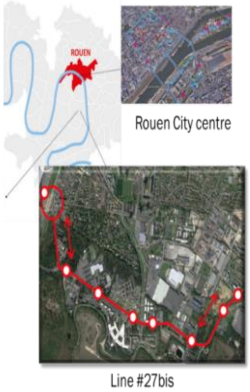
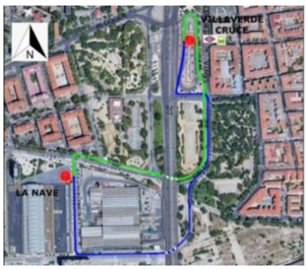
Country	City/Site	Vehicles	
Finland	Tampere	2 Sensible 4 Toyota ProAce vans, one AuveTech Iseauto shuttle. More (3 shuttles) will be added in 2022.	 
Denmark	Copenhagen	3 brand tbd (AV mini Shuttles) 2 brand tbd (AV mid-sized buses)	
Italy	Turin	1 AV Shuttle - Ollie 2 AV Shuttle–- NAVYA DL4	
Greece	Trikala	2 AMANI Swiss Cyprus Limited (iDriverPlus, Zhongtong Bus). 1 cargo autonomous vehicle FURBOT 2 passenger retrofitted L4 vehicles	 
Netherlands	Brainport, Eindhoven	1 brand tbd (AV shuttle, E-Bus on L4 level, provided by third party) 3 Renault Scenic (Passenger cars on L4 level)	 

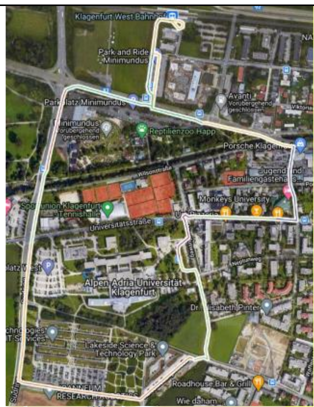
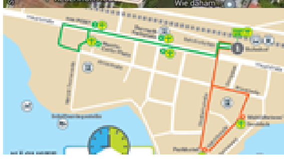
Country	City/Site	Vehicles	
Czech Republic	Brno	1 Hyundai i40 Retrofitted (Robo-Taxi), 1 Robotic Delivery Platform (Logistics), 2 Retro fitted Esagono, Energia, GRIFO	 

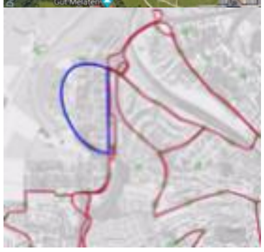
4.1.2 Environments

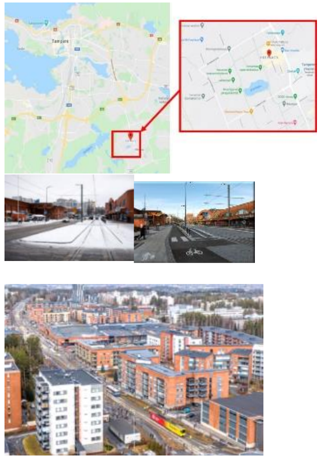
The SHOW demonstrations will take place in dedicated lanes but also in mixed flows, under real-life conditions. All urban traffic environments are represented, from dense city traffic to remote peri-urban areas and neighbourhoods, specific environments (University campus, hospital areas, business districts, cargo depot, link to key multi-modal hubs as airports or rail stations). The type of environment to use in the Pre-Demonstrations is seen in Table 8 as a complement to the use cases that elaborate more precisely the intended demonstration cases in each site. This will be revised in the updated deliverable (D9.3) using the work of WP8 "Infrastructure and functions" and the progress outcomes in this respect that will be reported in deliverable *D8.1: Criteria catalogue and solution to assess and improve physical road infrastructure*.

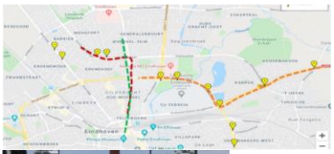
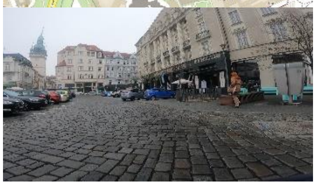
Table 8: Overview of the environment/ infrastructure at different sites.

Country	City/Site	Environment/ Infrastructure	Maps
France	Rouen	Urban and suburban. Including 8 V2X intersections, 2 linked to traffic lights controllers. Tests on a private test track in Versailles; Experimentation on a regular bus line enforced with i-Cristal automated shuttles in Technopole du Madrillet, Rouen; Experimentation of an on-demand Transport service in dense urban heart of Rouen in Renault ZOE (only part of the blue trajectory will be done in SHOW; the overall blue trajectory is the long-term ambition); Experimentation of an Operational Control Centre for fleet of multiband automated vehicles. https://www.rouennormandyautonomouslab.com	 
Spain	Madrid–-Villaverde	Restricted area–- a modern depot with different bus technologies (CNG, Hybrid, Electric). Semi-Controlled Area: Interaction with other non- automated buses and vehicles.	  
Spain	Madrid–-EMT depot (Carabanchel)	Urban and suburban: Villaverde round trip, from La Nave (Madrid City Innovation Hub) <–> Villaverde Bajo-Cruce Metro Station 800 m per journey (1,6 km line). The driving is in open traffic, including roundabouts. Urban route, where VRUs, mixed traffic, mixed lanes and dense traffic are present.	

Country	City/Site	Environment/ Infrastructure	Maps
Austria	Graz	An automated shuttle service between a suburban train station of Graz and a destination with high traffic demand (shopping centre) will be established with two automated vehicles. In this urban scenario the automated vehicles will stop at the terminal, pick up people and drive through the public stops where there are many pedestrians. With help from traffic infrastructure (e.g. guiding through traffic lights), vehicles will perform actions automated. The speed is slow.	
Austria	Salzburg	From the City of Salzburg to the peri-urban regions for leisure and recreation activities as well as for commuters, all in mixed traffic on public roads. Here a public road in rural area will be used. 1.4 km length one-way, paved, incline of 8 %, two separate driving lanes. 4 bus stops in each direction. Max. 20 km/h on public roads	  
Austria	Carinthia (Pörtschach and Klagenfurt)	Smart Urban Region Austria Alps Adriatic (SURAAA) is replacing the former site of Vienna. There are two test sites planned, Klagenfurt and Pörtschach. The test sites are in an urban and suburban environment. In Klagenfurt connecting the train and bus station of Klagenfurt West with the university of Klagenfurt, a science park, a work hub and residential area etc. with an automated shuttle. Conditions of mixed traffic, public roads and high traffic demand. Still in planning phase. In Pörtschach: connecting the train station of Pörtschach with the city center and the lake with an automated shuttle service on mixed traffic and on public roads.	 
Germany	Karlsruhe	Urban and peri-urban, mixed lanes, medium traffic density.	

Country	City/Site	Environment/ Infrastructure	Maps
Germany	Aachen	Peri-urban campus area “RWTH Campus Melaten Nord”. Mixed lanes for both PT and regular traffic. The traffic density is low to medium, consisting of PT, industrial and private vehicles, pedestrians and bicycles. The upper picture shows the test route, the lower picture the connection to the regular PT routes.	 
Sweden	Linköping	Urban area with a campus and residential area for a mix of people. Mixed traffic and shared spaces with VRUs. Speed limit is between 30-40 km/h. Mixed traffic has separate lanes for VRUs. Urban Campus area (the red area at the top) and a residential area (bottom right red area).	
Sweden	Gothenburg	Urban area. Scientific campus in the north-western district of Gothenburg. The traffic environment is urban with car/bus traffic, cars, pedestrians, cyclists and e-scooters, etc. The traffic density varies also across day, with rush hours in the morning, around lunch and in the afternoon/evening. VRUs don’t always have a dedicated lane / path along the AV route.	 

Country	City/Site	Environment/ Infrastructure	Maps
§Finland	Tampere	Hervanta suburb. Residential area in southern Tampere. Automated feeder transport service in Hervanta suburb to the new light rail station. The fixed route to be used is normally easy and smooth, but during winter challenging and includes also driving on the tram line corridor. Traffic lights and roundabout at the routes.	
Denmark	Copenhagen	The test area is at Lautrupgaard site, in Ballerup. It is a peri-urban area, with mixed traffic/mixed lanes, and will be driving on two types of roads: Smaller private roads (speed limits app. 20-30 km/h) and larger public roads that currently have speed regulation from 50-70 km/h. The area has several intersections. A BRT infrastructure will be implemented and then a change to dedicated lanes.	
Italy	Turin	The demonstration will take place in the City of Turin at the Health and Science area. The hospital of 'Città della Salute e della Scienza di Torino' passing through the usual traffic of the city, mainly on mixed lanes. Also a fenced area will be used for the test of the Ollie.	
Greece	Trikala	1. Inter-city bus terminal connection 2. Peri-Urban area DRT and MaaS 3. Urban freight transport LaaS. The environment is urban, no dedicated lanes. Mixed traffic with heavy density in specific hours per day.	

Country	City/Site	Environment/ Infrastructure	Maps
			 
Netherlands	Brainport, Eindhoven	Peri-urban and urban scenarios including straight roads and curved roads as dedicated bus lanes, intersections with traffic lights, crossing traffic at intersections, mixed traffic of passenger cars for automated mobility and busses. The bus lanes intersect normal traffic lanes, cyclists and pedestrian crossings. AV driving targeted for bus lanes. A part of the city that is one of the front-runner cities for C-ITS deployment, covering safe intersection crossings.	 
Czech Republic	Brno	Urban area. AV will operate in the historic centre of the city of Brno. 1 km, 5-6 stops, city centre, no road markings, one direction, shared with cyclists. The setting from the former project C-ROADS CZ will be partly used.	 

4.1.3 Digital infrastructures

All types of digital infrastructure and communications are employed at project sites of SHOW; among others 4G to 5G, LTE/IoT/ C-ITS G5 based interfaces for communication with non-equipped traffic participants, utilizing EGNOS/Galileo advanced positioning technologies, “Open message definitions” for all C-ITS stakeholders and relevant protocols and extended TM2.0 standard protocols are used, see Table 9.

Table 9: Overview of digital infrastructure at different sites.

Country	City/Site	Digital Infrastructure/sensors, systems & apps
France	Rouen	Smart infrastructure and secure telecommunications networks: ITS G5 networks, secure telecommunication networks, Private 4G+/5G Network, connected traffic lights, extended perception (with lidars, connected cameras).

Country	City/Site	Digital Infrastructure/sensors, systems & apps
		A supervision centre for the fleet of automated vehicles (located in the same room with the Public Transport Control Centre in Rouen). A user app to visualise the AVs position on the map; A DRT and a TMC operator centre will be integrated and evaluated.
Spain	Madrid - Villaverde	C- ITS (CCAM concept): Hybrid communication (RSU-ETSI ITS G5 – 5G), V2V, V2I. DGPS, Cameras, Radars, Lidars. a) Route + POE + Power supply, with access to power outlet. B) Communications antenna – to be placed on a mast / traffic light / lamppost, with connection to an Ethernet cable connected to a) equipment Maas concept will be used and evaluated.
Spain	Madrid - EMT depot (Carabanchel)	V2V: 4th generation of Commsignia's vehicular connectivity system V2I: Cinegears Ghost-Eye Wireless HDMI & SDI Transmitter 300M PT – EMT local TMC will be used and evaluated.
Austria	Graz	Smart camera platform from Siemens will be used on infrastructure to augment detection capabilities of vehicles sensors, bus stops. Travellers and public buses will be monitored. ITS-G5ITS-G5, 4G or 5G A DRT solution on fixed route will be used.
Austria	Salzburg	Communication technology: Road side units: ETSI-G5, 3GPP 4G and HD Map of the test route. RSU ETSI-G5, 3GPP 4G (LTE), ITS G5, 4G or 5G: GNSS correction system RSUs (related and not related to TLC) and OBU: Sensors: LiDARs, IMU, radar, odometry (all part of the EZ10 Gen 3 shuttle); cameras. PT: Service is planned to be integrated in PT MaaS: Service is planned to be integrated into a Maas App DRT: Demand responsiveness of the service is planned to be tested
Austria	Carinthia (Klagenfurt and Pörtschach)	4G to 5G, Wifi, C-ITS (connected traffic lights, smart lighting systems or cameras), GNNS-Navigation, Lidar sensors, cameras. DRT, MaaS/LaaS and PT services will be used.

Country	City/Site	Digital Infrastructure/sensors, systems & apps
Germany	Karlsruhe	The test area transmits local traffic information with several Roadside units (WLAN 802.11p ITS-G5), e.g. CAM, DENMs, SPaT and MAP messages. TMC for teleoperation supervision and on demand solution will be used.
Germany	Aachen	Aachen’s Campus Melaten Nord features a public 4.5G mobile network. Restricted 5G Campus Mobile Networks are also available. The 5G-Industry Campus Europe is being established here. MaaS, DRT and first/last mile feeder service will be used.
Sweden	Linköping	SAFE platform: a role-based, situational awareness platform that provides seamless information sharing between varied levels of users, designed to meet the ever-changing demands of day-to-day operations. In SHOW this is used for Connected Traffic Tower with remote monitoring & tele-operation. Radio, GPS (3G & 4G only) and GNSS are used. GNSS communication will be directly to the Navya shuttle with RTCM 3.2 MSM4 data form. MaaS, On demand and a TMC will be used.
Sweden	Gothenburg	5G Connected Traffic Tower with remote monitoring & tele-operation.
Finland	Tampere	LTE/5G and ITS G5. 5G & 4G network, intelligent lighting systems etc. will be complemented whenever required. LoRaWAN. 10 private 5G base stations in Hervanta suburb. SUMP and MaaS will be used. DRT to be added during or after SHOW.
Denmark	Copenhagen	Will be equipped with C-ITS infrastructure and traffic control centre. Road signs will be prepared to communicate with automated buses. Also a 5G network will be utilized. PT – BRT, Maas with focus on travel planning, DRT and a local TMC will be used.
Italy	Turin	TM system (TOC operated by 5T): traffic sensors, Intelligent Traffic Light Systems (51 centralised TLs; 39 Tls with PT Priority; 7 existing TLA-Traffic Light Assistant Enbled; 10 planned TLA Enabled), PMVs and 5G to be deployed completely by 2021. SUMP with pedestrian and bicycle asscess to PT will be used.
Greece	Trikala	4G, 5G, optic fibers network, Proximity sensors on traffic lights.

Country	City/Site	Digital Infrastructure/sensors, systems & apps
		DRT, MaaS, LaaS (on demand logistic) and prioritisation at traffic lights will be used.
Netherlands	Brainport, Eindhoven	L5 technology enhanced by hybrid ITS G5/cellular. Connected with C-ITS services, full 4G coverage, early 5G deployment and IoT service networks. Traffic light prioritisation, red light violation warning, green light optimal speed, emergency vehicle warning, platooning will be used.
Czech Republic	Brno	4G network. 6 Roadside units for C-ITS. TMC – remote control teleoperation, TMC – long distance, DRT and LaaS will be used.

Please note that the content of Table 9 is a snapshot as of December 2020 and is subject to change throughout the project.

4.2 Services

SHOW aims to promote and evaluate the future transformation of a current city traffic environment and ecosystem to a fully sustainable one driven by automation, electrification, cooperativeness, inclusiveness, and user friendliness. The SHOW Demonstrations will address the operation of motorised transportation means and fleets by bringing automated operation to all levels of city mobility from fixed route Public Transportation (PT) to Demand response transportation (DRT), connected Mobility as a Service (MaaS) and Logistic as a Service (LaaS).

Public Transportation (PT) SHOW integrates in its Demonstration sites several PT services, such as automated metro and automated buses. Relevant operations are also including parking, cleaning and maintenance services for automated PT fleets.

Mobility as a Service (MaaS) For first/last mile connection as well as covering all types of user needs, SHOW will research the links between automated fleets with MaaS services, including relevant car, e-bike and bike fleets. However, in the future many of these services will offer AVs, thus, SHOW connects also relevant automated MaaS to some of its sites. The MaaS might include planning, booking and payment solutions.

Demand Responsive Transport (DRT) Feeders and people movers currently form the backbone of emerging automated urban services and are present in all SHOW mega and satellite sites, over 70 such vehicles aimed to be used. At this point 67 of them are identified or under negotiation. Their operation ranges from first/last mile transport services to service lines for specific areas or linking flexibly a city centre with a peri-urban area. The DRT could be integrated as part of the MaaS concept.

Logistics as a Service (LaaS) Both for first/last mile delivery as well as for full urban logistics delivery of specific loads (mail, food, non-bulky commodities) automated vehicle fleets aim to constitute an improvement and SHOW considers them mainly in mixed schemes with passengers and goods delivery by common automated vehicle fleets, temporal (i.e. passenger at days, goods at nights) or spatial (passenger and goods in different compartments within the same vehicle or goods vehicle following the passengers one by platooning), but also as standalone.

Table 10: Overview of functions to be evaluated at different sites.

Country	City/Site	Service					
		PT	MaaS	DRT	LaaS	TMC	Other
France	Rouen	x		x		x	
Spain	Madrid - Villaverde	x	x				
Spain	Madrid - EMT depot					x	Existing TMC solution Platooning Automated parking
Austria	Graz			x			
Austria	Salzburg	x	x	x		x	
Austria	Carinthia	x	x	x	x		Covid adjusted services
Germany	Karlsruhe					x	Supervision
Germany	Aachen	x	x	x			Cooperative automated driving
Germany	Monheim			x			Platooning
Sweden	Linköping	x	x	x			Trunklines
Sweden	Gothenburg	x					Control tower
Finland	Tampere	x	x	(x)			SUMP/Sustainable Urban Mobility Planning method to be used
Denmark	Copenhagen	x (BRT)	x	x		x	Existing TMC solution
Italy	Turin			x		x	Control tower for teleoperated vehicles.
Greece	Trikala		x	x	x		Prioritisation at traffic light
Netherlands	Brainport, Eindhoven						Prioritisation at traffic light Red light violation warning Platooning
Czech Republic	Brno			x	x	x	Long distance Remote control - teleoperation

To summarize, an Automated transport systems classification was made based on the Trilateral Impact Assessment Framework for Automation in Road Transportation (Koymans et al., 2013). This was used to classify the automated systems included in the SHOW ecosystem to get an overview of what is targeted in the overall evaluation of SHOW, see Figure 19.

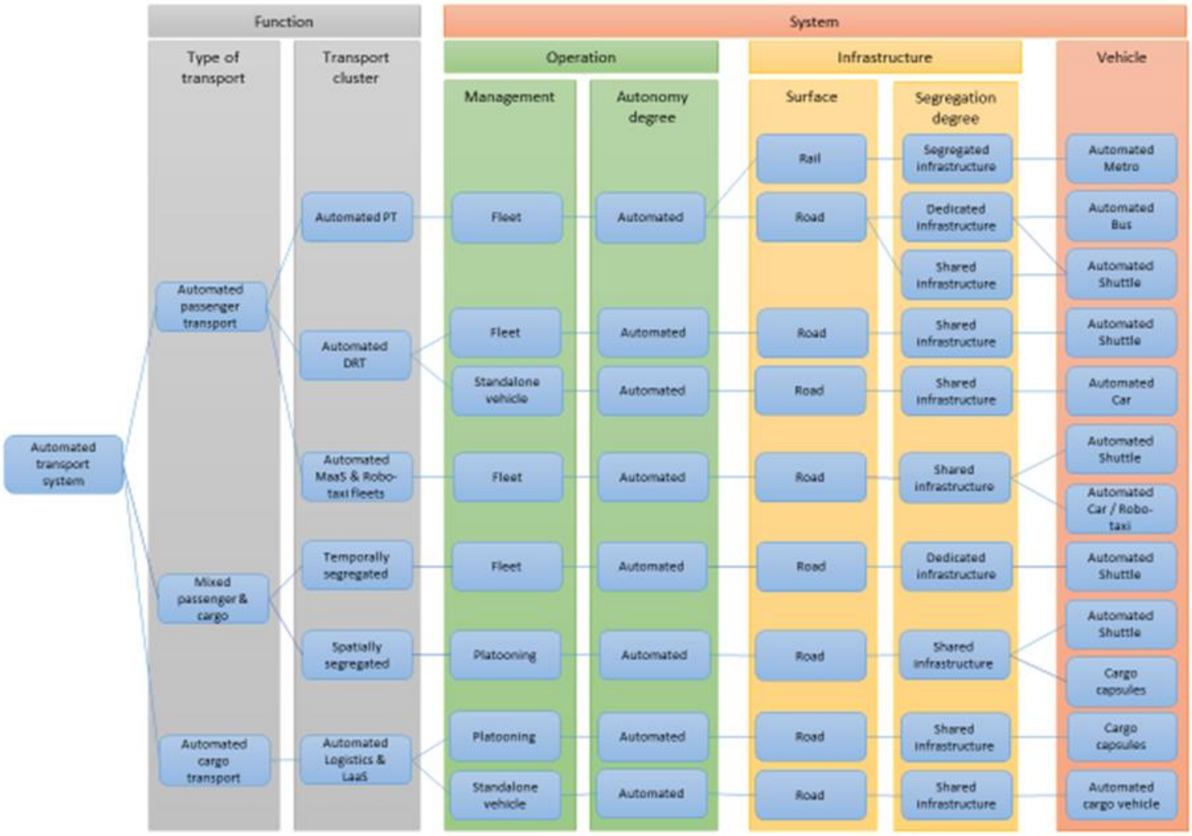


Figure 19: Automated transport systems classification modified from CityMobil2 project.

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5 Research questions

The overall aim of SHOW is to "support the migration path towards effective and persuasive sustainable urban transport through technical solutions, business models and priority scenarios for impact assessment by deploying shared, connected, electrified, fleets of automated vehicles in coordinated Public Transportation, Demand responsive Transport, Mobility as a Service and Logistics as a Service operational chains in real-life urban demonstrations across Europe". The research questions (RQ) to be answered in SHOW are derived from the Use Cases described in Deliverable D1.2: SHOW Use Cases. They are further specified for each impact area as described in chapter 2.3.

Table 11: UC and the connection to Research Questions.

Use cases	Research Questions
UC1.1: Automated passengers/cargo mobility in Cities under normal traffic & environmental conditions	How will road safety, traffic efficiency, mobility, and user acceptance be affected by AV operation (passenger or cargo) in a real city environment when operated in normal speeds, normal/smooth traffic context, without any traffic or other environmental complexity? Also, interfacing to any of the following modes: PT, DRT, MaaS and LaaS.
UC1.2: Automated passengers/cargo mobility in Cities under complex traffic & environmental conditions	How will road safety, traffic efficiency, mobility, and user acceptance be affected by AV operation (passenger or cargo) in a real city environment when operated in normal speeds but within a complex traffic or environmental context (e.g., curvatures in roundabouts, etc.)? Also, in cases of additional restrictions applied (e.g., heavy traffic, extreme weather conditions, etc.).
UC1.3: Interfacing non automated vehicles and travellers (including VRUs)	How will road safety, traffic efficiency, mobility, and user acceptance be affected by AV operation (passenger or cargo) in a real city environment when interacting with not automated (not connected) vehicles and/or VRUs?
UC1.4: Energy sustainable automated passengers/cargo mobility in Cities	Will AV operation (passenger or cargo) using an energy sustainable operation be able to cover the same services as the conventional vehicles?
UC1.5: Actual integration to city TMC	How will road safety and traffic efficiency be affected when AV operation is integrated to TMC in a real city environment together with the overall traffic supervision?
UC1.6: Mixed traffic flows	How will road safety, traffic efficiency, mobility, and user acceptance be affected by AV operation in a real city environment when operated in mixed flows with AV and non-AV vehicles?
UC1.7: Connection to Operation Centre for tele-operation and remote supervision	How will road safety, traffic efficiency and user acceptance be affected by AV operation connected to a control centre for teleoperation and remote supervision in a real city environment?
UC1.8: Platooning for higher speed connectors in people transport	Can platooning of passenger transport at higher speeds contribute to improved traffic efficiency, energy consumption and environmental impact of transport?
UC1.9: Cargo platooning for efficiency	Can platooning of cargo transport contribute to improved traffic efficiency, energy consumption and less space consumption?
UC1.10: Seamless autonomous transport chains of Automated PT, DRT, MaaS, LaaS	What will the societal, economic, safety, and environmental effects of using seamless autonomous transport chains of Automated PT, DRT, MaaS, LaaS be?
UC2.1: Automated mixed spatial mobility	How will traffic efficiency, energy consumption, and user acceptance be affected by using the same AV for passenger/cargo delivery at the same time?

Use cases	Research Questions
UC2.2: Automated mixed temporal mobility	How will traffic efficiency, energy consumption, and user acceptance be affected by using the same AV for passenger/cargo delivery, but at different times?
UC3.1: Self-learning Demand Response Passengers/Cargo mobility	How will transportation services (mobility) be affected by using services based upon self-learning DRT?
UC3.2: Big data/AI based added value services for Passengers/ Cargo mobility	How will transportation services (mobility) be affected by using services based upon big data and AI algorithms?
UC3.3: Automated parking applications	How will efficiency be affected by the use of AVs self-parking functions?
UC3.4: Automated services at bus stops	How will traffic efficiency and road safety be affected by automated services at bus stops?
UC3.5: Depot management of automated buses	How will traffic efficiency and safety be affected by automated services at AV depot areas?

Table 12: Overview of use cases in focus at each site.

	UC 1.1	UC 1.2	UC 1.3	UC 1.4	UC 1.5	UC 1.6	UC 1.7	UC 1.8	UC 1.9	UC 1.10	UC 2.1	UC 2.2	UC 3.1	UC 3.2	UC 3.3	UC 3.4	UC 3.5
Mega Demonstration Sites																	
Rouen site	×	×	×	×	×	×	×			×			×			×	
Linköping site	×		×			×	×						×	×		×	
Gothenburg site	×	×	×			×	×									×	
Madrid site	×	×	×			×	×	×		×					×		×
Graz site		×	×													×	
Salzburg site		×	×		×	×							×				
Carinthia site	×	x				×					x						
Karlsruhe site	×	×				×	×		×		×	×					
Aachen site	×			×		×				×						×*	
Monheim *(not formally endorsed yet)*	×					×		×									
Implementation score	*82%*	*55%*	*64%*	*27%*	*18%*	*82%*	*45%*	*18%*	*9%*	*36%*	*9%*	*27%*	*27%*	*9%*	*9%*	*45%*	*9%*
Satellite Demonstration Sites																	
Turin site		×	×		×		×			×							
Trikala site	×	×	×			×	×	×		×							
Tampere site	×	×	×	×			×										
Copenhagen site	×	×	×	×	×	×							×	×		×	
Brainport site	×		×					×									
Brno site	×	×	×			×	×										

*With the change of UC 3.4 definition Aachen is addressing this.

6 Evaluation methods

6.1 Key Performance Indicators

A list of KPIs, that will be collected by the demonstration sites and in simulations, was defined through an iterative feedback loop by the SHOW partners, as defined in the M3ICA framework, under section 2.3.6, and is overviewed in Table 5.

Use cases were matched to not only research questions but also to demonstration sites (as defined in D1.2) (see also Table 13, and for KPIs see Appendix V. In the listing of KPIs and their relationship to specific UCs business and project success targets or KPIs are excluded since they are generally appliable to all UCs.

The demonstration sites have reviewed the KPIs list and have provided their first outlook on the feasibility of collection for their site. Still, in the coming months, this list together with all other data needs for the project will be elaborated in the context of SP2 and will be inevitably revisited. Bilateral effort (from the technical teams' point of view and the demo sites point of view both) will be done to cover the so far identified gaps and unavailability as much as possible to the maximum extent possible.

Table 13: KPI matching with demo-sites

KPI #	Impact	Rouen	Linköping	Gothenburg	Madrid	Graz	Salzburg	Carinthia	Karlsruhe	Aachen	Monheim	Turin	Trikala	Tampere	Brainport	Brno	Copenhagen
1	Road accidents (leading to human injury)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
2	Conflicts	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3	Safety enhancement	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
70	Traffic flow	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
71	Vehicle occupancy	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
72	Illegal overtaking	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
74	Lateral and longitudinal headways	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
75	Harsh cornering	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
76	Road accidents (leading to material damage)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
4	Average speed	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
5	Acceleration variance	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
6	Hard brake events	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
7	Non-scheduled stops	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
9	Service reliability	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
10	Distance travelled with travellers	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

KPI #	Impact	Rouen	Linköping	Gothenburg	Madrid	Graz	Salzburg	Carinthia	Karlsruhe	Aachen	Monheim	Turin	Trikala	Tampere	Brainport	Brno	Copenhagen
11	Distance travelled without travellers	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
8	Scheduled number of stops	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
24	Average vehicle occupancy	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
36	Vehicle utilisation rate	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
37	Number of passengers	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
39	Persons km travelled	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
43	Level of inequality in transport	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
40	Resolving inequality in transport (target)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
41	Empty vehicle km	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
47	User reliability perception	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
49	User safety perception	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
50	Travel comfort	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
52	Perceived usefulness	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
53	Willingness to pay	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
54	Willingness to share a ride	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
26	Energy use	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
27	CO_2, PM, NO_x emissions	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

KPI #	Impact	Rouen	Linköping	Gothenburg	Madrid	Graz	Salzburg	Carinthia	Karlsruhe	Aachen	Monheim	Turin	Trikala	Tampere	Brainport	Brno	Copenhagen
29	Noise	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
51	Use of automated driving functions	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
65	Operative revenues	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
42	Operative cost	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
38	Cargo transported	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
81	Precision of deliveries	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
82	Customer satisfaction	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
83	Unit cost of delivery	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
84	Load factor patterns	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
85	Public acceptance	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
86	Willingness to pay for AV urban deliveries/logistics	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
87	Number of accidents at the logistics site	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
88	Accidents in AV UFT facility	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
89	Incidents of crime / theft in AV UFT facility	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
90	Number of incidents involving vandalism in AV UFT facility	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-
91	Loss and damage parcels at the AV UFT facility	-	-	-	-	-	-	✓	✓	-	-	-	-	-	-	-	-

6.2 Study design

A study design can be described as the procedure of employing research methods to recruit participants, administer interventions, and collect data. The difference between descriptive and experimental studies should be differentiated. Descriptive studies refer to situations in which vital research factors, such as gender or age, cannot be modified.

As already mentioned, the SHOW pre-demonstrations and final demonstrations will follow the generic plan presented in Figure 18. It is again underlined that this document (D9.2) is focused on the planning of the pre-demonstrations and its evaluations. As mentioned before, the pre-demonstrations are the rehearsal of the demonstrations both in terms of realisation and evaluation that will encompass all value chain of stakeholders.

Users involved in the pre-demonstrations will come solely from the consortium beneficiaries plus some “observer” travellers that will be incentivised by the test site authorities to participate.

The experimental plans for the pre-demonstrations will be evaluated in detail across all technical and user experience aspects defined therein, and revisions, if needed, will be implemented in the updated final version of the evaluation framework (D9.3). Till then, it might be the case and to align with the upcoming progress and evolution of the project in many regards, that an update of the current issue will also emerge for the pre-demo phase itself. In parallel the work of WP11 will result in the final set-up for pre-demo of the same WP but also real-life demonstrations in WP12.

Before the SHOW demonstration sites can start, there is a need for technical verification and validation of the systems and functions. The framework for this will be defined and developed in *D11.1: Technical Validation Protocol*, a work held in WP11. The aim is to ensure a satisfying level of robustness, reliability, and safety of all types of vehicles and other key technical ends of the system (communication, cybersecurity, etc.) which are part of the SHOW fleet across the demonstration sites, considering the use cases included in the different demonstration sites and the related KPIs and their need for measures.

The full demonstrations will be performed as a part of WP12 activities. All data to cover all KPIs and the needs for simulation will then be gathered together with a detailed reporting to support the evaluation results for the needs in WP10 for simulations and WP13 for impact assessment, as well as plan future replication actions with follower sites, to enhance the identified impacts target in SHOW. Data will be stored locally at demonstration sites and will be at defined events be uploaded to the Data Management Portal (DMP) of SHOW defined in WP5 and then, visualised through the SHOW Dashboard in WP4 (there might be updates in the way data will stored and communicated and variations among sites that will follow the evolution of SP2 technical work of the project though).

All data collected will be shared across partners and needs to comply with the Ethics and Data Protection Policy defined in *D3.4: SHOW updated Ethics manual & Data Protection Policy and Data Privacy Impact Assessment*. The key data flows need to be reported in the Data management plan upcoming updates (D14.3).

For each demonstration site the aim is to provide a clear description of **Why, What** and **How** data collection for evaluation will take place. This is documented in the Experimental Plan for each demonstration site, see chapter 9.

The demonstration will run for a specific time, and during this time data collection will take place both continuously and at pre-defined occasions. The study design has its starting point in the use cases, the related research questions (see Chapter 6) and the KPIs (see Chapter 7.1).

From an end user perspective, SHOW aims to consider the needs and wants of all citizens, with specific consideration and demonstrations for specific user clusters, such as tourists, commuters, the elderly, persons with restricted mobility, students, children.

6.3 Stakeholders

Relevant stakeholders for the SHOW project were identified in chapter 2.3.3.1 within the M3ICA methodology. For this project, the identified stakeholders are the following:

- Vehicle users (end users, drivers, and remote operator)
- Public interest groups and associations
- Decision-making authorities or regulators
- Operators (e.g., public transport operators, private fleet operators)
- Mobility service providers
- Industry (e.g., AV manufacturers)

In the case of AV logistics, the following stakeholder groups were identified in addition to the mobility stakeholder groups:

- Senders
- Receivers
- Delivery service providers

In Table 14, an overview of stakeholder groups at each demonstration site is presented. More details on the stakeholders at each demonstration site is presented in chapter 9.

Table 14: Overview of stakeholders at different Demonstration sites.

Cities	Passenger mobility stakeholders						Logistics stakeholders		
	Vehicle users	Public interest groups and associations	Decision-making authorities or regulators	Operators	Mobility service providers	Industry	Senders	Receivers	Delivery service providers
Rouen	x	-	x	x	-	x	-	-	-
La Nave - Madrid	x	-	x	x	x	x	-	-	-
Depot - Madrid	x	-	-	x	x	x	-	-	-
Graz	x	-	x	x	-	x	-	-	-
Salzburg	x	-	x	x	-	-	-	-	-
Carinthia	x	x	x	x	-	x	-	-	-
Karlsruhe	x	x	-	-	-	-	x	x-	-
Monheim (under formal endorsement)	*x*	*x*	*x*	-	*x*	*x*	-	-	-
Aachen	x	x	x	x	x	x	-	-	-
Linköping	x	-	x	x	x	-	-	-	-
Gothenburg	x		x	X	x	x	-	-	-
Tampere	x	-	x	x	x	x	-	-	-
Copenhagen	x	x	x	x	x	x	-	-	-
Turin	x	-	x	x	x	x	-	-	-
Trikala	x	-	-	x	-	-	-	-	-
Brainport, Eindhoven	x	-	x	x	x	x	-	-	-
Brno	x	-	x	x	x	-	-	-	-

6.4 End users

In SHOW a wide range of user categories are included in the evaluations. First, SHOW addresses all citizens at each site. There are also some target stakeholders in mind, described in *D1.1: Ecosystem actor's needs, wants & priorities & user experience*, Appendix 1 of D1.1.

The target end users at each demonstration site are presented in Table 15.

Table 15: Overview of targeted end user at different demonstration site.

Mega site/ Satellites	**City**	**End Users**								
		Commuters	**Residents**	**Students**	**Children/ young adults**	**Elderly**	**Tourist/ Visitor**	**Hospital visitors**	**VRU**	**PRM**
France	Rouen	x	x	x	x	x	x			
Spain	Madrid - Villaverde	x							x	
	Madrid - EMT depot (Carabanchel)								x	
Austria	Graz								x	x
	Salzburg	x	x				x			
	Carinthia			x			x			x
Germany	Karlsruhe	x	x							
	Aachen	x	x	x						
	Monheim (under formal endorsement)	*x*								
Sweden	Linköping	x	x	x	x	x				x
	Gothenburg	x	x				x		x	
Finland	Tampere	x*		x	x	x	x			x
Denmark	Copenhagen				x	x				x
Italy	Turin		x			x		x		x
Greece	Trikala	x		x		x			x	x
Netherland	Brainport, Eindhoven	x		x		x				
Czech Republic	Brno	x		x	x	x	x			x ***

Comment: VRU (cyclist, pedestrians, kickboard users etc., PMR=persons with special mobility requirements; * immigrants; *** blind.*

7 Capturing and monitoring tools and measurements

7.1 Collecting Data for Impact Assessment

In SHOW, various data are captured for different purposes. For various services implemented at the different demo sites such as traffic management, fleet management or predictive routing as well as for the SHOW dashboard, data need to be captured and transmitted in real-time during operation. These activities are covered in WP4 and WP5, respectively, whereas WP9 and in particular A9.2 are concerned with delivering the necessary data for the impact assessment performed in WP13.

In this sense, the capturing and monitoring tools fulfil the purpose to record the data needed to calculate the KPIs (and potential further data that will be progressively recognised) which help answering the different research questions associated with the SHOW use cases, as sketched in Figure 20.

Figure 20: Connection between research questions, KPIs and capturing/monitoring tools.

To allow for a comprehensive impact assessment, it must be made sure that all data captured at the different demonstration sites arrive in a consistent format and that all necessary information are included. Particularly,

- The implemented use cases, the associated research questions as well as potential peculiarities of the different demo sites have to be considered.
- The technical properties of the data to be recorded have to be aligned with the dashboard and the big data collection activities.
- The necessary pre-processing steps for measurable data have to be specified and aligned with the expectations from WP10 and WP13.

All these mentioned interactions with other activities and work packages within SHOW are depicted in Figure 21.

Since the different demo sites implement different use cases which are related to different research questions and thus KPIs, not all monitoring tools are relevant for all the sites, and not all observations have to be performed at all the sites. This implies that some of the KPIs might be refined by WPs 10 and 13 over the next months (and maybe based on some first feedback from the pre-demo activities in WP11), and especially the practical implementation of the measurements will show their feasibility across the different demo sites.

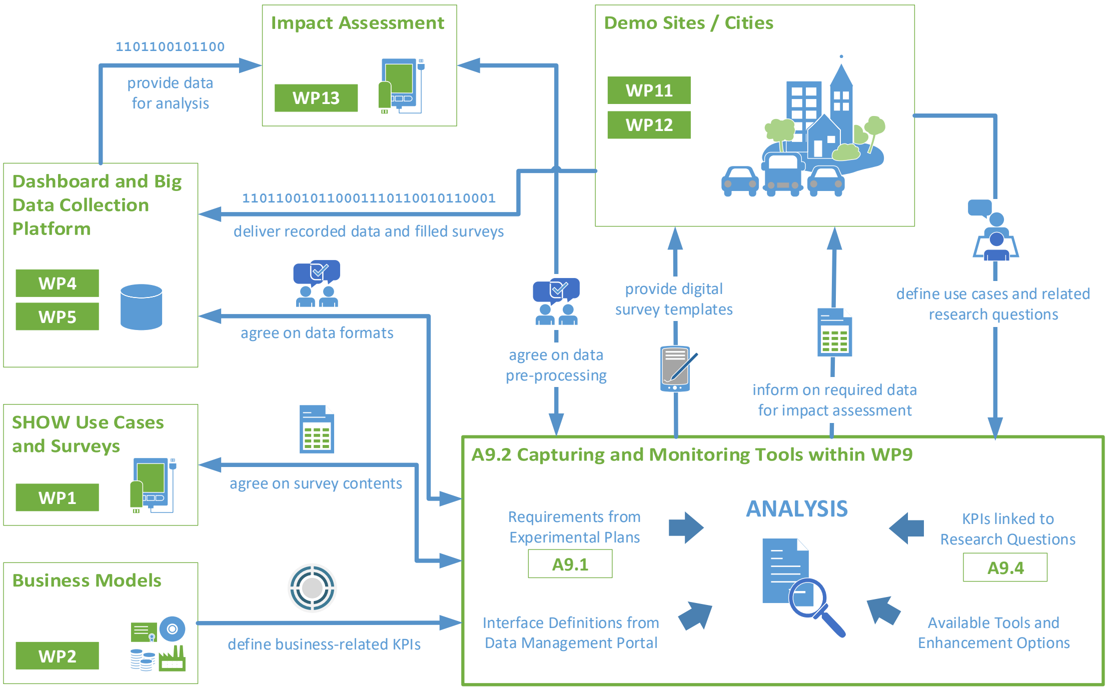


Figure 21: Interactions of A9.2 with other SHOW work packages.

7.2 Capturing and monitoring tools

The subjective and objective data analysis tools for the demonstrations are defined and developed in A9.2. The basis for the selection and further development of those tools are the Key Performance Indicators (KPIs, see chapter 6.1) defined in A9.4 which themselves depend on the different Research Questions (RQs) connected to the use cases which will be implemented at each demonstration site.

In the following, the different tools will be presented in detail.

7.2.1 User questionnaires

User questionnaires will be used to assess most of the subjective data. They will focus on experience, usability, user acceptance, trust and socio-economic questions and will be performed by using different questionnaires integrated in a web tool. It is then up to the different demo site owners to decide if their users should complete the questionnaires online, or if it might be more suitable to use pen and paper and to digitize the results later on.

The deliverable D1.1: Ecosystem actors' needs, wants & priorities & user experience exploration tools have proposed some recommendations concerning the user questionnaires and interviews with other stakeholders. Nevertheless, not all of the questions may be relevant for all of the demo sites as they address a certain use case, so at some sites, only a sub-set of the full questionnaire may be used.

The Table 16 resumes the instruments / tools suggested per user/stakeholder type.

Table 16: Synthesis of survey targets, campaign, instruments, moment, target, administration, and tools (defined by WP1).

User/ Stakeholder	Campaign	Instrument	When	Target	Administration	Tool
Traveller (passenger/ driver)	Needs / wants, *a priori* acceptance & intention to use	Long questionnaire	Before the implementation of the pilots	230 end-users per Mega Site and 65 per Satellite site	Online via invitations	Typeform, surveymonkey, socsurvey, etc.
	Acceptance *a posteriori* & intention to (re)use	Short questionnaire (15-questions)	On-site during the automated services piloting (3 measurement times: end of the pre-demo, at the midterm of demo, at the end of the demo)	230 end-users per Mega Site and 65 per Satellite site per measurement time	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, etc.
	Satisfaction	1-question	On-site during the automated services piloting	As much as possible	Travellers respond directly in the vehicle	Feedback strips
OEM, Operators, authorities, infrastructure operators, Tier 1 service providers, etc.	Needs/wants, acceptance & intention to deploy	Interview	Before the implementation of the pilots	20 stakeholders per Mega Site and 8-10 per Satellite site	Face to face	Hard copy/ tablet/ recordings
	Needs/wants, acceptance & intention to deploy	Interview	On-site during the automated services piloting (3 measurement times: end of the pre-demo, at the midterm of demo, at the end of the demo)	20 stakeholders per Mega Site and 8-10 per Satellite site per measurement time	Face to face	Hard copy/ tablet/ recordings

- The survey contents are developed in WP1 and WP2, respectively, in cooperation with A9.4 to ensure compliance with all relevant KPIs.
- The questionnaires are developed in English language and will subsequently be translated into the different languages which apply for the different demo sites. The translations will be done once per language by volunteers from the SHOW consortium and then provided to the different demonstration sites. This means that, for example, one and the same "German" version of a questionnaire will be available for all German and Austrian sites.
- The digital questionnaire templates for the long questionnaire will be provided to the demo sites which are then responsible for their execution during both the pre-demo and the actual demonstration phases as well as for the digital data transfer to WP13.

User questionnaire will be performed with different reasons and at different times depending on its aim, see Figure 22. At each demonstration site there will be questionnaires collecting data repeatedly three times. Those consists of 15 questions based on validated survey tools. Finally, there will be a continuously used question throughout the demonstrations using only one question with focus on the users' satisfaction. All questionnaires are found in Appendix II: Questionnaires for Travellers.

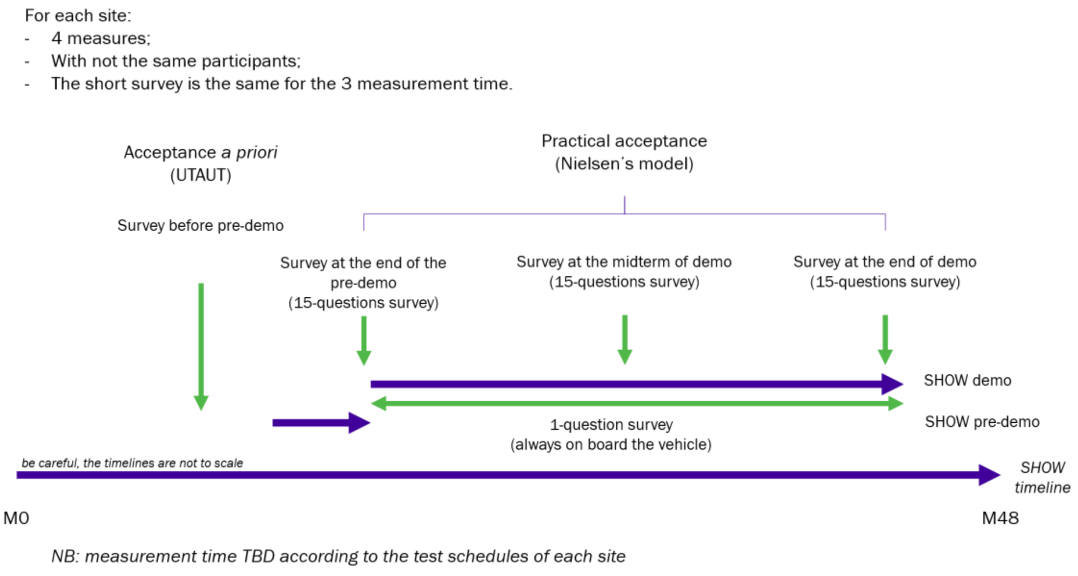


Figure 22: Timeline for SHOW questionnaires (From WP1).

7.2.2 Interviews with other Stakeholders

There will be a total of four rounds of interviews with other stakeholders (i.e. SHOW ecosystem except travellers such as OEMs, research and academia) at each demonstration site. The first round of interviews ("before the pre-demos") will be considered all relevant technical and economic factors, as prepared in WP1. These interviews will be analysed qualitatively. For the following interview rounds, also verbal interviews will be conducted.

For each site there will be interviews a priori to the demonstrations and after the pre-demonstration, mid-term during demonstrations and after demonstration, see Figure 23. The interviews a prior to the demonstrations are more extensive and addressed to a selection of stakeholders relevant for each demonstration site. All interview guidelines are found in Appendix III: Interviews with Stakeholders.

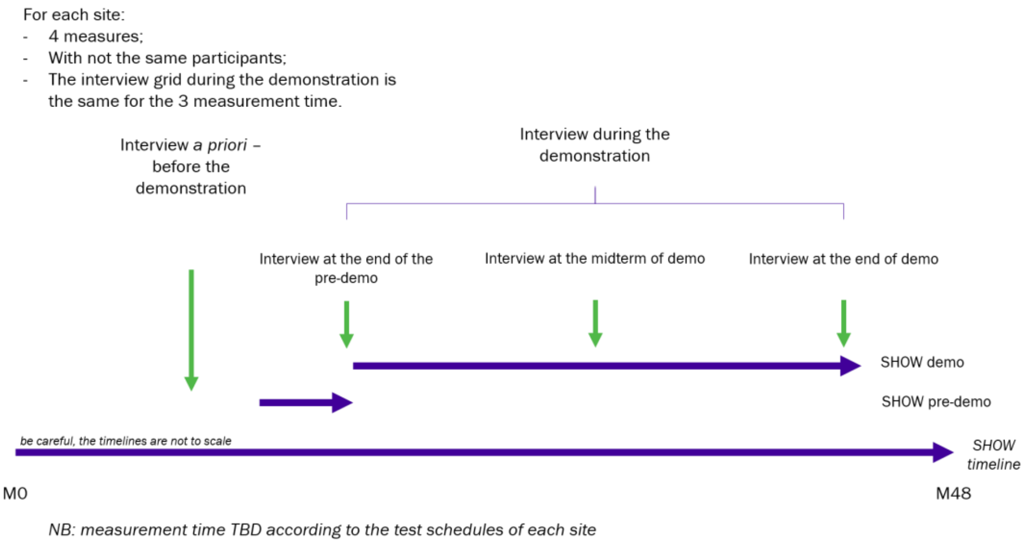


Figure 23: Timeline for SHOW Interviews (From WP1).

7.2.3 User engagement

The overall objective of A9.3, as a horizontal task within SHOW, is to support the SHOW demonstration sites in reaching out to end-users and other stakeholders and to guide and monitor their engagement plans and efforts. As part of A9.3, Ideathons and Hackathons will be organized, to recognize gaps and collect solution-oriented ideas to improve the services proposed by SHOW. In addition to these dedicated activities, the *Framework and guidelines for a successful stakeholder engagement process* developed within A9.3 will support the sites in developing their own customized engagement strategy and plan, adapted to the local context and taking into account the specificities of each Demonstration site in terms of objectives, stakeholders involved, user groups addressed, and factors affecting user acceptance.

These strategies are conceived as a ‘living document’, to be updated regularly as the project progresses, and cover the following core questions:

- Who are the local stakeholders, who are the end-users?
- Which communication channels and tools can we use to reach out to them?
- How can we engage and involve stakeholders and end-users in SHOW?
- How can we encourage people to try out the SHOW services?
- How can we exploit synergies with planned SHOW events – tools – actions?

Identifying the stakeholders and end-users

The first step in the engagement process is identifying who the end-users and stakeholders are. A stakeholder can be defined as any individual, group or organization that is impacted by the outcome of the project. Stakeholders are hence: those who may become (potential) users or partners; those on whom the project outcomes can have a positive or negative impact; and those who could contribute to better solutions with their knowledge or experience. Starting from the general inventory of stakeholders and end-user groups that are relevant, per site (as described earlier in this deliverable), the next important step is to identify good representatives for each of these. The SHOW local demo boards are a good place to start from. Are all relevant stakeholders involved there? Are there any important ones missing (including representatives of the targeted end-user groups)? We also need to consider intermediaries that can help communicate about and promote the SHOW services.

1. Communication channels and tools

The list of possible communication channels & tools to use for reaching out to stakeholders and end-users is quite long and diverse. The choice of optimal channels & tools depends on the target groups addressed and on the local situation in each pilot. Some examples are presented below:

- **Printed materials**: leaflets, posters, stickers, etc. can be distributed e.g. at the city hall, in theatres, libraries, bars, shops, restaurants, hospitals, schools, etc.
- **Press**: pilot partners could issue a press release, organise a press conference, propose interviews etc. which can lead to exposure in (local) newspapers, magazines, radio, television etc.
- **Videos** are a really attractive means of promoting the SHOW services. It is recommended that pilot sites record some video materials that can further be disseminated.
- **Social media**: social media posts can be shared by SHOW partners and relevant intermediaries; paid Facebook advertisements can also be considered as an additional option.

- For reaching out to **professional** stakeholders, LinkedIn is a good medium; in addition SHOW partners are many and they can each leverage their professional networks.
- **Advertising** is an option not only on social media, but also for example on other web pages, in newspapers and magazines, at public transport stops and stations, on billboards in the street etc.
- Especially (but not only) in case the SHOW service forms part of the **public transport** service, cooperation with the PT operator is crucial and the service can be promoted on buses, trams, metros, in stations etc.
- **Apps & booking sites**: promote the service through the websites and apps people use to look up information & buy tickets for transport or e.g. in case of a hospital book an appointment.
- Cooperation with **local & regional authorities** is also important, and using their relevant communication channels (e.g. city magazine, newsletters, city website etc.).
- **Information screens** can feature information about the SHOW services, e.g. at the city hall, in the library, at the reception or lobby of businesses, hotels, hospitals, etc.
- Participation in relevant **events**, big and small (e.g. fairs, exhibitions, workshops – also perhaps very local events like markets or local festivities), providing e.g. information stands.
- **Letters and calls**: in collaboration with local authorities, it could be considered to reach out to individual citizens by sending them a letter, phoning them, etc.
- **E-mailing**: respecting GDPR rules, such e-mailing can be done by organisations that are in direct contact with potential end-users, e.g. universities reaching out to their staff and/or students, schools reaching out to pupils & their parents, enterprises in a business park reaching out to their employees, organisations representing PRM or elderly people reaching out to their members, etc.
- If possible, specific **marketing** events and campaigns can be devised in collaboration with a professional agency.
- Intensive **educational campaigns** can be done in city halls, schools, universities, touristic information centres, housing associations, unions etc. This can include different materials, e.g. information leaflets, webinars, videos, infographics etc.
- **Targeted** communication (different messages & tools for different target groups) and **accessible** information (also understandable by persons with a disability and people with low education) is necessary to reach a wide audience, including vulnerable groups.

Figure 24: Example of how the AV services can be promoted at the bus stop (Linköping).

At each pilot site, several SHOW partners are active, who can each mobilise their own network of contacts. In the pre-demo phase of SHOW, this will be sufficient to gather responses to the pre-demo try-outs and surveys that are planned at each site. During the demonstration phase, more efforts are needed, to expand the existing reach, and we should count on relevant intermediaries that can help spread the news, inform a broad audience about the SHOW pilots and recruit participants for both the SHOW services and the accompanying user acceptance surveys.

In general, after identifying the target groups per pilot, there is a need to actively connect to them through existing organisations, (social media) communities and platforms. Intermediary organisations can help by reaching out to their own members or network. Some examples of useful intermediaries:

- Local administrations, such as municipalities (different departments: police, transport, …)
- Transport operators (including travel service e.g. MaaS providers)
- Businesses and organisations involved e.g. hospitals: employees, visitors etc.
- Citizen groups, community and voluntary organisations, etc.

Depending on the specific user groups that are targeted, other intermediaries will be relevant, for example student associations, schools, tourist associations, local businesses (delivery use case), organisations representing people with a disability, etc.

For a good example, watch the video made by the Linköping pilot, showing which stakeholders are involved and how the AV service is visualised on the field: at the bus stops (signs and sometimes additional information), on the bus itself, and on the road (markings, coloured asphalt).

2. **How to engage stakeholders and end-users?**

In addition to communicating about the SHOW services, we also would like to involve end-users and stakeholders in a more intensive way, asking their input and feedback on the proposed services and gathering ideas on how to improve them.

The different levels of citizen engagement / public participation are shown in the picture below, based on the categorisation by the International Association of Public Participation (IAP2):

1. *Informing*: to provide balanced and objective information in a timely manner;
2. *Consultation*: to obtain feedback on analysis, issues, alternatives and decisions;
3. *Involvement*: to work with the public to make sure that their concerns and aspirations are considered and understood;
4. *Collaboration*: to partner with the public in each aspect of the decision-making;
5. *Empowerment*: to place final decision-making in the hands of the public.

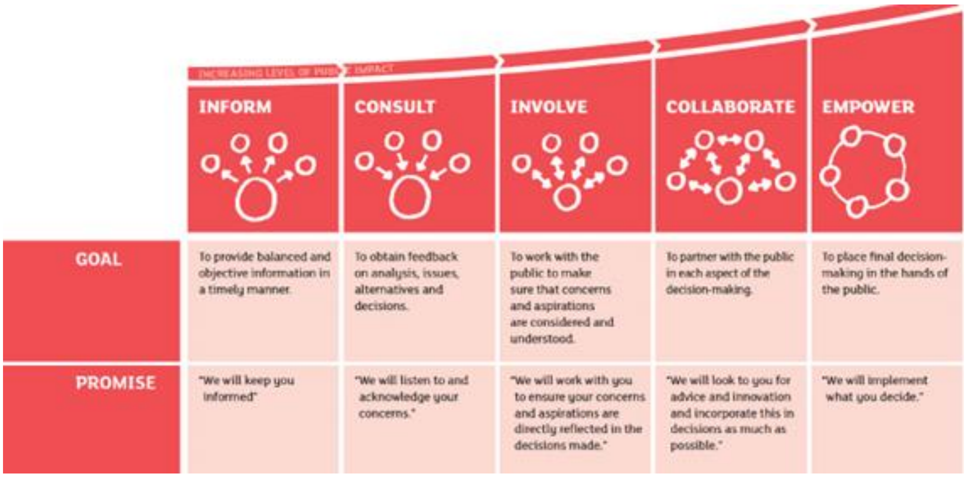


Figure 25: (c) International Association for Public Participation www.iap2.org (Source: Place Speak)

There are many ways of engaging citizens, reflecting different levels of engagement. Some examples are presented below. The choice for specific activities depends on the target groups, the local situation, and the desired level of public participation (in SHOW, this will be mainly consulting – through the user acceptance surveys and involvement / collaboration – through the user engagement and co-creation activities):

- **Co-creation workshop / 'Ideathon'**: Co-creation or co-design workshops are an interactive type of workshops, focusing on gathering new innovative ideas from a diverse group of participants who are invited to think out of the box, using creative methodologies. Many subtypes are possible, e.g. World Cafés, Serious Play games, modelling, mind mapping etc.

- **Hackathon**: A Hackathon is a 1- to 3-day workshop during which attendees form multidisciplinary teams that together, in a spirit of positive competition, develop prototype solutions for a specific problem. Originally, Hackathons referred to developing software only, nowadays they can also refer to non-IT events. Outcomes of a Hackathon can be: software, prototypes, pitches, business models, demos etc.

- **Crowdsourcing campaign**: Crowdsourcing generally means 'outsourcing work to the crowd', typically using the internet. Crowdsourcing can be used for different purposes: to gather data, to develop new content, to raise funds, to generate new innovative ideas etc.

- **Citizen dialogue**: Citizen dialogues are large-scale debates with citizens on a specific topic. Missions Publiques organized a series of citizen debates on the future of driverless mobility.
- **Citizen participation platform**: Digital platforms for citizen participation such as the open source one Decidim allows organisations to set up participatory processes with numerous functions: participatory budget, debate, contribution space, questionnaires/forms, etc.
- **Focus group**: A focus group can be defined as a 'group interview involving a small number of demographically similar people or participants who have other common traits / experience' (Wikipedia). They are an important tool for obtaining feedback on new products / services.
- **Interview / survey**: A survey or interview can be used to ask specific questions to a group of either stakeholders or end-users. A uniform set of questions enables to compile feedback and results to draw relevant conclusions.

SHOW pilot sites are encouraged to organize such more in-depth engagement activities with citizens and/or local stakeholders, as useful input to get solution oriented ideas, recognize gaps or SHOW solutions limitations.

3. Incentivisation and nudging strategies

How to encourage people to use / try out the SHOW services? Again, the answer to this question will depend on the user groups targeted and the specific local context in each pilot. However, it is relevant to list some general advice and ideas. To summarise:

- make it easy to use;
- make it attractive to use;
- offer help for first use;
- make it clear what the benefits are.

Firstly, **people need to know that the service exists** before being able to use it. It is therefore necessary to promote and advertise the service, communicate about it in different ways to target users. Communication campaigns, marketing, providing information about the service, is crucial (see above).

Secondly, as is already foreseen in many or even all SHOW pilots, the AV services provided will be **free of charge**, at least during the initial phase (pilots). Rather than being a real incentive, this can take away at least one barrier for people to try out the service. Related to price, it is also important, if applicable, to make it very easy for people to buy a ticket and, if possible, to **integrate** the service into the existing public transport network.

Thirdly, important barriers for people are **not knowing how the service works** and **not being sure it is safe**, and, as a result, not being confident or willing to try it. Many different possibilities exist to address this issue. For example, information leaflets can be made available (digital and on paper) with clear information about the service, what the conditions are and how it works. Another option is to make a short tutorial film, which for example could be shown at the stop, on the vehicle or even in other places, such as screens in the entrance of office buildings, hospitals, etc.

Human assistance is important to consider. Especially for first use, it is a good idea to have someone present, either at the stop and/or on the vehicle, to just 'be there', explain to people how the service works, answer any questions they may have, and help in case of trouble. This could be a safety driver, another personnel member, but also a volunteer. Such assistance could be provided permanently or on certain 'open days', for example. Group try-outs are also possible, for example school children together with their teacher, elderly people together with a peer trainer etc. Snowball referrals (a first wave of users spreading the message) are quite efficient.

In addition to the above, other **incentives** could be thought of, to **make the experience overall nicer and more rewarding**. Such small rewards could be:

- Incentives packages, in collaboration with local businesses, e.g. free vouchers for a coffee, a T-shirt of SHOW, stickers, free gadgets, etc.
- Introduce a competition element, e.g. a lottery, a drawing contest for children, pick a name for the shuttles, diploma for children having used the service, etc.
- Make the experience nicer, e.g. with music on board, a photo booth, etc.

Overall, when communicating about or promoting the service, we need to **make it very clear what the advantages are**: SHOW AV services can have a positive impact on inclusion / accessibility, environment, congestion and liveability in cities, … And in general, for people to use the service, we need to make sure it is: affordable, comfortable, fast, reliable, safe and easy to use. We need to make it clear and tangible what the (rational and emotional) benefits are. Focus on user needs (cf. involving users in the development) leads to better acceptance and uptake.

4. User acceptance surveys

In SHOW the user acceptance surveys will be conducted in different stages, a baseline measurement before the implementation of the pre-demonstrations and one on-site measurements in the end of the pre-demonstration. Later on in the Demonstrations they will be repeated two times more (mid and end of Demonstration).

Pre-demonstration phase – before implementation of the pilots

In the pre-demo phase, before the actual implementation of the pilots with real i.e. 'public' end-users, two main activities are planned:

- a (long) a priori acceptance survey, targeted at a broad public. A specific survey will collect the view of those VRUs outside the operation and the safety operators.
- interviews with stakeholders – will take place with individual interviews.

How to recruit participants for the stakeholder surveys?

- A contact list will be compiled and validated by each demonstration site manager.
- A specific communication needs to be drawn up, making sure that stakeholders understand the purpose and feel encouraged to participate.
- For the interviews with stakeholders, SHOW partners will mobilise their own network of contacts which should be sufficient to gather enough responses. A preliminary list of interesting stakeholders to approach is included in D9.2 per pilot site.

How to recruit participants for the (long) a priori user acceptance surveys?

The a priori user acceptance survey is targeted at a broader audience, and hence requires broader dissemination. The a priori acceptance survey is a long one and is available online.

Different methods can be used to recruit participants:

- **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.
- **Stakeholders in the demo site's ecosystem** – The various stakeholders could send an e-mail to all their employees inviting them to complete the online questionnaire and distribute it to their personal networks via their communication service (newsletter, website homepage, etc.).
- **Social networks** – Communication can be made both through a link to the online survey on the websites of the various stakeholders, but also via their social networks (Twitter, LinkedIn, Instagram, Facebook, etc.).
- **Posters and flyers** – Posters can be displayed on notice boards and flyers can be distributed near high-traffic areas (public transport, shopping centres, universities, large companies, etc.). Flyers can also be distributed in mailboxes.
- **Interviewers with tablets** – Interviewers can be mobilised to recruit participants directly in high-traffic areas or close to the site of the new service. Participants can complete the online survey directly on the tablet.
- **Local associations or users' committees** – It may be useful to approach local associations or users' committees to mobilise their members by providing them with the link to complete the online survey.
- **Local authorities** – Local authorities can be asked to communicate about the new service, for example in a local newspaper/newsletter or on their website.
- **Information day for users in the neighbourhood** – If possible, organising an event for the inhabitants of the neighbourhood before the deployment of the service informs them about the service and meanwhile also invites them to complete the online survey.
- **Specific agency of panel recruitment** – A specific agency of panel recruitment can be used to recruit a large sample quickly. In this last case, incentives for voluntary participants have to be defined, to motivate them to participate.

For the a priori surveys, a big audience is targeted, **also people from outside the SHOW demo sites** can participate. For this, all SHOW partners will make use of their social media channels and leverage their networks.

Demonstration phase – implementation of the pilots

In the demo phase, during the actual implementation of the demonstrations with real i.e. 'public' end-users, the following activities are planned:

- a (short) acceptance survey (15 questions) on site in three iterations: end of the pre-demo phase, middle of the demo phase, end of the demo phase, targeted at a broad public
- 1-question satisfaction surveys during the demonstrations on site

- interviews with stakeholders on site in three iterations: end of the pre-demo phase, middle of the demo phase, end of the demo phase – either individual interviews or focus groups.

How to recruit participants for the (short) user acceptance surveys & 1-question satisfaction surveys?

During the pre-demo phase (for most sites, the timing for this will be Q3-Q4 2021 and Q1 2022), the SHOW demonstrated services will (with some exceptions) normally not be accessible to the general public. A small number of end-users will be involved in the pre-demonstrations but in this stage, such users will come solely from the consortium beneficiaries (e.g. employees from the PT companies) plus some "observer" travellers that will be invited to participate by the SHOW test site authorities.

For the Demonstration phase, however, more efforts are needed, to expand the existing reach, and we should count on relevant intermediaries that can help spread the news. In general, after identifying the target groups per site, there is a need to actively connect to them through existing organisations, (social media) communities and platforms. Intermediary organisations can help by reaching out to their own members or network.

- The population of end-users will be mainly made up of people from each of the Demonstration sites. Depending on the site, different user groups may be targeted.
- A specific communication needs to be drawn up, making sure that end-users understand the purpose and feel encouraged to participate.
- Recruitment can be done with the help of local stakeholders (e.g. advertising displays, collaboration with local associations) or a specialised agency.
- Incentives need to be defined, to motivate passengers to make us of the services and when doing so, in one go, also fill in the questionnaire.

In the Demonstration phase, the recruitment of participants for the planned surveys will run in parallel with the recruitment of participants for the SHOW service in general. For this, the general guidelines and strategies for communication & user engagement as described above can be applied.

Unlike the long a priori surveys in the pre-demo phase, on site questionnaires during the demo phase are short and can be filled in directly in the vehicle, during the journey. 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)** – this 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.

For the 15-questions survey:

- If the population is recruited to test the services, the questionnaire should be included in the procedure;
- If the service is open to all people:
  - A specific poster should be made in the demonstration site environment;
  - The on-board staff should inform the users that a questionnaire is available;
  - In or near the services, questionnaires should be available in the form of paper/pencil with a drop box;
  - Staff members could ask users to participate via tablets or paper/pencil at the exit of the service.

For the 1-question survey:

- It is possible to have an agent on board who asks users directly at the exit of the service and/or a tablet/stick/etc. is always available inside the vehicle for users to answer or paper/pencil with a drop box for people to evaluate the service;
- For real-life use testing we can apply contextual methods (i.e. Guerilla interviewing, so we can bring the testing to the public/user area; a bit unsophisticated but can be very effective and rich and at the same time non (or little) obtrusive), and administer primarily close-ended, easy question items via pods (e.g. via emoticons). Feedback pods can be installed at selected hubs and in the vehicles.

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.

5. Ideathons and Hackathons

As part of A9.3, Ideathons and Hackathons will be organized, to recognize gaps and collect solution-oriented ideas to improve the services proposed by SHOW. Ideathons – co-creation workshops with citizens and core stakeholders – are conceived as creative brainstorming sessions focusing on end-user needs. Importantly, SHOW will attempt to implement the solutions that come up during these Ideathons in practice by organizing follow-up Hackathons during which the best ideas coming from the Ideathons will be further developed. In a third step, the outcomes of the Hackathons will again be evaluated by end-users and stakeholders in a round of focus groups.

Figure 26: Three-step approach for Ideathons, Hackathons, Focus groups.

The first SHOW Ideathon took place on 15. January 2021 and was organized by ERTICO, EPF, EUROCITIES, UITP and CERTH/HIT, consisting of three phases: Context setting – Brainstorm – Enrichment. The Ideathon focused on the main priorities/needs of end-users in different contexts for CCAV. These priorities were based on SHOW research conducted in A1.1 and other relevant sources, notably the citizen dialogue events organised by Missions Publiques dealing with public acceptance of automation and the recent survey on needs, wants and behaviour of AV users conducted by the Drive2the Future project. After careful assessment of the Ideathon outcomes with the project team, three ideas were selected to be taken forward to the first SHOW Hackathon, which is currently being prepared:

- 24/7 surveillance on board and stand-by human assistance
- Flexibility to adapt capacity to increased demand and potential impact on bus depots
- Accessibility, audio-visual messaging and assistance for PRMs across the whole trajectory

During the demonstration period in SHOW, we plan further Ideathons, in collaboration with SHOW pilot sites as part of their overall citizen engagement strategies. The idea is there to collect end-users' input and feedback on the concrete services that they have been able to experience. Some of the end-users' ideas can possibly be directly implemented, which can lead to direct improvement of the services. Other ideas will take more time and effort to be developed. The latter could, combining results from all Ideathons across SHOW pilot sites, be taken to a subsequent Hackathon.

7.2.4 Observations

7.2.4.1 Continuous Measurements

Observations will target user behaviour, user performance or system performance and will be captured through log files, video recordings or objective measurements. For this purpose, data from different sensors both from the vehicles and the infrastructure will be recorded. Where direct measurements are not possible, estimations will be performed instead.

- The demo sites are provided with a list of mandatory data types (= quantities to be measured) based on the research questions addressed at the respective site. The sites own KPIs are given in Table 13 on page 90.
- How these quantities are assessed is left open to the demo site owners, thus allowing for maximum operational flexibility while still maintaining a high degree of data quality and minimizing technical efforts at the sites. As an example, the number of passengers during a ride could be assessed through AI methods analysing the video stream from an in-cabin camera, but as well be estimated based on the current vehicle weight or counted manually by an operator with a tally list.

- Among the main contributions from A9.2 is the definition of calculation methods which yield the KPIs required for the Impact Assessment in WP13 based on these recorded data. These methods have to be harmonized with the requirements and expectations from the respective work packages which will analyse the data later on. The current state of the discussions is described in section 7.3; the final definitions will be provided in the subsequent deliverable, D9.3.
- The recorded data can be either streamed live to the cloud (as mandatory for different SHOW services) or logged locally and transferred to a central database at a later stage.

7.2.4.2 Situational Variables

In addition to these continuously measured variables, several situational variables will help in interpreting the measurement data. A preliminary list has been provided by WP13 which will be used during the pre-demo activities (see Table 17).

Table 17: Preliminary list of situational variables.

Variable Name	Explanation
Weather	Weather conditions such as dry/wet, sunny/cloudy/foggy, rain/snow/sleet/hail, etc. Road condition (wet/dry) may also be relevant.
Sight conditions	Unrestricted/restricted (e.g. fog, snow, rain, glare from sun)
Road type	Road or network characteristics: motorway, rural road, urban road, speed limits, number of lanes, number of intersections, …
Road works	Road works (planned/unplanned, restricting capacity or not, lanes closed, …)
Incidents	Incidents, events, calamities that may influence traffic demand or infrastructure supply in the area
Traffic conditions	Traffic conditions: level of service – from hardly any traffic to congested, period of the day, day of the week, season, holiday, …
Traffic composition	Vehicle types allowed / dominant type of vehicle types on the road / …
Traffic control	Traffic control / traffic management (operational characteristics: traffic light states, bridge open, …)
Area type	In- or outside built-up area
HMI	Way of informing or warning travellers/drivers

Based on the outcomes of the pre-demonstration phase, both categorizations and specifications of the single variables might be revised which will be reported accordingly in the subsequent deliverable, D9.3, or in an intermediate update of D9.2 prior to that.

7.3 Measurements

Table 18 lists the relevant KPIs for the real-world demonstrations at the different demo sites, excluding those which are covered by the surveys and interviews, calculated using simulation methods or in post-processing steps as high-level features of other KPIs.

For each KPI, four important aspects are given:

- the *underlying measurement channel* describes the measurable quantity which forms the basis for the calculation.

- the *calculation method* is a pseudo-code description of how the respective KPI should be calculated from the measured data.
- the *monitoring frequency* indicates “how often” this KPI should be calculated to facilitate a meaningful impact assessment.
- the *baseline* tells us which existing data sources could be used to assess the benefits of shared automated mobility in relation to the state of the art. For most of the selected KPIs, it should be possible to define a reasonable baseline which allows to assess the benefits of automated urban mobility solutions over the existing public transport systems. However, these baseline values will be highly specific to the respective site and the use cases implemented. Most of the network-based quantities including average speeds, distances, service reliability etc. as well as operational costs and revenues are known to and should be available from the local PTOs[5]; and there are web services available which provide timetables and sometimes even live data feeds from several locations worldwide as GTFS files[6].

On the contrary, it is virtually impossible to define a baseline for KPIs related to safety or driving style (such as conflicts or harsh cornering), because these values are simply not assessed as long as a human driver is in control of the vehicle.

The information in Table 18 is valid for the pre-demonstrations and subject to changes after the evaluation of the pre-demo phase. The KPI numbering has been re-defined during the creation and revision of this deliverable, so two IDs are given: the consecutive numbering (e.g., “KPI #1”) refers to the historical will be superseded by the categorical reference (e.g., “B1”) in the future.

Table 18: KPIs and measurements.

KPI #1 (B1)	**Road accidents (accidents/year)**
Underlying Measurement Channel	(observation)
Calculation Method	---
Monitoring Frequency	Counter – once per occurrence
Aggregation rule	Sum
Condition (dimension slab)	Per vehicle or per km
Baseline	Statistics of road accidents over a certain time period, individually for each demo site, depending on availability
KPI #2 (B2)	**Conflicts (conflicts/ km)**
Underlying Measurement Channel	Time to Collision, Time Headway, Hard Breaking
Calculation Method	conflict = (TTC < 1.5s) OR (TH < 1.5s) OR (hard_breaking == 1)
Monitoring Frequency	Counter – once per occurrence
Aggregation rule	Sum
Condition (dimension slab)	Per vehicle or per km
Baseline	No baseline exists, as this quantity is generally not measured
KPI #4 (B7)	**Average speed (km/h)**

[5] Urban Mobility Indicators: https://ec.europa.eu/futurium/en/system/files/ged/convenient-access-to-public-transport.pdf

[6] The OpenMobilityData portal at transitfeeds.com currently provides data from 1327 providers in 677 locations worldwide (as of November 2021).

Underlying Measurement Channel	Vehicle Speed [km/h]
Calculation Method	avg_speed = mean(vehicle_speed)
Monitoring Frequency	One value per non-stand-still phase
Aggregation rule	Average
Condition (dimension slab)	Per vehicle
Baseline	Comparison to (non-automated) vehicles currently used in the public transport fleet. If those data are not available, network average speed could be used as calculated from PT timetables
KPI #5 (B8)	**Acceleration variance (m^2/s^4)**
Underlying Measurement Channel	Vehicle Acceleration [m/s^2]
Calculation Method	acc_var = var(vehicle_acceleration)
Monitoring Frequency	One value per non-stand-still phase
Aggregation rule	Variance
Condition (dimension slab)	Per vehicle
Baseline	Comparison to (non-automated) vehicles currently used in the public transport fleet
KPI #6 (B9)	**No. hard breakings per km (#/km)**
Underlying Measurement Channel	Vehicle Acceleration [m/s^2]
Calculation Method	hard_breaking = (vehicle_acceleration < -3m/s^2), normalization over distance
Monitoring Frequency	Counter – once per occurrence
Aggregation rule	Sum
Condition (dimension slab)	Per vehicle
Baseline	No baseline exists, as this quantity is generally not measured
KPI #7 (B10)	**No. non-scheduled stops per km (#/km)**
Underlying Measurement Channel	(observation)
Calculation Method	(counting and normalization over distance)
Monitoring Frequency	Counter – once per occurrence
Aggregation rule	Sum
Condition (dimension slab)	Per vehicle
Baseline	No baseline exists, as this quantity is generally not measured
KPI #8 (B11)	**No. scheduled stops per km (#/km)**
Underlying Measurement Channel	(observation)
Calculation Method	(counting and normalization over distance)
Monitoring Frequency	Counter – once per occurrence
Aggregation rule	Sum
Condition (dimension slab)	Per vehicle
Baseline	Scheduled stops from PTO databases, available as GTFS files
KPI #9 (B12)	**Service reliability (%)**
Underlying Measurement Channel	Time of Departure (both actual and planned) Time of Arrival (both actual and planned)
Calculation Method	punctuality = |ToD_actual - ToD_Planned| OR |ToA_actual - ToA_planned|
Monitoring Frequency	One or two values per stop
Aggregation rule	---
Condition (dimension slab)	Per vehicle

Baseline	Planned ToD and ToA as available in PTO databases, actual ToD and ToA to be provided by local PTOs
KPI #19 (B13)	**Distance travelled with passengers (km)**
Underlying Measurement Channel	(passenger detection method – to be decided by each demo site individually)
Calculation Method	km_with_trav = (no_passengers > 0), normalization over distance
Monitoring Frequency	Continuously – one value per second
Aggregation rule	Sum
Condition (dimension slab)	Per vehicle
Baseline	The number of passengers between consecutive stops is not available in public databases, to be requested from local PTOs
KPI #11 (B14)	**Distance travelled without passengers (km)**
Underlying Measurement Channel	(passenger detection method – to be decided by each demo site individually)
Calculation Method	km_wout_trav = (no_passengers == 0), normalization over distance
Monitoring Frequency	Continuously – one value per second
Aggregation rule	Sum
Condition (dimension slab)	Per vehicle
Baseline	Not available in public databases, to be requested from local PTOs – could be calculated from distance <u>with</u> travellers and total distance
KPI #24 (A3)	**Increase in average vehicle occupancy (%)**
Underlying Measurement Channel	(passenger detection method – to be decided by each demo site individually)
Calculation Method	pass_occupancy_percent = (no_passengers / max_no_passengers) * 100
Monitoring Frequency	One value between stops
Aggregation rule	Average
Condition (dimension slab)	Per vehicle
Baseline	Occupancy statistics are available in some public databases, otherwise to be requested from local PTOs
KPI #26 (B26)	**Energy use (as appropriate: kWh/km, liter/km, J/km)**
Underlying Measurement Channel	(direct measurement, depending on powertrain type)
Calculation Method	---
Monitoring Frequency	Continuously – one value per second
Aggregation rule	---
Condition (dimension slab)	Per vehicle
Baseline	Depending on state of the art – either data from non-automated vehicles of same kind, or average data on network level (to be provided by local PTOs)
KPI #27 (B27)	**CO2, PM, NOx Emissions (g/kg)**
Underlying Measurement Channel	(direct measurement, depending on powertrain type)
Calculation Method	---
Monitoring Frequency	Continuously – one value per second
Aggregation rule	---
Condition (dimension slab)	Per vehicle
Baseline	Depending on state of the art – either data from non-automated vehicles of same kind, or average data on network level (to be provided by local PTOs)
KPI #36 (B32)	**Vehicle utilization rate (%)**

Underlying Measurement Channel	Vehicle Speed [km/h]
Calculation Method	util_rate_percent = time_where_speed>0 / total_time
Monitoring Frequency	Continuously – one value per second
Aggregation rule	Average
Condition (dimension slab)	Per vehicle
Baseline	Historical data to be provided by local PTOs (where non-automated shuttle services are already implemented)
KPI #37 (A9)	**No. passengers (#)**
Underlying Measurement Channel	(passenger detection method – to be decided by each demo site individually)
Calculation Method	(counting, only “incoming” passengers)
Monitoring Frequency	Counter – one value per stop
Aggregation rule	Sum
Condition (dimension slab)	Per vehicle
Baseline	Occupancy rates are usually available in PTO databases
KPI #38 (A14)	**No. cargo (#)**
Underlying Measurement Channel	(cargo detection method – to be decided by each demo site individually)
Calculation Method	(counting, only “incoming” cargo)
Monitoring Frequency	Counter – one value per stop
Aggregation rule	Sum
Condition (dimension slab)	Per vehicle
Baseline	Historical data to be provided by local cargo delivery companies
KPI #39 (A10)	**Person km travelled (special groups) (% person kms)**
Underlying Measurement Channel	(passenger detection method – to be decided by each demo site individually)
Calculation Method	km_with_special_trav = no_special_passengers > 0, normalization over distance
Monitoring Frequency	Continuously – one value per second
Aggregation rule	Sum
Condition (dimension slab)	Per site
Baseline	No baseline exists, as this quantity is generally not measured
KPI #40 (A13)	**Ratio of average load (m^3/m^3)**
Underlying Measurement Channel	(cargo detection method – to be decided by each demo site individually)
Calculation Method	pass_cargo_percent = (volume_cargo / max_volume_cargo) * 100
Monitoring Frequency	One value between stops
Aggregation rule	Average
Condition (dimension slab)	Per site
Baseline	Historical data to be provided by local cargo delivery companies
KPI #41 (A11)	**Empty vehicle km (%)**
Underlying Measurement Channel	(passenger detection method – to be decided by each demo site individually)
Calculation Method	km_wout_trav = no_passengers < 1, normalization over distance
Monitoring Frequency	Continuously – one value per second
Aggregation rule	Average
Condition (dimension slab)	Per vehicle

Baseline	Not available in public databases, to be requested from local PTOs – could be calculated from distance with travellers and total distance
KPI #42 (A12)	**Operative cost (EUR/km)**
Underlying Measurement Channel	(general calculation)
Calculation Method	---
Monitoring Frequency	Once (post-processsing after the demos)
Aggregation rule	---
Condition (dimension slab)	Per site
Baseline	Historical data to be provided by local PTOs
KPI #65 (B33)	**Operative revenues (EUR/km, EUR/trip)**
Underlying Measurement Channel	(general calculation)
Calculation Method	---
Monitoring Frequency	Once (post-processsing after the demos)
Aggregation rule	---
Condition (dimension slab)	Per site
Baseline	Historical data to be provided by local PTOs
KPI #70 (B4)	**Traffic flow (Number of vehicles /km)**
Underlying Measurement Channel	(observation)
Calculation Method	---
Monitoring Frequency	Counter - once per occurrence
Aggregation rule	Sum (traffic count), Average (traffic flow)
Condition (dimension slab)	Per route of each site
Baseline	General traffic count indicators are available at city level, can be provided by the city's transport authority[7]
KPI #72 (B3)	**Illegal overtaking (Events/km)**
Underlying Measurement Channel	(observation)
Calculation Method	---
Monitoring Frequency	Counter - once per occurrence
Aggregation rule	Average (over route distance)
Condition (dimension slab)	Per vehicle
Baseline	No baseline exists, as this quantity is generally not measured
KPI # (B5)	**Lateral and longitudinal distances (km)**
Underlying Measurement Channel	(direct measurement)
Calculation Method	---
Monitoring Frequency	Continuously – one value per second
Aggregation rule	---
Condition (dimension slab)	Per route of each site
Baseline	No baseline exists, as this quantity is generally not measured
KPI #74 (B6)	**Lateral and longitudinal headways (Seconds)**

[7] An example is Brussels Mobility providing a live API for traffic count in their open data platform (https://datastore.brussels/web/data/dataset/9a047e86-3947-424a-84e8-a192f18a735a). Such data can be requested from cities participating in the pilot demonstrations (if they do collect it).

Underlying Measurement Channel	(direct measurement)
Calculation Method	---
Monitoring Frequency	Continuously – one value per second
Aggregation rule	---
Condition (dimension slab)	Per route of each site
Baseline	No baseline exists, as this quantity is generally not measured
KPI #80 (B36)	**Punctuality of deliveries (%)**
Underlying Measurement Channel	Time of Delivery (both actual and scheduled)
Calculation Method	punctuality = |ToD_actual - ToD_scheduled|
Monitoring Frequency	One value per delivery
Aggregation rule	Sum
Condition (dimension slab)	Per service
Baseline	Historical data to be provided by local cargo delivery companies
KPI #81 (B37)	**Precision of deliveries (#)**
Underlying Measurement Channel	Number of packages
Calculation Method	(no_packages_arrived / no_packages_sent) * 100
Monitoring Frequency	One value per delivery
Aggregation rule	Sum
Condition (dimension slab)	Per service
Baseline	Historical data to be provided by local cargo delivery companies
KPI #83 (B39)	**Unit cost of delivery (EUR/km, EUR/shipment, EUR/vehicle)**
Underlying Measurement Channel	(general calculation)
Calculation Method	---
Monitoring Frequency	Once (post-processing after the demos)
Aggregation rule	Average
Condition (dimension slab)	Per service
Baseline	Historical data to be provided by local cargo delivery companies
KPI #84 (B40)	**Load factor patterns (%)**
Underlying Measurement Channel	(observation)
Calculation Method	---
Monitoring Frequency	Once (post-processing after the demos)
Aggregation rule	Average
Condition (dimension slab)	Per vehicle
Baseline	Historical data to be provided by local cargo delivery companies
KPI #87 (B43)	**Number of accidents on site (Accidents/km)**
Underlying Measurement Channel	(observation)
Calculation Method	№ accidents / km
Monitoring Frequency	Counter - once per occurence
Aggregation rule	Sum
Baseline	Historical data to be provided by local cargo delivery companies
KPI #87 (B44)	**Accidents in AV UFT facility (Accidents/km)**
Underlying Measurement Channel	(observation)
Calculation Method	№ accidents / km
Monitoring Frequency	Counter - once per occurence
Aggregation rule	Sum

Condition (dimension slab)	Per vehicle
Baseline	Historical data to be provided by local cargo delivery companies
KPI #88 (B45)	**Incidents of crime / theft in AV UFT facility (Number of crime relevant incidents)**
Underlying Measurement Channel	(Observation)
Calculation Method	---
Monitoring Frequency	Counter - once per occurence
Aggregation rule	Sum
Condition (dimension slab)	Per vehicle
Baseline	Historical data to be provided by local cargo delivery companies
KPI #90 (B46)	**Number of incidents involving vandalism in in AV UFT facility (Number of accidents related to vandalism)**
Underlying Measurement Channel	(observation)
Calculation Method	---
Monitoring Frequency	Counter - once per occurence
Aggregation rule	Sum
Condition (dimension slab)	Per vehicle
Baseline	Historical data to be provided by local cargo delivery companies
KPI #91 (B47)	**Loss and damage parcels in AV UFT facility (%)**
Underlying Measurement Channel	(observation)
Calculation Method	---
Monitoring Frequency	Counter - once per occurence
Aggregation rule	Sum
Condition (dimension slab)	Per vehicle
Baseline	Historical data to be provided by local cargo delivery companies

7.4 Statistical analysis

During the pre-demonstration the aim is to “rehearse” to make sure that the data collection and the process for data upload works, but also to check that the data collected are good enough to calculate the defined KPIs. The KPIs will be analysed to validate that they are correct defined to be able to perform the impact analysis in WP13. The analysis is described earlier in chapter 2.3.

Type of data and how to avoid bias

In SHOW data in relation to **observations** (quantitative measure collected from the vehicles and services while running) are collected continuously and not as a sample. They are uploaded in real-time to the SDMP or at least off-line during the last week of the pre-demonstration. For the observations the risk of bias is hence not in general high since data collections are done continuously on technical systems.

For the **subjective data** there will be surveys to end-users and interviews with stakeholders.

The surveys are three different and cover end-users.

1st: The first survey is done to collect the generic knowledge on Automation and travel behaviour etc before the pre-demonstration starts. This survey is rather long and target a random sample of citizens in general. To avoid statistical bias (such as sample bias and response bias) the minimum number of answers for each target group of end users have been identified per site (see Chapter 9). This will also be done for the Demonstration phase (2nd large scale pilot) in D9.3.

2nd: The second survey aims to collect the view of the travellers/ users of the implemented functions and system at a specific site. The survey consists of 15 questions with focus on acceptance and satisfaction. The target sample is those using/ travelling with for example the shuttles. To get their view a QR code on strips, bus stops etc. will be used, but also handouts at different times of the day/ week to get a wide profile of the respondents covering different age groups, different travel needs, different gender etc. Just as for the 1st survey the aim with the data collection during the pre-demonstration is to test and validate that the surveys include the correct questions and that the tool (Netigate) works for all user groups in focus. But of course, also to make sure that the impact analysis is possible to perform based on the answers. Hence, a small number of answers is expected during the pre-demonstration. The expected number of answers per user group is described per site in Chapter 9 in order to avoid bias and to make sure that end user in target per site is covered. In addition, separate surveys will be used for those outside (VRU) and for safety operators.

3:rd: The third survey consists of 1 question using a VAS scale that aims to collect the satisfaction of the service / trip they user just experienced. This will be collected continuously during the Demonstration, but only during the one week the last month in the pre-demonstration. This question will be implemented by the sites themselves in the most suitable way for the site. All passengers will be asked to give their satisfaction rate. The data will be reported as an average and standard deviations per site. There might be risk that those that are positive to new technology will be more represented than others. However, since running for such a long time the aim is to include answers from those that also have learned how to use the service.

Finally, there will be **interviews with stakeholders**. Those will take place before the pre-demonstration starts and in the end of the pre-demo. Those will also take place after the final Demonstration. The results will be used to understand the business models and the interpretation of the impact analysis in general. The interview guide is found in the Annex of D9.2, and the results are reported in a Netigate survey that will be used by the interviewers.

Analysis

The consolidation of the results from each site will be done in WP11 by FEV and reported in D11.3. In addition, the results will be analysed by each site and integrated in each pilot site report. An analysis guideline and tool (excel) have been developed to support the sites and to make sure they all do it in the same way. This is mainly focused on descriptive statistics.

After an initial analysis of the descriptive statistics, the statistical analysis of the surveys will use non-parametric statistical methods like the Chi-squared test. However, this is only where there exists baseline data to compare with. Nonetheless, other tests like independence (observations are independent of each other), correlation of the dependent variables, normality (to check if the data follows a normal distribution, and homoscedasticity (to identify the variance of residuals) will be conducted as well. While these tests provide valuable information about the characteristics of the sample, they also prepare for further analysis and hypothesis testing like multiple linear regression and structural equation modeling, which allow to identify the factors influencing the responses of the participant. For all surveys the results will be analysed by each site and integrated in each pilot site report.

Concerning the pilot sites measurements and the simulation outputs, the partners in WP13 conducting the impact assessments using these data points will conduct analysis of the data tailored to their assessment methodology. While data preparation will differ across the different impact assessment areas (indicators vary in data type, frequency, format…), for all, descriptive analysis will be conducted, preceded by data cleaning. As the data may not be consistently complete across all the pilot sites, a deep exploration of the data to identify missing, incorrect, or inaccurate values in the dataset is needed. An important step here is also evaluating the consistency in terms of format and aggregation level of the data across the pilot sites to ensure comparability. In addition, there could be outlier values which could skew the analysis that must be dealt with. Outliers may be easily identifiable as measurement errors, while others may be unexpected correct measurements. Considering many of the use cases and services to be demonstrated in the project are innovation activities that have not been part of the existing transport ecosystem, it may be difficult to identify outliers, as there is little data on the "expected" outcomes of the measurements. Nonetheless, using the baseline data identified for some of the KPIs in table 18 above, and methods like clustering (K-means is the most preferred considering its adaptability and capacity to scale to large datasets), Cook's Distance (often used in regression analysis), or even box plots or IQR (interquartile range) can be used. The choice will depend on the type and size of the data available. With the outliers identified, handling them will depend on the intended purposes of the data. They can be filtered out of the subsequent analysis, by setting a threshold value or range that an indicator value should stay within, and eliminating values that are out of it. Otherwise, resampling using random sampling processes can be used to predict alternative values for the outliers based on an assumed distribution to keep them in the dataset. After the data is cleaned and prepared, the descriptive and exploratory analysis can be done to better understand the dataset.

Preliminary descriptive analysis will be conducted, by looking at metrics like means, medians, standard deviations and variances, and producing visualizations like scatter plots to identify general patterns or trends in the data under each scenario. Next, clustering of the data will be done by some of the partners in order to classify the dataset by various factors like the situational variables (which will allow to consider the influence of the variations between the different sites and their physical environment). Methods like factor analysis will be used for certain indicators (traffic, energy and emissions impact area) to uncover latent factors that could influence the performance of the scenarios and services but that cannot be measured in a single factor. Considering the potential large size of the dataset, the benefit of this method in data reduction is also valuable. In the case of the societal impact assessment, which relies on qualitative methods like stakeholder interviews and the Delphi method, the fuzzy Delphi method will be used to reduce ambiguity and discrepancy of opinions. Additionally, sensitivity and uncertainty analysis will be used on the data collected at the pilot sites to deal with potential biases and uncertainties, though the quality of the data will determine if this is feasible. Nonetheless, the partners are aware of the potential biases and discrepancy and plan to address them as best as possible with the data available.

After conducting the assessments, validation is also considered. For all assessments, cross site evaluation is planned to validate the findings, mainly through methods like correlation, also used to identify potential links with the situational variables and the specifications of each pilot site and use case, but also explanatory analysis to visualize the outputs across the different pilot sites and/or scenarios. Finally, sensitivity analysis is planned for all assessment, assuming the size and quality of the dataset allows it. It is to be noted that the scenarios defined in 2.3.4 will be used in all impact assessments in order to allow for complementarity of the assessments, but also comparability with the holistic impact assessment. Considering the latter is based on a combination of data-driven assessment and stakeholder driven assessment through the MAMCA workshops, comparison and validation with the individual impact assessments allows for another layer of validation and sensitivity check.

8 Realisation of Data Acquisition during pre-Demonstration

8.1 The procedure

The procedure for pre-demo evaluation has been defined jointly by WP11 and WP9. The information and test results from pre-demo evaluation will be assessed and reviewed within WP11. Pre-demo evaluations can be considered a rehearsal for the real-life demonstrations and include a run-through of selected use cases and measurements. Data collections will take place at pre-defined time points during the pre-demo evaluations.

The approach for pre-demo evaluation at all sites is common and consists of the following steps:

1. Obtaining permissions for AV operation and data collection.
2. Preparation of the site's physical and digital infrastructure, including SHOW dashboard.
3. Implementation of the specific test cases at each site based on the use cases as defined in D1.2.
4. Technical verification, including iterative revisions and optimisation as defined in WP11.
5. Preparation of the capturing and monitoring tools for measurements related to performance KPIs as defined in chapter 8.
6. Pre-demo data collection activities according to the site-specific experimental plans described in chapter 10.
7. Store and transfer raw data according to the procedures described in D4.1.
8. Adjust procedures for the full demonstration based on the results of the pre-demo evaluations.

Continuous assessment of the demonstration activities' progress will be pursued during the demonstration activities, to allow early recognition of problems and take-up of mitigation/corrective actions and needs for changes and optimisations in any aspect (planning, technical). Those mechanisms will address among other the data collection processes on a subjective basis from the involved stakeholders but also on a performance basis through the tools that will be developed in SP2 and in A9.2 and upon the impact and simulation assessment framework of WP13 and WP10 respectively.

Datasets will be gathered at the end of the pre demonstrations (logs and performance indicators, questionnaires, and documentation) and lessons learned will be documented (key challenges identified, etc.). Pre-demo should be done until all test cases for the demo-site has been successfully run through at least 10 times.

For the pre demonstration there will be no specific report on the results, instead a checklist will be utilized to track the progress of the pre-demo (see 8.6) and lessons learned per site will be collected. Also, data from the different surveys and interviews will be looked at and revision will be made, if necessary, to optimize the data collection during demonstrations. This is a work done in collaboration between WP1 and WP9.

For the pre demonstration each site will report its findings using a common online template stored in the project collaboration tool. These reports will be fed to WP10 simulations and WP13 impact assessment, to allow for iterative development and improvement of simulation models. The template will be defined in the update of this deliverable (D9.3).

Data from the pre-demo evaluations will be collected and managed by the Big Data Collection Platform and Data Management Portal developed in A5.1. This will be further described by WP5.

8.2 Roles and responsibilities

To make the Demonstrations and their evaluations a success a lot of different parts need to be put together and a lot of persons need to be involved. Each Demonstration site has a denoted leader and a city or operator representative.

Each Demonstration site has an Executive board that manages the operation in the local community. The Executive board consists most often of the following local entities:

- Ministry;
- City/Municipality;
- Operators;
- Fleet provider;
- User Associations;
- SMEs and other stakeholders;
- Research and Academia entities.

In SHOW there is a Project demonstration board (PDB) that is led by SHOW-partner Eurocities. Their responsibility is for the upper level of coordination a monitoring of all demonstration activity in SHOW. The PDB consists of the denoted leaders for each Demonstration site. The PDB reports to the Project Core group once each month through the SP3 leader.

For the five distinct phases described in chapter 3 it is important that each site has a clear view on the roles and responsibilities. There is no mandatory definition of roles and responsibilities in setting up the SHOW Demonstration site, but it is important to define at least who is in charge of the following aspects and what support can be expected from other partners involved in the site, see also the checklist in chapter 8.6.

- **Licensing/Authorisation**: This work is described in *D3.1: Analysis report on legal, regulatory, institutional framework*. Most often it is the owner of the vehicles that oversees this. However, one part of the authorisation is related to the physical infrastructure for which the owner of the road (most often the municipality or the owner of the ground/houses) are in charge. A site assessment needs to be done including a risk and mitigation strategy. The risk assessment plan from a demonstrations site operational and realisation point of view are included in *Deliverable 14.1: SHOW Project management plan Quality Assurance & Risk assessment plan* a deliverable that will be updated twice in D14.4 and D14.5, whilst the mere technical parts will be reflected in the risk assessments of WP4.
- **Technical verification & Commissioning** will be to some degree handled at the lab. But for the licencing and authorisation a technical verification at site is needed in order to get the approval. The responsible partner might be the vehicle owner in close collaboration with the operator (if it is not the owner) and the municipality or owner of the land.
- **Pre-demonstrations**
    - **The Operation** will be held in real traffic for which the approval is achieved and the responsible party of the actual operation during the demonstration needs to be the partner that holds the permission for the

AV operation at the site. The pre-demonstration is seen as the rehearsal for the final Demonstrations.

  - **The evaluation** of the pre-demonstration will follow the Pilot plans defined in WP9 *D9.1: Evaluation framework* and its current update D9.2. The leader of the evaluation is recommended to be a party independent to the operator (e.g., research or academia), with support from the Demonstration site Executive board. In this role all issues related to writing up the Pilot plan, ethical considerations, engagement and incentivisation strategies, data collections, and data management, etc. is included, but also writing a report on the Pre-demonstration site set-up and achievements.

- **Real-life demonstration**
  - **Operation**: this is where the actual real-life demonstrations will take place in the Demo site. This will be done in WP12 Real-life Demonstrations and just as for the pre-demonstrations, the responsibility is connected to the partner that holds the permission for running the operation with AV vehicles.
  - **The evaluation** of the Demonstration is also here recommended to be done by a party independent to the operator (research or academia), with support from the Demonstration site Executive board. In this role all issues related to writing up the Pilot plan, ethical considerations, engagement and incentivisation strategies, data collections, and data management etc. is included, but also writing a report on the Demonstration site set-up and achievements.

8.3 Ethics

SHOW is a user-oriented project where the participation of humans is essential for a successful outcome. A sound and correct ethical treatment of participants is therefore of great importance for SHOW.

SHOW Updated Ethics Manual, *D3.4: SHOW Update Ethics Manual and Data Protection policy and Data Privacy Impact Assessment* constitutes the Ethics Code of Conduct of Research and it aims to be a reference and living document throughout the whole duration of the project with respect to ethical issues and protection of any type of data collected during the lifetime of the project. An Ethics Controlling process, as defined in D3.4, will be applied prior and after each evaluation phase, with each test site to ensure compliance with the SHOW ethics of conduct.

SHOW will include all potential types of users coming from diverse backgrounds and travel patterns and preferences, with the ambition to investigate the sustainability and acceptance of automated driving and traveller experience across different modes and stakeholders in an autonomous urban ecosystem.

Concerns about the use of tools, services, and in general technologies, in transport can be summarised as following (adapted from opinion 13 from the European Group on Ethics, EGE):

- The pervasiveness of a technology which many people do not understand and have difficulty to incorporate in everyday daily living activities such as transport/commuting.
- The lack of transparency of the work of other parties necessarily involved such as IT systems' and control centres' operators, service providers and other involved providers (e.g. vendors) and their effects on the automation/'driver'- 'user' relationship (i.e. both commercial and socio-economic related).

- The difficulty of respecting privacy and confidentiality when third parties may have a strong interest in getting access to electronically recorded and stored personal mobility and transport mode use data.
- The difficulty in ensuring the security of shared personal, localisation, service-use data. Therefore, the SHOW Consortium need to commit to the following:
  - Personal identification data necessarily touch upon the identity and private life of the individual and are thus extremely sensitive.
  - Interoperable services, tools, and architectures create the potential for the free circulation of personal travelling data, across local, national and professional borders, giving such data an enhanced European dimension.

The principles of the European Convention of Human Rights, the rules of the Convention of the Council of Europe for the protection of individuals in relation to automatic processing of personal data and especially the European Directive 95/46/EC, for the protection of personal need and General Data Protection Regulation (GDPR) 2016/679 to be strictly followed when addressing the ethical questions during the evaluations in SHOW. Users will primarily be involved in surveys (WP1, WP11, WP12) and user tests (WP11, 12) and secondarily in workshops, events, and focus groups. This is elaborated in the first version of the Data Privacy Impact Assessment (DPIA) that is included in D3.4 and will be further explored and updated as the project progresses, gaining more knowledge on exactly what data will be collected during demonstrations and which data flows that will be applied.

Data collection during demonstrations in SHOW will be conducted in 17 cities across Europe across both during pre-demonstration and Demonstration. The Informed Consent mechanisms are discussed in D3.4, but an elaborate account and templates can be found in D18.1.

It is stressed that all SHOW users and stakeholders (e.g. operators, service providers, etc.) who will be recruited by the project will be able to give Informed Consent or a guardian/ legal representative will be able to do on behalf of them, if this is required in line with the GDPR regulation. All types of users will be informed they are going to be part of research tests and will be also informed on the way their personal and performance data will be treated by the project.

To assure continuous monitoring and control of the project, an Ethics Board (EB) has been established, led by VTI, including Local Ethics Representatives from the test sites. The name of the persons and their contact information has been already identified and will be continuously updated.

In D3.4, the structure of the ethical procedures to guarantee a sound and correct ethical treatment of human participants are described together with the DPIA. The document is aligned with the two pre-defined ethic requirements asked by the European Commission (ECHR) to be written for SHOW, Requirement No. 1 and Requirement No. 3, that also need to be regarded.

8.4 Overview on approvals needed at each site

Tests on public roads with non-homologated AV vehicles (= PROTOTYPES) require valid permits from national or sometimes even local (transport) authorities as there is no common EU procedure and legislation. Differences between what is required in each country exist and the procedures toward an approval of vehicles and sites need to be carefully analysed and adapted for each demonstration country. The description below has its starting point in the Swedish approval process to provide an example of what the process can look like.

In general, it is important to have in mind that issuing permits takes time and has costs (internal resources, certificates, fees for authorities, etc.) and that it might be necessary to apply for more than one permit (at different authorities). An overview of how it can look is presented in Figure 27.

In general, during the different steps: It is important to have a common thread in the application. It is a way to prove that you know what you are doing and that your trial is safe. A common way to organize an application is:

Vehicle (ADS + DDT) + Environment (ODD) => Risk analysis => Risk minimization

Vehicle (ADS + DDT): You need to provide a detailed technical description of the vehicle including a list of exemptions you need from the Vehicle Act i.e. if your vehicles don´t have a steering wheel you need an exception. To get an exception you need to prove that your vehicle is safe. You also need to describe Dynamic Driving Tasks (DDT) and Automated Driving Systems (ADS) and their limitations. DDT is about vehicle movements (acceleration, brake, turn left, etc.) and ADS is the autonomous technique itself. DDT combined with ADS shall ensure that the vehicle complies with traffic regulations. You also need to do a Factory Acceptant Test (FAT).

Environment (ODD): ODD stands for Operational Design Domain. You need to provide a detailed description of the environment (including infrastructure aspects) within which the vehicle will operate and a description of traffic rules within the testing area. It is also important to talk to the road owner at an early stage (maybe the road owner is thinking about carrying out road construction works). The road owner also knows about traffic accidents in the area and can give you advice about road safety.

Risk analysis: How does Vehicle and Environment fit together? An example: The description of the vehicle´s ADS shows that the vehicle cannot handle roundabouts and the description of the environment shows a roundabout. Ergo you have a risk. How will you as a test operator solve this problem? You need to assess how serious the risk is. Under what circumstances are you prepared to take a risk? Why?

Risk minimization: You need to prove that your trial is safe enough. Developing a Safety case is a way to work with risk minimization. You can also apply

- Threat Analysis and Risk Assessment in Automotive Cyber Security (TARA)
- Hazard and Risk Analysis for the automated system (HARA) (ISO 26262)
- Safety of the Intended Functionality (SOTIF) (ISO 21448:2019)

Site Acceptance Test (SAT): A pre-permit test is needed. It could for instance be a one-day test with the local or national transport authority to check everything before getting the real permit.

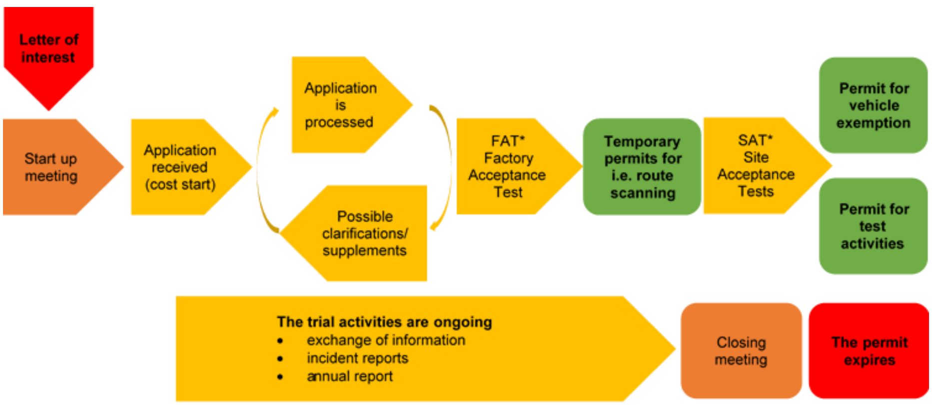


Figure 27: Illustration of the Swedish application process for trials with self-driving vehicles.

8.5 Data and information exchange

The data collection carried out at all Pilot sites will generate large amounts of research data. Collection of person-related data will comply with European and national legislation and Directives relevant to the country where the data collection is taking place. Person-related data will be centrally stored in an anonymised and secure standards-abiding way, and in accordance with the General Data Protection Regulation [Regulation (EU) 2016/679 of the European Parliament].

WP4 will define the interfaces to the SHOW cloud platform and will also define the data storage inside the SHOW cloud platform (e.g. one database for user surveys data; one database for fleet dynamic data; and one database for fleet processed data).

For the transfer of data collected at the pilot sites to the SHOW Big Data Collection Platform and Data Management Portal, two alternative dataflows co-exist and both alternatives can be present in one demo site. A description of the key clusters of data and how this will be handled and communicated is included *in D4.1: Open modular system architecture and tools - first version*. The two main alternatives for the data flow will be: 1) directly from the fleet to SHOW platform (fewer demo sites) 2) fleet to private cloud and then to SHOW cloud (majority of demo sites). In Figure 28 the two alternative data flows and the location of logger components are visualized. The sites can have a complementary approach where some of the data are stored in a private cloud for example at the OEM and then shared towards SHOW platform and some other data, not available from OEMs, are directly sent from the fleet to the SHOW cloud data platform via dedicated in-vehicle APIs developed for SHOW purposes.

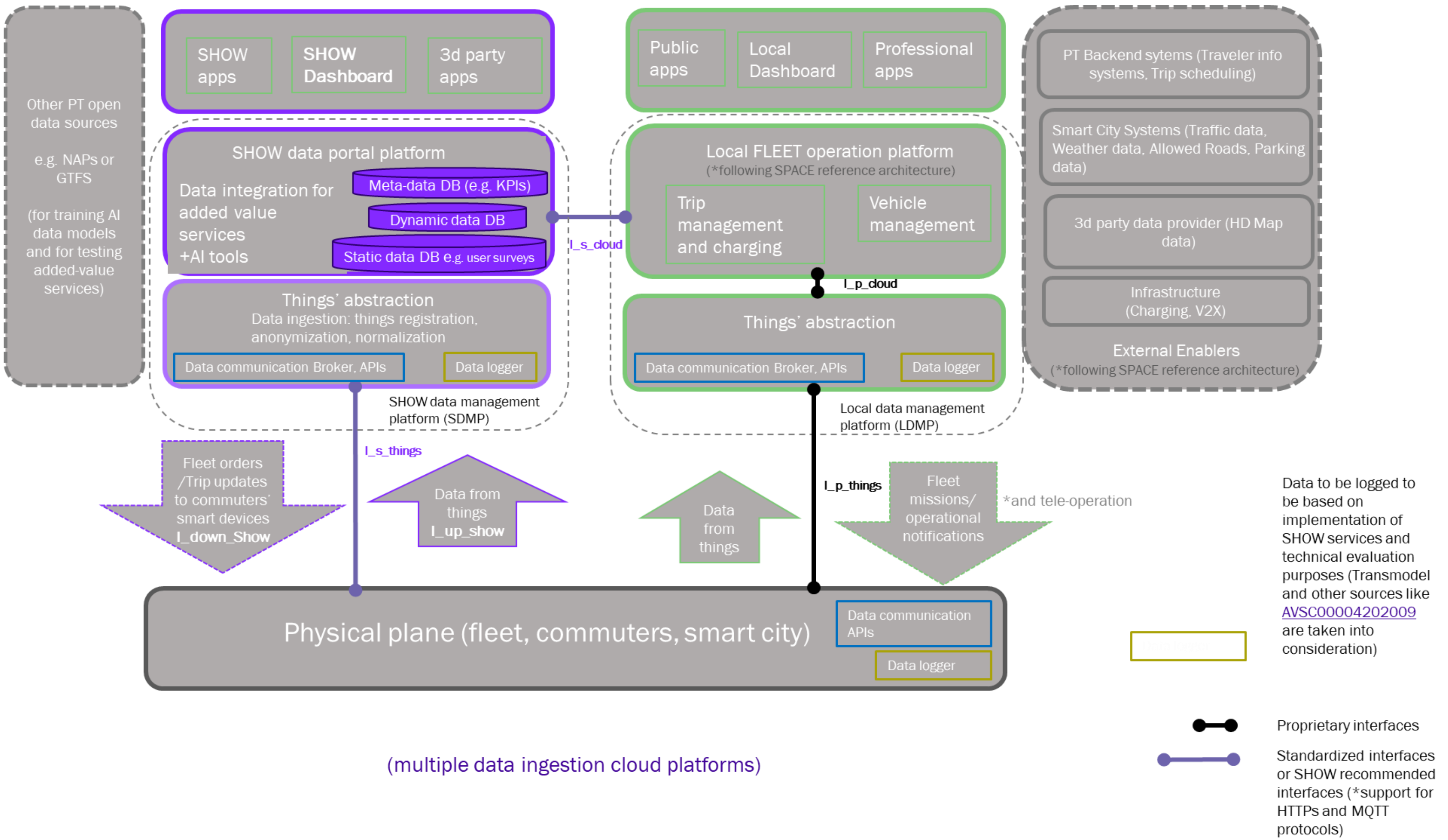


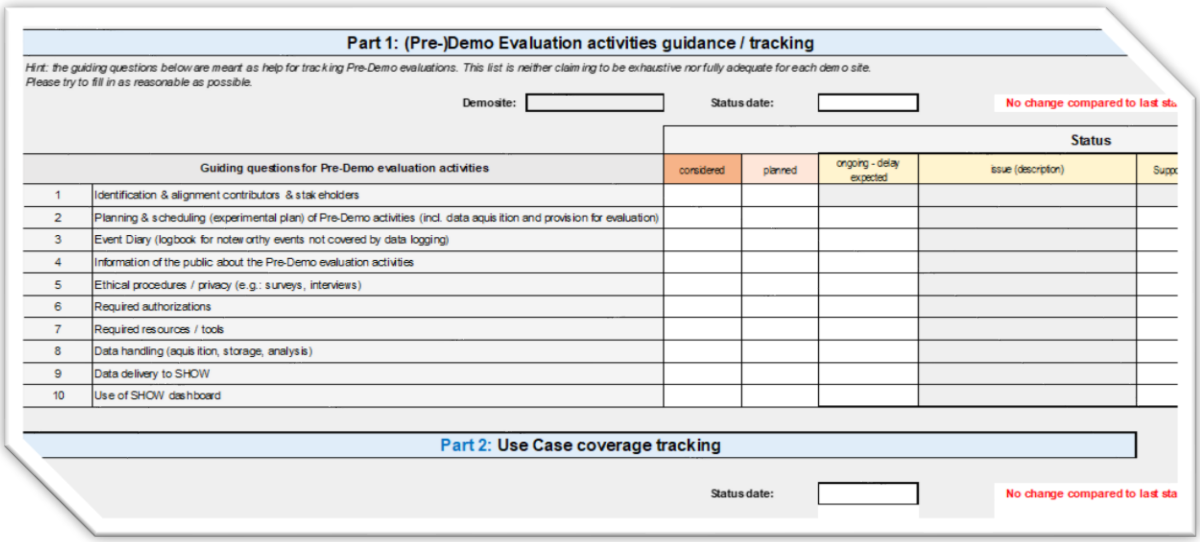
Figure 28: Current version of the SHOW system architecture diagram, as described in D4.1.

Representative research data generated by the SHOW project will be made open and will be offered to the Open Research Data Pilot, in which SHOW has declared its intention to participate.

Descriptions of all data generated in the project and details about how it will be exploited or made accessible for verification and re-use, and how it will be curated and preserved are/will be clearly defined in the Data management plan of the project (D14.2 & D14.3).

8.6 Checklist

A guidance checklist has been developed for the pre-demo evaluation phase to help the demonstration sites in the set-up of the real-life demonstrators and the evaluations, see Figure 29. This checklist is used for tracking the progress of the pre-demo evaluation activities in the pilot evaluation phase to ensure readiness for the subsequent real-life demonstration phase. The checklist will be available digitally and should be completed regularly by the pilot sites and reported to WP11. The full checklist is found in “Appendix IV: Checklist for pre-demonstrations”.



Part 1: (Pre-)Demo Evaluation activities guidance / tracking

Hint: the guiding questions below are meant as help for tracking Pre-Demo evaluations. This list is neither claiming to be exhaustive nor fully adequate for each demo site. Please try to fill in as reasonable as possible.

Demosite: Status date: No change compared to last sta

		Status				
Guiding questions for Pre-Demo evaluation activities		considered	planned	ongoing - delay expected	issue (description)	Suppc
1	Identification & alignment contributors & stakeholders					
2	Planning & scheduling (experimental plan) of Pre-Demo activities (incl. data aquisition and provision for evaluation)					
3	Event Diary (logbook for noteworthy events not covered by data logging)					
4	Information of the public about the Pre-Demo evaluation activities					
5	Ethical procedures / privacy (e.g.: surveys, interviews)					
6	Required authorizations					
7	Required resources / tools					
8	Data handling (aquisition, storage, analysis)					
9	Data delivery to SHOW					
10	Use of SHOW dashboard					

Part 2: Use Case coverage tracking

Status date: No change compared to last sta

Figure 29: Excerpt from the checklist for setting up the pre-demonstration and its evaluation.

9 Pilot Experimental plan for pre-demonstrations

The following section is mainly addressed to the demonstration sites.

The section aims to give an overview of each demonstration site including key objectives, site specific test cases with short storyboards (coming from and connected to the use cases defined in D1.2), stakeholders and end users in focus, and the experimental plans for the pre-demonstrations together with the most updated timeline (Figure 18).

Chapter 10 is based on information given by the demonstration sites during end of November and beginning of December 2020 and will be updated continuously. The structure of the information is harmonised as much as possible, with some minor deviations due to the demonstration sites' own wishes. *Some updates have been done in the current revised section to reflect progress and changes in the sites and their planning.*

9.1 Mega site France

The French site combines demonstrations in Rouen and Rennes (will be replaced) which are two regional metropolises, see Figure 30. For both cities connected and automated mobility is in the centre of their SUMP policies.

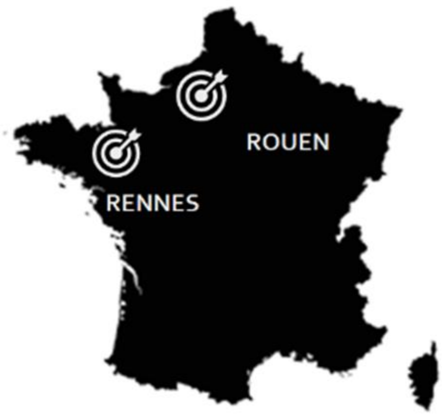


Figure 30: The sites Rouen and Rennes.

9.1.1 Rouen

The public transport in Rouen have automated systems in use since 2001. There are 4 lines of BRT (Bus Rapid Transit) and the last one opened in 2019 with a total of more than 80 buses equipped with level 2 SAE technologies.

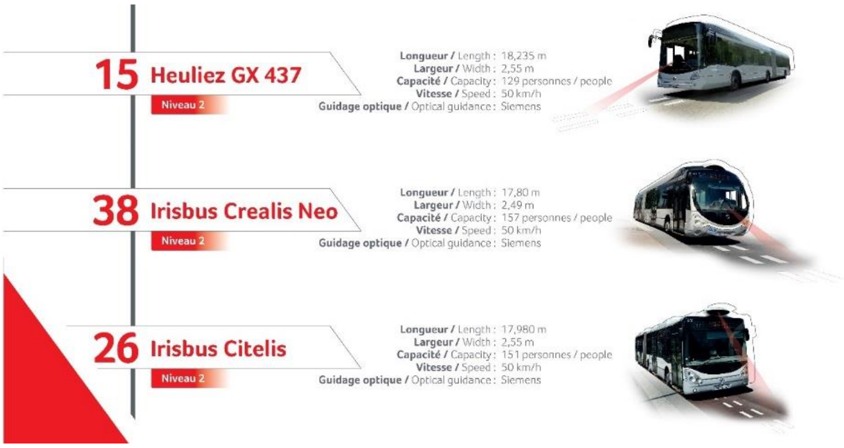


Figure 31: Rouen – BRT level 2 SAE .

Rouen has already deployed the first on-demand transport service using autonomous vehicles on open roads in Europe with the Rouen Normandy Autonomous Lab project[8], in various suburban locations. Rouen Normandy Autonomous Lab has allowed Rouen Normandy Metropolis and its partners (Normandy Region, Caisse des Dépôts, Transdev, Renault, Matmut and FEDER / Europe) to gain a valuable experience and know-how from those on-going field operations.

Between 2018 and 2020, under the Round Normandy Autonomous Lab project[9], an on Demand Transport service addressed the First/Last Mile challenge provided with 4 Renault ZOE on 10 kms open roads in Techonopole du Madrillet with 17 stops.

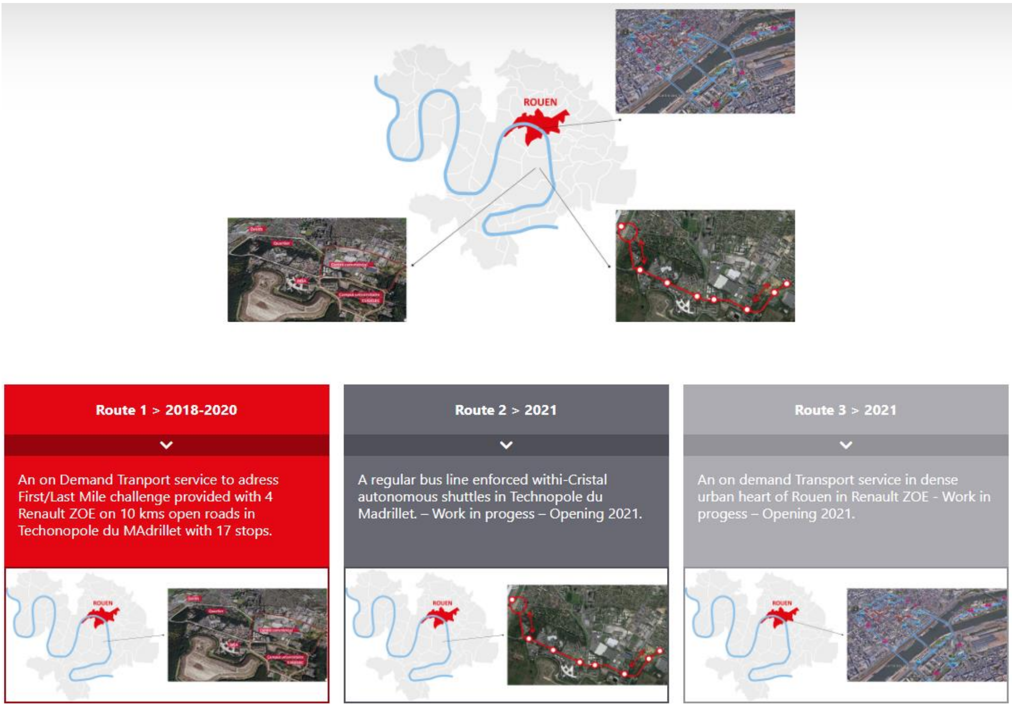


Figure 32: Rouen Normandy Autonomous Lab.

[8] https://www.rouennormandyautonomouslab.com/

[9] Rouen Normandy Autonomous Lab

As a next step, one aim is to complete existing bus line, linking the multimodal city centre hub to a fast-growing business, culture and industry suburb. Within the project automated shuttle services will coexist with the existing bus line as well as explore a first real multimodal offer of an on-demand robot taxis service available in the city centre hub connected to the shuttles and offering an innovative seamless service. **Error! Reference source not found.**

9.1.1.1 Key objectives

In SHOW the key objectives for Rouen are the following:

- Use of a single fleet control management system for multiple brands of vehicles.
- Integrate the fleet control of the AVs with the Public Transport Operations Control Centre to facilitate the global management of the fleet of vehicles.
- Integrate ITS and intelligent communication infrastructure (sensors or at points of vigilance).
- Provide recommendation for the standardization of supervision procedures for the fleet of vehicle and for the intervention procedure of the human operator (remote supervision, monitoring...).
- Reach TRL 8/9 with a fleet of SAE L4 shuttles and robo - taxis (today TRL6).

9.1.1.2 Test cases

The Rouen site specific use cases (here called test cases) cover 10 of the SHOW use cases and are specified as follows:

- Automated passengers' mobility in Cities under normal traffic & environmental conditions (UC1.1)
- Automated passengers' mobility in Cities under complex traffic & environmental conditions (UC1.2);
- Interfacing non automated vehicles/ travellers (VRU) (UC1.3);
- Energy sustainable automated passengers' mobility in Cities (UC 1.4);
- Actual integration to city Public Transport Control Centre (UC 1.5);
- Mixed traffic flows (UC 1.6);
- Connection to Operation Centre for remote supervision (UC1.7);
- Seamless autonomous transport chains of Automated PT, DRT, MaaS (UC 1.10);
- Self-learning Demand Response Passengers mobility (UC 3.1);
- Big data/AI based added value services for Passengers mobility (UC 3.4).

In general, there are two aspects to be covered from the scenarios, one is the technological aspects and the other is service aspects.

From a technical point of view, the focus is on the ability of the vehicle to travel in automated mode from an origin to a destination while deserving several point/stops. Also, a supervision centre will be used in Rouen. The operator will monitor the fleet from the control room. Audio and video communications between passengers and the control room will also be possible at any time.

From a service point of view, in this project we have two different services covering a large palette of users that will be able to experiment the services:

- Regular fixed-route shuttles services on a dedicated bus line complementing the service for commuters, residents, students, PRM;
- On demand Robo-taxi in the dense urban heart of Rouen for residents/commuters, tourists.

All of them are aim for better transport options between home/workplace or train station (for tourists) and other destinations.

9.1.1.3 Evaluation methods

9.1.1.3.1 Stakeholders and end users

In Rouen end users are generally commuters defined as people living or working in Rouen, searching for transport options between home and workplace/school and other destinations. As the city centre is a touristic area, also tourists will use the robo-taxis.

All categories of ages will be represented, but also vulnerable road users and persons with special needs. Stakeholders targeted in the pre-demonstrations in Rouen are presented in Table 19.

Table 19: Stakeholders in Rouen to be target for pre demo evaluations.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator)	Commuters to and from hospital but also visitors, including persons with reduced mobility. Transdev employees Renault Group employees
Public interest groups and associations	No
Decision-making authorities or regulators	Métropole Rouen Normandy, Région Normandie
Operators (e.g. public transport operators, private fleet operators)	PTO: Transdev
Mobility service providers	No
Industry (e.g. AV manufacturers)	Vehicle provider: Groupe Renault, Lohr,
Other	Insurance provider: Mamut Banque de Territoires – Caisse de Dépots

9.1.1.3.2 Pre-demo study design and capturing and monitoring tools

Vehicle data will be collected continuously in all vehicles, visualised, and stored locally. Data collection during pre-demonstrations in Rouen is described in Table 20.

Table 20: Data collections during pre-demonstration in Rouen.

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
User Surveys		
Long – Needs and wants and Acceptance - A Priori survey	1 month before the pre-demo - 100 answers The last week during the pre-demo	 Middle and end of demonstration

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
Short - Acceptance: 15 question survey – target groups:	Commuters – 10 answers Visitors – 10 answers Persons with reduced mobility – 10 answers	
Satisfaction - 1 question survey	The last week during the pre-demo – 10 answers	Continuously during demonstration
Observations		
As defined in Table 13 (page 90) and Table 18 (page 111).	Continuously monitoring during pre-demo, stored locally. Data submission at the end of pre-demo.	Continuously monitoring. Data submitted end of demonstration month 3, 6, 9 and 12.
Interviews with stakeholders		
Needs and wants and acceptance interview - Before	I month before pre-demo: Région Normandie – 1 answer Transdev - 2 answers Vehicle provider: Groupe Renault, Lohr – 1 answer Insurance provider: Mamut – 1 answer Banque de Territoires – Caisse de Dépots – 1 answer	
Needs and wants and acceptance interview – During demonstration	End of pre-demo: Métropole Rouen Normandy, Région Normandie – 2 answers Transdev - 2 answers Vehicle provider: Groupe Renault, Lohr – 1 answer Insurance provider: Mamut – 1 answer Banque de Territoires – Caisse de Dépots – 1 answer	Middle and end of demonstrations.

*Number of answers will be defined in D9.3.

9.1.1.4 Timeline

The generic timeline for Rouen is presented in Table 21 (*the iCristal timeline is under exploration to be shifted earlier).

Table 21: Rouen timeline.

Z10 and Zoe	2020 (M1-M12)				2021 (M13-24)				2022 (M25-M36)				2023 (M37-M48)			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

I-Cristal	2020 (M1-M12)				2021 (M13-24)				2022 (M25-M36)				2023 (M37-M48)			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

The development of the shuttles and of the robo-taxi have been affected differently, therefore the respective demonstrations may not take place at the same time. Transdev is collaborating on the Autonomous Transport Systems with various international stakeholders and the COVID crisis has strongly impacted the planned development. For example, Torc our AD System provider from the USA was not able to send, as usual, their teams to France for development and tests during this period. For clients (PTA, Cities…), budgets are under pressure and the urgency of the COVID crisis has put some innovation projects temporarily in the back seat.

9.1.2 Rennes

The Rennes site is under replacement as already mentioned.

9.2 Mega site Spain

Madrid Mega site enables and provides safe, sustainable, and integrated mobility, see Figure 33. The demonstrations will take place in urban, suburban, and restricted areas, thus the vehicles will follow complex trajectories with difficult manoeuvres in various real traffic conditions. Auto parking and platoon solutions are also planned at the restricted area (EMT depot, Carabanchel). The demonstrations will deploy a mixed fleet of up to five passenger vehicles, to complement the existing service offers, composed of bus (two mini-buses, and a 12 m long bus), and of two passenger cars for people transport. A Mobility as a Service (MaaS) solution will also be included, with the aim to simply travelling with shared solutions.

In Madrid, there are two demo areas to be used by the mixed fleet of five passenger vehicle, see Figure 33.

1. *Madrid-Villaverde* holds a 1,6 km round itinerary with two stops - from Villaverde (Bajo Cruce metro station) to La Nave - driving in open traffic, providing a fluid transport service to all the road users that demand an efficient way to connect both stops. Automated re-planning overtaking process (in case of unexpected situations or pedestrians on the road), smooth and comfortable speed profiles, interaction with (non)connected vehicles will ensure the operation in Villaverde's mixed traffic circumstances.
2. *Madrid-EMT depot (Carabanchel)* is a modern depot with different bus technologies (CNG, Hybrid, Electric) driving inside a semi-controlled area, where interactions with other non-automated buses and vehicles will take place during SHOW project. Automated docking and parking applications are in focus, as well as platoon.

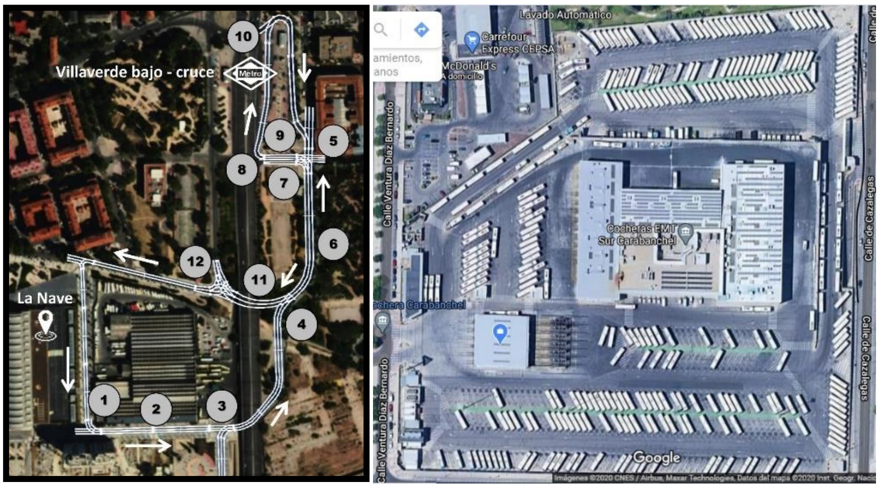


Figure 33: Madrid - Villaverde (left), Madrid - EMT depot Carabanchel (right).

9.2.1 Madrid - Villaverde

9.2.1.1 Key objectives

The key objectives in Villaverde are to enable and provide safe, sustainable, and integrated mobility by:

- A fluid transport service with mixed fleet of five AVs (passenger vehicles) to all the road users that demand an efficient way to connect both stops in the round trip

- Following complex trajectories with difficult manoeuvres (intersections, mixed lanes) in open dense traffic
- In various traffic conditions (urban, and sub urban) covering speed on 15-30 km/h,
- Supervised by one single interoperable system with a high TRL (8), which is Madrid MaaS Platform, hold by EMT.

9.2.1.2 Test cases

The site-specific test cases in Villaverde are:

- Automated passengers' mobility in Villaverde around Nave area (normal traffic & environmental conditions) (UC1.1).

  Here the vehicles will attend the urban route that connects La nave with the Subway station and vice-versa.
- Automated passengers' mobility in Villaverde around Bajo Cruce (subway station) (complex traffic & environmental conditions) (UC 1.2).

  The objective is to supply a fluid transport service to all the road users that demand an efficient way to connect both sites. One of the stops will be in La Nave and the other one in the Subway station. Both stops will have an available vehicle to provide the service.
- Reliable and safe VRU interfacing at Villaverde Bajo Cruce (subway station) (UC1.3).

  Here the vehicles will be capable to execute an automated re-planning process in case of unexpected situations or pedestrians, present on the road.
- Villaverde open traffic conditions (UC1.6).

  The aim is to demonstrate how smooth and comfortable speed profiles, interaction with connected and non-automated vehicles through V2X or lighting symbols, information of future actions to the users of the service, obstacle avoidance, and overtaking capacities, will ensure the operation in mixed traffic circumstances.
- SAE L3-4 Villaverde passenger mobility (UC 1.10).

  In this test case the target speed considers the maximum and minimum speed limits of the urban environments (50 km/h) that avoids a negative impact over the traffic flow. Nevertheless, the Gulliver automated shuttle will reach speeds around 15-30 km/h due to vehicle limitations of the power system.

9.2.1.3 Evaluation methods

9.2.1.3.1 Stakeholders and end users

End users in focus are commuters and VRUs. In addition, safety drivers at shuttles and PT operator, will be involved during the evaluations. Stakeholders to be target at evaluation in Madrid, Villaverde is presented in Table 22.

Table 22: Stakeholder in Madrid, Villaverde to be target for evaluations in the pre demo.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator)	Gulliver EMT drivers I2ebus IRIZAR drivers Twizzy TECNALIA drivers Villaverde round trip commuters and VRUs
Public interest groups and associations	
Decision-making authorities or regulators	Madrid city council (Villaverde municipality) DGT (“*Dirección General de tráfico”,* General Directorate of Traffic)
Operators (public transport operators, private fleet operators etc.)	EMT
Mobility service providers	EMT
Industry (AV manufacturers etc.)	Irizar (OEM)

9.2.1.3.2 Pre-demo study design and capturing and monitoring tools

Vehicle data will be collected continuously in Madrid mixed fleet of five vehicles, see Table 23. User surveys will be collected from at least 10 commuters and VRUs during the pre-demonstrations.

Table 23: Data collections during pre-demonstration in Madrid, Villaverde.

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
User Surveys		
Long – Needs and wants and Acceptance - A Priori survey	1 month before the pre-demo - 100 answers	
Short - Acceptance: 15 question survey – target groups:	The last week during the pre-demo Commuters – 10 answers VRU – 10 answers Safety/bus drivers – 5 per company.	Middle and end of demonstration
Satisfaction - 1 question survey	The last week during the pre-demo – 10 answers	Continuously during demonstration
Observations		
As defined in Table 13 (page 90) and Table 18 (page 111).	Continuously monitoring during pre-demo, stored locally. Data submission at the end of pre-demo.	Continuously monitoring. Data submitted end of demonstration month 3, 6, 9 and 12.
Interviews with stakeholders		

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
Needs and wants and acceptance interview - Before	I month before pre-demo: EMT Operator – 1 interview Madrid city council (Villaverde municipality) – 1 interview DGT (“*Dirección General de tráfico”,* General Directorate of Traffic) – 1 interview	
Needs and wants and acceptance interview – During demonstration	End of pre-demo: EMT Operator – 1 interview Madrid city council (Villaverde municipality) – 1 interview DGT (“*Dirección General de tráfico”,* General Directorate of Traffic) – 1 interview	Middle and end of demonstrations.

*Number of answers will be defined in D9.3.

9.2.1.4 Timeline

The timeline for Madrid – Villaverde is presented in Table 24.

Table 24: Madrid – Villaverde timeline.

	2020 (M1-M12)				2021 (M13-24)				2022 (M25-M36)				2023 (M37-M48)			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

9.2.2 Madrid - EMT Depot (Carabanchel)

9.2.2.1 Key objectives

The overall objective with the demonstration at the depot is to operate the vehicles remotely from a control centre in EMT depot, at Carabanchel. More specifically the following will be demonstrated:

- Buses will enter the depot and find their parking lot (platoon and auto - parking).
- Buses should be called to different work areas.
- Teleoperation will be done from staff office.

9.2.2.2 Test cases

The site-specific test cases are as follows:

- Shuttle teleoperation at Carabanchel depot (UC 1.7).

  The target vehicle will be one of the EMT's Gulliver shuttle. The objective is to operate this vehicle remotely from a control centre in Carabanchel when it arrives at the depot. This procedure aims to increase the efficiency of the drivers through daily operation and the process of parking vehicles. Moreover, an expert depot operator will organize them in the parking area based on his expertise and knowledge of daily operations.

- Cooperative V2V platooning for electric bus and passenger car (UC1.8).

  The Twizy vehicle will guide the automated IRIZAR's bus using a platoon formation. This procedure will permit the movement of multiple vehicles with one driver or guiding vehicle in the EMT's depot that improves the performance of daily operative. The zone to execute the manoeuvre is in the dense parking zone of Carabanchel (north-east) which demands efficiency while executing the exit and parking processes of the buses. Further analysis needs to be done to identify where in the depot this cooperative manoeuvre will take place.

- Shuttle and electric bus automated docking at Carabanchel depot (UC 3.3).

  This test case will provide the capacities of parking automatically the shuttle and bus in the best spots in the depot. Moreover, the docking processes in the charge stations will be performed with the use of the automated parking algorithms.

- SAE L3-4 automated depot management, at Carabanchel (UC 3.5).

  The depot management has a relation with other use cases of the Madrid pilot, such as platoon and teleoperation, although, the automated parking process has a stronger relationship with the efficiency of the depot.

9.2.2.3 Evaluation methods

9.2.2.3.1 End users and stakeholders

The evaluations at the EMT depot focus on the bus drivers, maintenance personnel and the operator's perspective on remote control of parking and platooning, see Table 25.

Table 25: Data collections during pre-demonstration in Madrid, EMT depot.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator etc.)	Gulliver EMT drivers I2ebus IRIZAR drivers Twizzy TECNALIA drivers EMT maintenance personnel VRUs at Carabanchel
Public interest groups and associations	
Decision-making authorities or regulators	
Operators (public transport operators, private fleet operators etc.)	EMT
Mobility service providers	EMT
Industry (AV manufacturers etc.)	Irizar (OEM)

9.2.2.3.2 Per demo study design and capturing and monitoring tools.

Vehicle data will be collected continuously in all vehicles. User surveys will be collected on at least 10 people working at EMT depot, in Carabanchel, see Table 26.

Table 26: Data collections during pre-demonstration in Madrid, Carabanchel.

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
User Surveys		
Long – Needs and wants and Acceptance - A Priori survey	1 month before the pre-demo - 100 answers	
Short - Acceptance: 15 question survey – target groups:	The last week during the pre-demo Gulliver EMT drivers – 5 answers	Middle and end of demonstration

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
Satisfaction - 1 question survey	I2ebus IRIZAR drivers – 5 answers Twizzy TECNALIA drivers – 5 answers EMT maintenance personnel – 2 answers VRUs at Carabanchel – 10 answers Not relevant	Continuously during demonstration
Observations		
As defined in Table 13 (page 90) and Table 18 (page 111).	Continuously monitoring during pre-demo, stored locally. Data submission at the end of pre-demo.	Continuously monitoring. Data submitted end of demonstration month 3, 6, 9 and 12.
Needs and wants and acceptance interview - Before	I month before pre-demo: EMT maintenance personnel – 2 answers.	
Needs and wants and acceptance interview – During demonstration	End of pre-demo: Gulliver EMT drivers – 2 answers I2ebus IRIZAR drivers – 2 answers Twizzy TECNALIA drivers – 2 answers EMT maintenance personnel – 2 answers	Middle and end of demonstrations.

*Number of answers will be defined in D9.3.

9.2.2.4 Timeline

The timeline for Madrid – EMT depot is presented in Table 27.

Table 27: Madrid – EMT depot (Carabanchel) timeline.

	2020 (M1-M12)				2021 (M13-24)				2022 (M25-M36)				2023 (M37-M48)			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

9.3 Mega site Austria

The Austrian mega site consists of Graz, Salzburg and Carinthia area, see Figure 34. The Mega site are connecting peri-urban regions to intermodal mobility hubs in mixed traffic. Across all Austrian sites, vehicles from different types, speeds, automation levels and communication enablers will be used.

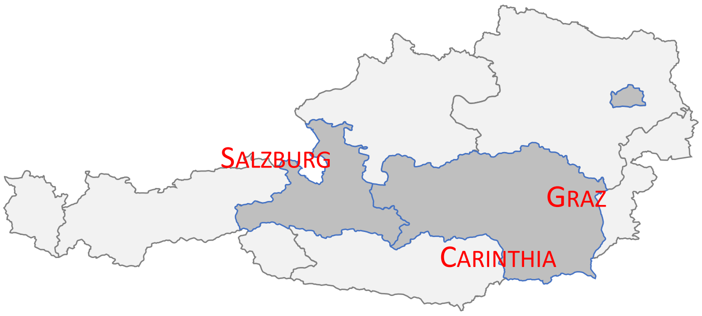


Figure 34: The Sites Graz, Salzburg and Carinthia.

9.3.1 Graz

The city of Graz has some 290,000 inhabitants with one of the highest growth rates in Austria, adding about 3,500 new inhabitants every year. The city has a very high number of commuters, about 100,000 people commute into the city daily. Graz is highly affected by pollution from traffic, and although the public transport in the city centre is good it is difficult to encourage people to change from private cars to public transport. Traffic situation and pollution could be improved with intelligent use of automated vehicles in addition to public transport.

9.3.1.1 Key objectives

The key objectives in Graz are as follows:

- Integrate automated and connected shuttles into existing mobility services (but not as a permanent service).
- Enable automated vehicles to enter highly frequented public transport bus stops.
- Perform safe detection of pedestrians and shuttle passengers at bus stops.
- Construction of an automated shuttle line demonstrator linked to a bus stop.

9.3.1.2 Test cases

The specific test cases are as follows:

- An automated shuttle drives along a route (UC1.2) and detects VRUs (UC1.3).

  The passenger gets off a public bus and wants to proceed to a shopping centre. He or she either books an onward journey with help of an app on the smartphone or decides spontaneously to take the AV vehicle.

- Serves a bus stop (UC3.4).
  The passenger recognizes that the AV vehicle is available and gets on board. After a confirmation of the departure and a safety check, the shuttle starts and autonomously searches for a passage through the terminal. The AV vehicle

follows a predefined route and crosses a traffic light-controlled intersection. When the AV vehicle reaches the destination, the passenger gets off and the vehicle drives back on its own.

9.3.1.3 Evaluation methods

9.3.1.3.1 Stakeholders and users

End users in focus are generally visitors at the shopping centre. Stakeholders targeted in the pre-demonstrations are presented in Table 28.

Table 28: Stakeholder in Graz to be target for pre-demo evaluations.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator	Visitors at shopping centre Safety drivers
Public interest groups and associations	No
Decision-making authorities or regulators	AustriaTech
Operators (e.g. public transport operators, private fleet operators)	Holding Graz
Mobility service providers	No
Industry (e.g. AV manufacturers)	Yunex (smart camera)
Other	

9.3.1.3.2 Pre demo study design, capturing and monitoring tools

Vehicle data will be collected continuously in the vehicles, visualised, and stored locally. As Graz implements a variety of Use Cases, nearly all the "direct observation" KPIs apply to this site. The only KPIs not addressed are an emissions-based quantity and operative revenue estimates. Data collection during pre-demonstrations in Graz is described in Table 29.

Table 29: Data collections during pre-demonstration in Graz.

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
User Surveys		
Long – Needs and wants and Acceptance - A Priori survey Short - Acceptance: 15 question survey – target groups:	1 month before the pre-demo - 100 answers The last week during the pre-demo Employees from VIF and AVL – 10 answers	Middle and end of demonstration

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
Satisfaction - 1 question survey	Safety drivers - 2 answers The last week during the pre-demo – 10 answers	Continuously during demonstration
Observations		
As defined in Table 13 (page 90) and Table 18 (page 111).	Continuously monitoring during pre-demo, stored locally. Data submission at the end of pre-demo.	Continuously monitoring. Data submitted end of demonstration month 3, 6, 9 and 12.
Interviews with stakeholders		
Needs and wants and acceptance interview - Before	I month before pre-demo: AustriaTech – 1 interview Holding Graz - 1 interview SIEMENS - 1 interview	
Needs and wants and acceptance interview – During demonstration	End of pre-demo: AustriaTech – 1 interview Holding Graz - 1 interview SIEMENS - 1 interview	Middle and end of demonstrations.

*Number of answers will be defined in D9.3.

9.3.1.4 Timeline

The generic timeline for Graz is presented in Table 30.

Table 30: Graz timeline.

	2020 (M1-M12)				2021 (M13-24)				2022 (M25-M36)				2023 (M37-M48)			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

It should be noticed that the authorization for open-road driving requires 1,000 km of testing before being granted. In addition, the current legislation allows for a maximum speed of 20 km/h, a permission for 30 km/h is worked on.

9.3.2 Salzburg

The city of Salzburg is heavily affected by traffic congestion. Every day, 60000 commuters enter the city centre from the hinterland, a high percentage of them in private cars. To reduce congestion and provide sustainable, integrated transport, the Federal State of Salzburg and the City of Salzburg have joined forces to implement and test new mobility concepts connecting the hinterland efficiently to the city centre. An installation of C-ITS roadside units along this corridor is planned.

9.3.2.1 Key objectives

In Salzburg the key objectives in SHOW are as follows:

- Enable and provide safe, sustainable, and integrated transport.
- Build upon existing trials, tests and learning environments in Austria.
- Integrate automated and connected shuttle(s) into the existing mobility services (e.g., DRT, PT).
- Deployment of C-ITS infrastructure along test corridors in Salzburg.
- Enhance MaaS platforms & frameworks and make use of existing steering groups e.g., ITS Austria.

9.3.2.2 Test cases

The Salzburg demonstration site envisages the implementation of two scenarios (scenario 1 and scenario 2). With these scenarios, Salzburg will be able to realise and evaluate UCs: 1.2, 1.3, 1.5, 1.6 and 3.1.

Automated shuttle will connect the centre of Koppl (village in a rural environment) to an intermodal interchange (“Koppl Sperrbrücke). The length of the autonomous shuttle route is approximately 1.4 km one-way. It is a slightly curved asphalt road with a maximum of 8 percent incline. The whole route has driving lanes for both directions. Including start and terminus stops, the route serves four bus stops in each direction.

The whole route is fully equipped with ETSI ITS-G5-enabled Roadside Stations (#5). HD map of the whole test route has been created. The use of the shuttle is free of charge. ITS enabled buses equipped with OBU’s connect the station “Koppl Sperrbrücke” with the city centre. It is planned that the route will be equipped with ETSI ITS-G5-enabled Roadside Stations, which are connected to the TMC of Salzburg, enabling e.g. ITS-G5-based traffic light prioritization for public buses.

- Scenario 1: (UCs 1.2, 1.3, 1.6, 3.1): Testing automated demand responsive transport (DRT) for connecting a peri-urban area to a city centre via an intermodal mobility hub (Shuttle). Demand-responsive automated shuttles are used to bridge the first/last mile.

  Passengers exit the C-ITS enabled bus line 150 from Salzburg city centre at the station “Koppl Sperrbrücke” and board an automated electrified shuttle to bridge the last mile to their destination. They take a seat and fasten their seatbelts. The safety operator on board welcomes the passengers and starts the automated service from “Koppl Sperrbrücke” to “Koppl centre”. The shuttle is following a pre-defined trajectory along the 1.4 km stretch of road, stopping at two stations, giving passengers the opportunity to exit or enter the shuttle. At the terminal stop “Koppl centre”, all passengers have to exit the shuttle. From there the shuttle takes up the service from the village centre back to the intermodal mobility hub. In addition, DRT functionalities should enhance service quality. Due to the limited capacity of the automated electrified shuttle, the possibility of reserving/booking a seat in the shuttle before the trip is essential for the acceptance of a first/last mile transport by the users. With the use of recorded travel data (e.g. number of travellers per service, boarding and disembarking per stop recorded via an on-board passenger counter) a self-learning solution for optimisation should be used in order to establish the most suitable timetable (frequency of the service) along the route.

- Scenario 2 (UC 1.5): Testing of a C-ITS enabled bus corridor, connecting an intermodal mobility hub to the city centre at high efficiency. Buses will be equipped with OBU's and RSU's connected to the TMC of Salzburg are planned to be installed.

9.3.2.3 Evaluation methods

9.3.2.3.1 Stakeholders and end users

End user groups in focus in Salzburg are pedestrian in the role of commuters from peri-urban residents, tourists, safety drivers and TMC personal, see Table 31.

Table 31: Stakeholder in Salzburg to be target for evaluations in the pre-demo.

Stakeholders	**Org. Name**
Vehicle users (end users, drivers, and remote operator	Commuters (Salzburg Researchers) Safety drivers
Public interest groups and associations	No
Decision-making authorities or regulators	Federal State of Salzburg
Operators (e.g., public transport operators, private fleet operators)	Salzburg Transport Authority
Mobility service providers	No
Industry (e.g., AV manufacturers)	No

9.3.2.3.2 Pre-Demo study design, capturing and monitoring tools

Vehicle data will be collected continuously in all vehicles, visualised, and stored locally. Data collection during pre-demonstrations in Salzburg is described in Table 32.

Table 32: Data collections during pre-demonstration in Salzburg.

Capturing and monitoring tools	**Pre -demonstration Timing of data collections and number of answers**	**Demonstration Indicative timing of data collection***
User Surveys		
Long – Needs and wants and Acceptance - A Priori survey Short - Acceptance: 15 question survey – target groups: Satisfaction - 1 question survey	1 month before the pre-demo - 100 answers The last week during the pre-demo Commuters – 10 answers Safety drivers – 2 answers The last week during the pre-demo – 10 answers	Middle and end of demonstration Continuously during demonstration
Observations		

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
As defined in Table 13 (page 90) and Table 18 (page 111).	Continuously monitoring during pre-demo, stored locally. Data submission at the end of pre-demo.	Continuously monitoring. Data submitted end of demonstration month 3, 6, 9 and 12.
Interviews with stakeholders		
Needs and wants and acceptance interview – Before	I month before pre-demo: Federal State of Salzburg – 1 answer Salzburg Transport Authority – 1 answer	
Needs and wants and acceptance interview – During	End of pre-demo: Federal State of Salzburg – 1 answer Salzburg Transport Authority – 1 answer	Middle and end of demonstrations.

*Number of answers will be defined in D9.3.

9.3.2.4 Timeline

The timeline for Salzburg is presented in Table 33.

Table 33: Salzburg timeline.

	2020 (M1-M12)				2021 (M13-24)				2022 (M25-M36)				2023 (M37-M48)			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

No shuttles are at the site (November 2021). In accordance with the PL, Salzburg Research as partner of a consortium will apply for the funding of one autonomous vehicle (i.e. a retrofitted electrified vehicle being used as SAE level 4 passenger shuttle) through a national call (Opening: October 2021). In case of a successful application, it is planned to use this demonstrator in the Salzburg Pilot Site. The second demonstrator will be used either in Salzburg or in another Austrian Site in order to ensure that fleet requirements for the Austrian Megasite in total will be fulfilled. A close cooperation within the Austrian Megasite Consortium is guaranteed.

The conduction of the Pre-Demonstration phase is planned for August – October 2022. The conduction of the Demo phase is planned for November 2022 – August 2023.

9.3.3 Carinthia

The Carinthia area (Klagenfurt and Pörtschach) site is planned to be used instead of Vienna. Negotiation is still on-going, and the details might be changed. The Carinthian site is replacing the site of Vienna within the Austrian Mega Site.

Carinthia is the southernmost Austrian state. Situated within the Eastern Alps, it is noted for its mountains and lakes. Carinthia borders to Italy and Slovenia in the south, Tyrol in the west, Salzburg in the north and Styria in the east. The population is 561,390. Carinthia's main industries are tourism, electronics, engineering, IT, manufacturing, forestry, and agriculture. The multinational corporations Philips, Infineon Technologies and Siemens have large operations there.

There are two demo sites in Carinthia, one is in Pörtschach at the Lake Wörthersee and one is in the city of Klagenfurt. The pre-existing site of Pörtschach is a smaller demo site which will be used as back-up site, when it is difficult to use the demo site in Klagenfurt. This will be the case for example during the summer month. The plan is to use the Pörtschach site as a substitute site, there is no intention to use both sites at the same time.

Pörtschach: The demo site of Pörtschach is a pre-existing site with a length of 2.7 km and 8 bus stops. Pörtschach is situated directly at the Lake Wörthersee and therefore a typical Austrian tourist area. The route is connecting the train station with the lake, hotels, shops and the town centre. End users and stakeholders on this site are mainly tourists, younger students, senior citizens and public interest groups (tourist organisations, hotel owners, public authorities).

The pre-demo in Pörtschach started at the end of September and is running until end of November 2021.

Klagenfurt: This is a larger site with a complex traffic situation. The route will include traffic lights, a roundabout and different and traffic barriers. There are three different route options, which will be implemented as level 1-3,the final route length will be 4.4 km. The route will connect the train station with a living area, restaurants, shops, the university and a business and science park. On this route we have a high variety of stakeholders: tourists, students and commuters.

The pre-demo in Klagenfurt is planned for March/April 2022.

9.3.3.1 Key objectives

The exact city of Carinthia area is not defined yet. The key objectives will however be as follows:

- Enable and provide safe, sustainable, and integrated public transport.
- Build upon existing trial, tests and learning environments in Carinthia area.
- Integrate automated & connected fleets into the existing mobility systems (e.g., DRT, PT).
- Enable MaaS platforms & frameworks.
- Cooperation with existing support groups e.g., ITS Austria, local decision makers, local PT operators.
- Achieve efforts for legal enablers.

9.3.3.2 Test cases

The specific test cases are built around three of the original use cases, in addition one test case with focus on safe Covid-19 transportation will be demonstrated. The test cases are as follows:

UC1.1: Automated passenger/cargo mobility in Cities under normal traffic & environmental conditions (including semi-automated DRT)

UC1.2: Automated passengers/cargo mobility in Cities under complex traffic & environmental conditions (including semi-automated DRT)

UC1.6: Mixed traffic flows

UC2.1: Automated mixed spatial mobility (passengers & parcel service)

Covid-19 safe transport (new)

As soon as the Carinthia site (planned Klagenfurt and/or Pörtschach) is defined the details of the test cases storyboard will be updated.

9.3.3.3 Evaluation methods

9.3.3.3.1 Stakeholders and end users

Target end user groups are citizens and visitors of selected urban quarters, commuters, staff of science park, students, and persons with reduced mobility like elderly, see Table 34.

Table 34: Stakeholders in Carinthia to be target for evaluations in the pre-demo.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator	End users (tourist, special needs – mob/cog, students), Safety driver Remote or supervised operator
Public interest groups and associations	Tourist organisation
Decision-making authorities or regulators	Several authorities are (including BMK and local authorities) are involved
Operators (e.g., public transport operators, private fleet operators)	LOI expected from PT Klagenfurt or PT Villach
Mobility service providers	Not available
Industry (e.g., AV manufacturers)	Navya for Shuttles and one additional

9.3.3.3.2 Pre-Demo study design, capturing and monitoring tools

Vehicle data will be collected continuously in all vehicles, visualised, and stored locally. Data collection during pre-demonstrations in Carinthia is described in Table 35.

Table 35: Data collections during pre-demonstration in Carinthia.

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
User Surveys		
Long – Needs and wants and Acceptance - A Priori survey	1 month before the pre-demo2022 - 100 answers The last week during the pre-demo	 Middle and end of demonstration

Capturing and monitoring tools	**Pre -demonstration Timing of data collections and number of answers**	**Demonstration Indicative timing of data collection***
Short - Acceptance: 15 question survey – target groups: Satisfaction - 1 question survey	Tourist – 10 answers Persons with reduced mobility (mob/cog) – 5 answers Students – 5 answers Commuters – 10 answers Safety drivers – 2 answers Remote/ supervised operator – 1 answer. The last week during the pre-demo – 10 answers	Continuously during demonstration
Observations		
As defined in Table 13 (page 90) and Table 18 (page 111).	Continuously monitoring during pre-demo, stored locally. Data submission at the end of pre-demo.	Continuously monitoring. Data submitted end of demonstration month 3, 6, 9 and 12.
Interviews with stakeholders		
Needs and wants and acceptance interview - Before Needs and wants and acceptance interview – During demonstration	I month before pre-demo: The site is still under negotiation. End of pre-demo: The site is still under negotiation.	Middle and end of demonstrations.

*Number of answers will be defined in D9.3.

9.3.3.4 Timeline

The timeline for Carinthia area is presented in Table 36.

Table 36: Carinthia area timeline.

	2020 (M1-M12)				**2021 (M13-24)**				**2022 (M25-M36)**				**2023 (M37-M48)**			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

The planning and preparation have the following outline: Preparation 2020 and 2021 (12 months): during this period SURAAA (living lab) will undertake preparation of the site, descriptions of use cases and contribute to all other work packages within SHOW as required. Pre-Demo 2021 and 2022: Q 2/3 2021 (done September/October to the end of November in Pörtschach) and Q 1/2 2022 (planned March/April 2022 in Klagenfurt) with shuttle 1. The Demonstration is planned for 12 months. However, depending on the weather conditions (e.g. winter, snow) it might be that some months will not be able to operate or that there may be a time shift. Demonstration 2022 and 2023: Shuttle 1 in 2022 (8 months, planned April/May to the end of November/December) and 2023 (4 months, planned March to the end of June).

Shuttle 2 Q 3 2023 (3 months, planned April to the end of June), Vehicle 3 Q 3 2023 (1 month, planned June). The post processing, including evaluation and research is planned for 2023 (up to 12 months).

9.4 Mega site Germany

The Germany Mega site includes three cities, see **Error! Reference source not found.**. Karlsruhe is a regional centre with a big share of commuter traffic. The test area Baden-Württemberg setup in Karlsruhe is in the city centre. Aachen at Germany's western border close to both Netherlands and Belgium. Aachen is usually strongly frequented by tourists, due to the large technical university RWTH Aachen students represent a significant share in daily commuters. 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 unique characteristics of Mega site Germany is level 4/5 operation in complex scenarios and combined urban and peri-urban environments. *Monheim is under formal endorsement to replace the former Mannheim site and be part of the German Mega Site.*

9.4.1 Karlsruhe

Population 313 000. Karlsruhe is a regional centre with a big share of commuter traffic. The Test Area Autonomous Driving Baden - Württemberg (TAF) in Karlsruhe is located in the city centre and is continuously expanded. To be able to analyse test drives of partially and fully automated vehicles, wide-ranging sensor systems are installed along the test field's routes. Individual traffic and PT are being equally considered.

9.4.1.1 Key objectives

The key objectives for the Karlsruhe site will be on:

- The robust operation of automated shuttles in peri-urban scenarios with remote supervision by the operation of common control stations for several users.

9.4.1.2 Test cases

In total 7 Use Cases will be in focus in Karlsruhe and the site-specific test cases are described as follows:

- Restricted area Markensen Kaserne (UC1.1)
  The passenger arrives in the restricted area to visit a specific building. Since the area is restricted, visitors are not allowed to drive inside in their own car. Therefore, a shuttle service to the specific target building is provided.

- Driving in (peri-) urban areas (UC1.2)
  The driving area belongs to a residential area. By offering autonomous rides to local Points of Interests like bus stops or tram stations interest and trust in autonomous vehicles shall be created. Especially the concept of the last mile shall be deployed.

- Driving in (peri-) urban areas with mixed traffic flow (UC1.6)
  The driving area belongs to a residential area. By offering autonomous rides to local Points of Interests like bus stops or tram stations interest and trust in autonomous vehicles shall be created. Especially the concept of the last mile shall be deployed.

- Demonstration of Connection to Operation Centre for remote supervision and decision aid in restricted or in (peri-) urban areas (UC1.7)
  For the Demonstration of Connection to Operation Centre for tele-operation and remote supervision the autonomous vehicles will provide the possibility for a tele operator to supervise it. He has the possibility to investigate the current state of the vehicle and can support the vehicle in his decision process. So, there is no direct control of the driving shaft, it is only possible through the planning process which is running on the vehicle. This may take place in either the restricted area mentioned in UC1.1 or the residential area mentioned in UC1.2.

- Demonstration of Cargo platooning in restricted or in (peri) urban areas (UC 1.9).
  To demonstrate the efficiency of cargo platooning the autonomous vehicles will automatically follow each other in a defined distance. The platooning may take place in either the restricted area mentioned in UC1.1 or the residential area mentioned in UC1.2.

- Demonstration of automated mixed spatial mobility in restricted or in (peri-) urban areas (UC 2.1).
  To demonstrate the automated mixed spatial mobility the autonomous vehicles will transport cargo and passenger at the same time within the same vehicle. This may take place in either the restricted area mentioned in UC1.1 or the residential area mentioned in UC1.2.

- Demonstration of automated mixed temporal mobility in restricted or in (peri-) urban areas (UC 2.2).
  To demonstrate the automated mixed temporal mobility the autonomous vehicles will transport cargo and passenger at different time within the same vehicle. This may take place in either the restricted area mentioned in UC1.1 or the residential area mentioned in UC1.2.

9.4.1.3 Evaluation methods

9.4.1.3.1 Stakeholders and end users

In Karlsruhe, the target end users are all citizens, but with focus on commuters and residents. Also, tele operator supervisors is an end user target group of interest, see Table 37.

Table 37: Stakeholder in Karlsruhe to be target for evaluations in the pre-demo.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator	Residents Commuters
Public interest groups and associations	-
Decision-making authorities or regulators	x
Operators (e.g., public transport operators, private fleet operators)	Tele operators

Stakeholders	Org. Name
Mobility service providers	x
Industry (e.g., AV manufacturers)	-

9.4.1.3.2 Pre demo study design, capturing and monitoring tool

Vehicle data will be collected continuously in all vehicles, visualised, and stored locally. As Karlsruhe implements a variety of test case, nearly all the "direct observation" KPIs apply to this site. The only KPIs not addressed are an emissions-based quantity, since full-electric vehicles are used at this site, and operative revenue estimates.

Data collection during pre-demonstrations in Karlsruhe is described in Table 38.

Table 38: Data collections during pre-demonstration in Karlsruhe.

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
User Surveys		
Long – Needs and wants and Acceptance - A Priori survey	1 month before the pre-demo - 100 answers	
Short - Acceptance: 15 question survey – target groups:	The last week during the pre-demo Commuters – 10 answers Tele operators – 2 answers	Middle and end of demonstration
Satisfaction - 1 question survey	The last week during the pre-demo – 10 answers	Continuously during demonstration
Observations		
As defined in Table 13 (page 90) and Table 18 (page 111).	Continuously monitoring during pre-demo, stored locally. Data submission at the end of pre-demo.	Continuously monitoring. Data submitted end of demonstration month 3, 6, 9 and 12.
Interviews with stakeholders		
Needs and wants and acceptance interview - Before	I month before pre-demo:	Middle and end of demonstrations.
Needs and wants and acceptance interview – During demonstration	End of pre-demo:	

*Number of answers will be defined in D9.3.

9.4.1.4 Timeline

The timeline for Karlsruhe is presented in Table 39.

Table 39: Karlsruhe timeline.

	2020 (M1-M12)				2021 (M13-24)				2022 (M25-M36)				2023 (M37-M48)			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4

Preparation																
Pre-Demo																
Demonstration																

All shuttles and individual vehicles are available.

9.4.2 Monheim

As mentioned, Monheim is subject to formally replace the former Mannheim site.

9.4.3 Aachen

Aachen is Germanys most western city with cross-borders to Belgium and the Netherlands and with a population of 247000 citizens. The city of Aachen can be characterized as both a science hub with the RWTH Aachen and several other universities of applied sciences, representing 57000 students in MINT disciplines, and as a major touristic destination. The test site “Campus RWTH Melaten Nord” is a peri-urban environment centred in the heart of the university’s innovation drivers, see Figure 35. This is the area were the demonstration will take place.

Source: Google Maps

Figure 35: Test area / route at the campus “RWTH Melaten Nord”.

9.4.3.1 Key objectives

A collaborative automated driving function (CADF) based on V2V communication and employing an optimization algorithm for longitudinal vehicle control over a group of vehicles shall demonstrate the potential for energy saving through a CADF in a typical traffic scenario (bus stop).

Aachen’s PTO ASEAG aims at integrating autonomous people movers into regular transport service to provide a 24/7 on-demand service also on less frequently used routes with reasonable operating costs/tariffs.

For the digital infrastructure the CADF makes use of mobile network technology, but uses the PC5 interface for V2V communication and as such doesn’t run over the mobile network. The mobile network is used for the evaluation of vehicle performance through the LCMM (Low Carbon Mobility Management) system provided through T-Systems and for the MaaS and DRT services.

9.4.3.2 Test cases

In Aachen 4 major use cases will be addressed described with 2 test cases, the site-specific description is as follows.

(1) Collaborative automated driving function / automated driving manoeuvres at bus stops based on V2V communication and an optimization algorithm for the longitudinal vehicle motion for a group of vehicles to minimize the collective energy consumption (UC 1.4)
(2) Ring feeder with on-demand service in a campus environment, based on automated people mover vehicles interfacing PT and interfacing to a connected intelligent DRT/MaaS application (movA) (UC 1.6, UC 1.10, UC3.4)

UC 1.1 is considered as the general scenario / boundary condition for both test cases. Mixed traffic flow (UC1.6) is only in focus in the second test case (meshing with regular PT), but is part of the general setting also for the first use case. Both test cases include bus stops (UC3.4), but passenger service is only in focus in the second test case.

9.4.3.3 Evaluation methods

9.4.3.3.1 Stakeholders and end users

The service is for all citizens but with target groups commuters and students. The transportation with the People Movers will be for free, see Table 40

Table 40: End users and Stakeholders in Aachen.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator	Commuters Students Remote operators
Public interest groups and associations	-
Decision-making authorities or regulators	x
Operators (e.g., public transport operators, private fleet operators)	PT operator
Mobility service providers	MaaS operator
Industry (e.g., AV manufacturers)	-

9.4.3.3.2 Pre demo study design, capturing and monitoring tools

Data collection during pre-demonstrations in Aachen are described in Table 41.

Table 41: Data collections during pre-demonstration in Aachen.

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
User Surveys		
Long – Needs and wants and Acceptance - A Priori survey Short - Acceptance: 15 question survey – target groups:	1 month before the pre-demo - *100 answers* The last week during the pre-demo Commuters – 10 answers	 Middle and end of demonstration

Capturing and monitoring tools	**Pre -demonstration Timing of data collections and number of answers**	**Demonstration Indicative timing of data collection***
	Students – 10 answers Remote operators – 2 answers	
Satisfaction - 1 question survey	The last week during the pre-demo – 10 answers	Continuously during demonstration
Observations		
As defined in Table 13 (page 90) and Table 18 (page 111).	Continuously monitoring during pre-demo, stored locally. Data submission at the end of pre-demo.	Continuously monitoring. Data submitted end of demonstration month 3, 6, 9 and 12.
Interviews with stakeholders		
Needs and wants and acceptance interview - Before	I month before pre-demo: PT operator– 1 answer MaaS operator– 1 answer Decision making authority (tbd) – 1 answer Industry (tbd) – 1 answer	
Needs and wants and acceptance interview – During demonstration	End of pre-demo: PT operator– 1 answer MaaS operator– 1 answer Decision making authority (tbd) – 1 answer Industry (tbd) – 1 answer	Middle and end of demonstrations.

*Number of answers will be defined in D9.3.

9.4.3.4 Timeline

The timeline for Aachen is presented in Table 42.

Table 42: Aachen timeline.

	2020 (M1-M12)				**2021 (M13-24)**				**2022 (M25-M36)**				**2023 (M37-M48)**			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

9.5 Mega site Sweden

The Mega site Sweden includes the sites Linköping and Gothenburg, approx. 270 km apart, see Figure 36. In Gothenburg a 5G control tower concept will be used to remotely monitor and tele-operate a fleet of vehicles in both Gothenburg and Linköping.

Figure 36: The Linköping and Gothenburg sites, Sweden.

9.5.1 Linköping

The site Linköping is on Campus Valla Area. The demonstration site is run in a collaboration between VTI, Linköping University, Transdev, Östgötatrafiken, RI.SE, Linköping's Municipality, Linköpings Science park and Akademiska Hus. The area is connected to the Science park with, Ericsson and Combitech and 370 more companies as well as schools, elderly and child-care centres, and residential houses. There are two shuttles operating in the Campus Valla area, and a third AV is planned for. The operation will be extended to also cover a residential area, called Vallastaden, that was used for the living exhibition 2017 (https://nordregio.org/sustainable_cities/vallastaden/).

9.5.1.1 Key objectives

The key objectives for Linköping are as follows:

- Improve user experience for all users (end users)
- Test cooperation including multiple OEMs and multiple operators here defined as OEM, PT providers, PT operators.
- Prove a robust, safe, and reliable operation of a fleet of electric automated vehicles with a solution for connected traffic tower for last/first mile service, using the SAFE platform. (OEM, industry and service providers).

9.5.1.2 Test cases

In Linköping 7 use cases will be covered, with the following site specific test case descriptions:

- First & Last mile public transportation in mixed traffic (UC1.1).

  Along the route there is a school for children with special needs and in the same building there is a residential for elderly people. The distance from this building to the PT trunk line is >300 meters and hence too long to walk. The work is connected to the PT service. Thanks to the AV shuttle the children and elderly will be able to access the PT.

- First & Last mile public transportation at shared space with VRU (UC1.3).

The area at the Campus Core consists of a dedicated area for pedestrians and cyclists. The AV shuttles will be integrated as an additional mobility solution and used to get to the existing PT bus stops, rental e-bikes or parking space in the out boundaries of the area." The work is connected to the PT service.

- First & Last mile public transportation in mixed traffic (UC1.6).

  In the area of Vallastaden the operation is done on normal traffic road and integrated with passenger cars, buses and trucks using the same lanes. In addition, pedestrian/cycle crossing exists, sometimes with prioritisation for shuttles and sometimes not. The work is connected to the PT service.

- Elin operational Dashboard (UC1.7).

  Using the shuttles APIs for monitoring and the APIs for control (to initiate actions) and potentially additional sensors, the shuttles connect to an operation centre via a dashboard solution. Initially the connection will only be to monitor operation (and save data for further use). In a second step simple control functions will be added, i.e. for stopping at specific bus stops etc. (route is fixed). The work is a connected to the Control tower.

- On-demand stop signal at bus stops (UC3.4).

  The shuttles intend to stop only when there is an actual demand. Using the shuttles control APIs, the shuttles will stop only when travellers want to get on or off. A simple but integrated and connected "stop button" is placed along the route. The stop button (and potentially other sources like an app or Linköping MaaS) will signal the operation centre and create a stop order at the correct bus stop. The work is a connected to a DRT service.

- Route optimisation based on passenger counting (UC3.1).

  Using historical travel data (number of travellers, boarding and disembarking per stop, date and time) a self-learning solution for route optimisation is used for suggesting number of shuttles per sub route, frequency and automatic stops along the routes. The work is a connected to a DRT service.

- Personalised route (on & off) suggestions (UC3.2) (not in pre-demo).

  Combining Linköping MaaS, real time data city wide public transport information, historical travel data and passenger information suggest the most optimal way of transport for all individual users of this service in terms of where and when to embark and disembark. The system considers the users' personal preferences and/or limitations e.g special needs.

  - Strategic (when to leave home/work/school to get to the shuttle that connects to PT etc.).
  - Tactical (to know when and where to go and to get off the bus stop taking the passengers specific needs into consideration).

9.5.1.3 Evaluation methods

9.5.1.3.1 Stakeholders and End users

Stakeholders and end users that will be target in Linköping is presented in Table 43.

Table 43: End users and Stakeholders in Linköping.

Stakeholders	Target / Org. Name
Vehicle users (end users, drivers, and remote operator	Commuter and residents in the area. Children <15 years, with reduced mobility. Elderlies > 66-90 years, with reduced mobility. Safety drivers
Public interest groups and associations	No
Decision-making authorities or regulators	Region Östergötland
Operators (e.g. public transport operators, private fleet operators)	Transdev
Mobility service providers	Transdev
Industry (e.g. AV manufacturers)	No

9.5.1.3.2 Pre Demo Study design and capturing and monitoring tools

Vehicle data will be collected continuously in all vehicles, visualized and stored through the Linköping dashboard provided by Rise and Combitech, supported by Ericsson. Data collection during pre-demonstrations in Linköping is described in Table 44.

Table 44: Data collections during pre-demonstration in Linköping.

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
User Surveys		
Long – Needs and wants and Acceptance - A Priori survey Short - Acceptance: 15 question survey – target groups: Satisfaction - 1 question survey	1 month before the pre-demo - *100 answers* The last week during the pre-demo Children – 10 answers Elderly – 10 answers Students – 10 answers The last week during the pre-demo – 10 answers	Middle and end of demonstration Continuously during demonstration
Observations		
As defined in Table 13 (page 90) and Table 18 (page 111).	Continuously monitoring during pre-demo, stored locally. Data submission at the end of pre-demo.	Continuously monitoring. Data submitted end of demonstration month 3, 6, 9 and 12.
Interviews with stakeholders		
Needs and wants and acceptance interview - Before Needs and wants and acceptance interview – During demonstration	I month before pre-demo: Municipality - 1 answer Region - 1 answer PT provider -1 answer End of pre-demo: Municipality - 1 answer Region - 1 answer PT provider -1 answer	Middle and end of demonstrations.

*Number of answers will be defined in D9.3.

9.5.1.4 Timeline

The timeline for Linköping is presented in Table 45.

Table 45: Linköping timeline.

	2020 (M1-M12)				2021 (M13-24)				2022 (M25-M36)				2023 (M37-M48)			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

Everything is running as planned despite COVID-19. No major delays are foreseen for the technical validations and pre-demonstrations. The third AV shuttle will be an EM Gen 2. The shuttle will arrive Linköping the 6th of December. The third AV is planned to be integrated in the demonstration starting in Q1 2022.

User engagement with the school and the retirement home for elderly was done during the summer and autumn 2021.

9.5.2 Gothenburg

The Gothenburg site (replacing former Kista) is located in the Lindholmen Science Park, an urban area situated in north-western Gothenburg. Around 30.000 people commute every day to Lindholmen Science Park with around 350 companies, Chalmers University of Technology, different high schools and approx. 370 other companies of which many are related to mobility and IT. In the 1990s the city of Gothenburg began to transform the shipyard areas into the dynamic district it is today, with Lindholmen Science Park in the centre. This transformation is one of the largest urban development projects in Sweden.

The demonstration site is run in a collaboration between Keolis, RI.SE, Ericsson, Gothenburg Municipality, and the local PTA Västtrafik Götaland. Two Navya shuttles are operated during the pre-demonstration. A third vehicle will be added for the demonstration.

9.5.2.1 Key objectives

The key objectives in Gothenburg are the following:

- Prove a robust, safe, and reliable operation of a fleet of electrical automated vehicles with a 5G connected traffic tower for last/first mile service.
- Improve user experience for commuters to reduce usage of private vehicles

9.5.2.2 Test cases

In Gothenburg 6 Use Cases will be addressed. The specific test cases applied at the demonstration site are the following:

- **First/last mile public transport in Gothenburg under normal environmental conditions (UC1.1) and under complex environmental conditions (UC 1.2)**

For the pre-demo, two autonomous shuttles are driving along the route at Lindholmen in Gothenburg. The route is in total approximately 2.5km long with 3 stops, connecting the public transport network of Västtrafik from the bus station Regnbågsgatan with a remote parking lot at Hugo Hammars Kaj. The shuttles turn at the parking and head back to the bus station on a slightly different route.

Complex environmental conditions anticipated are as follow:

- Extreme weather conditions in winter: snow and extremely low temperatures, reduced luminosity (up until 40% of operations run in the dark in winter), fog, heavy rain and puddles
- Dense car traffic in an open road environment (peak hours, special events, etc.)
- 1 roundabout on the route

First/last mile PT in Gothenburg operated in mixed traffic (UC 1.6)

The AV is driving on a designated route in an urban open road context. The shuttle crosses streets, bicycle lanes and pedestrian crossings on their way. The shuttles connect with the public transport network at the Regnbågsgatan bus stop. The traffic density varies also across day, with rush hours in the morning, around lunch and in the afternoon/evening.

Control Tower connecting to other travellers in Gothenburg (UC 1.3)

The Control Tower can connect to VRUs and other passengers in the surroundings of the shuttle to warn them of the shuttle's impending arrival.

- **Assistance of driverless vehicle by the 5G Control Tower (UC 1.7)**

The Control Tower is permanently connected to the vehicle through a 5G connection. The 5G infrastructure enables communications between the control tower and the vehicle, for example to confirm an action, to send a request for assistance, , to switch to manual mode or to exit the planned route. The Control Tower can also send a request for additional information to the vehicles' API. If the connection to the Control Tower is lost, the vehicle brakes.

- **Autonomous driving functions at bus stop (UC 3.4)**

The shuttle's integrated assistance systems help the vehicle at the bus stops to get back into traffic: the shuttles wait for the path to be clear before starting again.

9.5.2.3 Evaluation methods

9.5.2.3.1 End users and stakeholders

Stakeholders and end users targeted in Gothenburg are commuters, residents and tourists/visitors, but also safety operators and remote operators, see Table 46.

Table 46: End users and Stakeholders in Gothenburg

Stakeholders	Target/ Org. Name
Vehicle users (end users, drivers, and remote operator)	Commuters/visitors Safety operator: Keolis Remote operator: Keolis / Ericsson
Decision-making authorities or regulators	Swedish transport Agency Municipality: Gothenburg Traffic office

Stakeholders	Target/ Org. Name
	Public Transport Authority: Västtraffik Götaland
Operators (e.g., public transport operators, private fleet operators)	Västtraffic Götaland
Mobility service providers	Service provider (Keolis) Service provider (Ericsson)
Industry (e.g., AV manufacturers)	OEM: Navya)

9.5.2.3.2 Pre demo Study design and capturing and monitoring tools

Vehicle data will be collected continuously in all vehicles, visualized and stored through the Ericsson dashboard. Data collection during pre-demonstrations in Gothenburg is described in Table 47.

Table 47: Data collections during pre-demonstration in Gothenburg.

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
User Surveys		
Long – Needs and wants and Acceptance - A Priori survey Short - Acceptance: 15 question survey – target groups: Satisfaction - 1 question survey	1 month before the pre-demo - 100 answers. The last week during the pre-demo Commuters – 10 answers Visitors – 10 answers Safety operators – 1 answer Remote operators - 1 answer The last week during the pre-demo – 10 answers	 Middle and end of demonstration Continuously during demonstration
Observations		
As defined in Table 13 (page 90) and Table 18 (page 111).	Continuously monitoring during pre-demo, stored locally. Data submission at the end of pre-demo.	Continuously monitoring. Data submitted end of demonstration month 3, 6, 9 and 12.
Interviews with stakeholders		

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
Needs and wants and acceptance interview - Before Needs and wants and acceptance interview – During demonstration	I month before pre-demo: Västtrafik - 1 answer Service provider Keolis - 1 answer Service provider Ericsson - 1 answer OEM Navya - 1 answer End of pre-demo: Västtrafik - 1 answer Service provider Keolis - 1 answer Service provider Ericsson - 1 answer OEM Navya - 1 answer (scheduled for 08/21)	Middle and end of demonstrations.

*Number of answers will be defined in D9.3.

9.5.2.4 Time line

The current time plan is seen in Table 48.

Table 48: Gothenburg timeline.

	2020 (M1-M12)				2021 (M13-24)				2022 (M25-M36)				2023 (M37-M48)			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

9.6 Satellite sites

9.6.1 Finland - Tampere

Figure 37: Site Tampere, Finland.

Tampere is the third largest city in Finland and the largest inland regional centre in the Nordics. There are 232,000 inhabitants in Tampere city and close to half a million inhabitants in the whole Tampere Region. In the Tampere site real operations under adverse weather conditions will take place, see Figure 37.

9.6.1.1 Key objectives

For Tampere, the key objectives are as follows:

- Tampere Regional Transport offers a complete regional bus services and route network with connections to main national services. Starting 2021 autonomous buses, city bikes and e-scooters will gradually act as feeder means to the new tramway and other services. The feeder services will first use fixed routes and there are plans to also introduce DRT services either during or after the SHOW project. The objective is to improve and integrate the mobility system with autonomous feeder buses and shared services as MaaS.
- Existing technologies will be complemented whenever needed. The number of vehicles is expected to increase from the 2 vehicles used during the demonstration, to about 10 after the project. Originally the targeted figures were higher, but the COVID-19 situation has caused some challenges in the procurement process.
- The City of Tampere aims to establish a permanent autonomous transport test and pilot area to the Hervanta suburb, where the SHOW piloting will take place.

Demonstrations will be carried out in connection with the new automated light rail corridor between Hervanta suburb the Tampere City Centre with automated feeder services in Hervanta suburb. Tampere will have remote control and tele-operated manoeuvres. Both 5G-test network with 10 bases-stations and ITS 5G units are included in the project and will offer technologies needed for advanced tele-operated manoeuvres. Self-learning DRT services will to be developed and piloted either during or after the SHOW-project based on the funding possibilities. They will cover fleet management and monitoring, order management, DRT and first/last mile service optimisation (heuristic & algorithms), pre-booked and ad-hoc transports, use of smart phones and the data they offer, passenger profiles, vehicle profiles and service parameters, etc.

9.6.1.2 Test cases

In Tampere a total of 5 use cases will be evaluated with the following site-specific test cases (use case UC3.1 will be piloted either during or after the SHOW project):

- Automated passengers/cargo mobility in Cities under normal traffic & environmental conditions (UC1.1)
- Automated passengers/cargo mobility in Cities under complex traffic & environmental conditions (UC1.2)
- Interfacing non automated vehicles/ travellers (VRU) (UC1.3)
- Energy sustainable automated passengers/cargo mobility in Cities (UC1.4)
- Connection to Operation Centre for tele-operation and remote supervision (UC1.7)
- Self-learning Demand Response Passengers/Cargo mobility (UC3.1), during or after SHOW

9.6.1.3 Evaluation methods

9.6.1.3.1 Stakeholders and End users

In general, the demonstration is for all citizens (business travellers, tourists and residentials), but with target groups commuters, and students at the hospital and university. There are also specific groups of interest, within those, like elderly and persons with reduced mobility, see Table 49.

Table 49: End users and Stakeholders in Tampere.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator	Commuter/students Elderly with reduced mobility Safety Drivers (Sensible 4)
Public interest groups and associations	
Decision-making authorities or regulators	City of Tampere
Operators (e.g. public transport operators, private fleet operators)	Tampere City Transport VR (Tram operator)
Mobility service providers	Tampere City Transport Sensible 4
Industry (e.g. AV manufacturers)	Sensible 4 Toyota ProAce

9.6.1.3.2 Pre demo study design, capturing and monitoring tools.

Data collection during pre-demonstrations in Tampere is described in Table 50.

Table 50: Data collections during pre-demonstration in Tampere.

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
User Surveys		
Long – Needs and wants and Acceptance - A Priori survey	1 month before the pre-demo - *100 answers*	

Capturing and monitoring tools	**Pre -demonstration Timing of data collections and number of answers**	**Demonstration Indicative timing of data collection***
Short - Acceptance: 15 question survey – target groups:	The last week during the pre-demo Commuters/ students – 10 answers Elderly with reduced mobility – 10 answers Safety Drivers (Sensible 4) – 2 answers	Middle and end of demonstration
Satisfaction - 1 question survey	The last week during the pre-demo – 10 answers	Continuously during demonstration
Observations		
As defined in Table 13 (page 90) and Table 18 (page 111).	Continuously monitoring during pre-demo, stored locally. Data submission at the end of pre-demo.	Continuously monitoring. Data submitted end of demonstration month 3, 6, 9 and 12.
Interviews with stakeholders		
Needs and wants and acceptance interview - Before	I month before pre-demo: City of Tampere – 1 answer Tampere city transport – 1 answer VR (Tram operator) – 1 answer Sensible 4– 1 answer Toyota – 1 answer Muji – Gacha (tbd) The operator – 1 answer	
Needs and wants and acceptance interview – During demonstration	End of pre-demo: City of Tampere – 1 answer Tampere city transport – 1 answer VR (Tram operator) – 1 answer Sensible 4– 1 answer Toyota – 1 answer Muji – Gacha (tbd) The operator – 1 answer	Middle and end of demonstrations.

*Number of answers will be defined in D9.3.

9.6.1.4 Timeline

The timeline for Tampere is presented in Table 51.

Table 51: Tampere timeline

	2020 (M1-M12)				**2021 (M13-24)**				**2022 (M25-M36)**				**2023 (M37-M48)**			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4

Preparation																
Pre-Demo																
Demonstration																

The focus is on SUMP (Sustainable Urban Mobility Planning. Physical and digital infrastructure preparations are ongoing. At the date of submission of this deliverable, the route is decided and fine-tuned. Some first steps toward technical validations have been carried out, outside the scope of SHOW, but related.

All digital infrastructure like LTE/5G and ITS G5 and LoRaWAN are ready in Hervanta. The licencing will be ready during the spring 2021, education of drivers is planned for mid of 2021, SHOW pre-demonstration will start autumn/late 2021.

9.6.2 Denmark - Copenhagen

The test site Lautrupgaard is located 15 km Northwest of Copenhagen in the municipality of Ballerup. Lautrupgaard is often mentioned as the Danish Silicon Valley due to its concentration of ambitious tech businesses in combination with the Technical University of Denmark (DTU) and a local tech high school, see Figure 38.

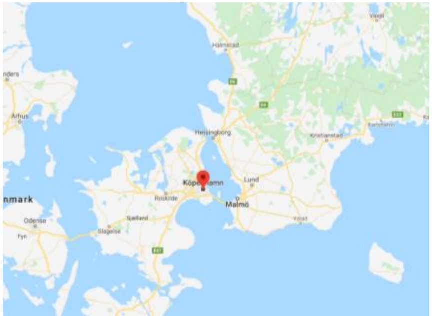


Figure 38: Site Copenhagen, Denmark.

9.6.2.1 Key objectives

The key objective for Copenhagen is the following:

- The test site will allow for a demonstration of a full-scale high-capacity feeder service, in full cooperation with the existing PT service, using an upcoming BRT infrastructure linking efficiently to the nearby multi-modal PT hub (S-train, high-speed buses, local busses and shared e-bikes).

9.6.2.2 Test cases

In total 10 use cases will be demonstrated. The site-specific test cases are presented as follows:

- Feeder service to Multi Modal PT Hub (UC 1.1)
  The small and medium-sized AVs will operate as integral part of the existing PT bus service – creating a stronger connection between the multimodal PT hub “Malmparken” and the companies and schools in the area.

- Driving in heavy traffic and intersections (UC 1.2)
  The Lautrup area has heavy morning rush hour from 7AM to 9AM and a more spread out afternoon rush from 2PM to 6PM. Cars, bicycles, trucks and buses are all part of the daily traffic scenario.

- Presence of vulnerable road users in intersections" / "Presence of vulnerable road users in AVs driving SAE4 without a safety driver on board (UC 1.3)
  Vulnerable road users are expected as part of the daily operation on the site. Both outside and inside the AVs.

- Operator neutral intelligent planning (UC1.4)
  The operator-neutral intelligent planning and dispatching of vehicles will optimize energy and take into account the optimal charging pattern.

- Integration to local TMC (UC 1.5)
  All AVs will be part of the local TMC.

- Operation in mixed traffic on smaller private roads & large public roads (UC 1.6)
  Cars, bicycles, trucks and buses are all part of the daily traffic scenario.

- AV Supervision centre (UC 1.7)
  Depending on AVs chosen in public tender, the aim is to have an AV Supervision centre, from where operation can be monitored.

- Shift between route and DRT mode (UC 3.1)
  The AVs will shift between route and DRT mode, according to time of day and demand.

- Real time planning and information to passengers (UC 3.2)
  The aim is to demonstrate the intelligent, real-time planning and dispatching of the AVs combined with real time information to passengers.

- Automated service at bus stop (UC 3.4)
  Adjust all bus stops to accommodate AVs. Further bus stops will be added to the network.

9.6.2.3 Evaluation methods

9.6.2.3.1 Stakeholders and end users

Copenhagen is in general targeting the commuters going to and from the demonstration area on daily basis. There are also specific groups of interest here defined as elderly, young adults, and persons with reduced mobility, see Table 52. At this point the travel intended to be free of charge.

Table 52: End users and Stakeholders in Copenhagen.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator etc)	Commuters Elderly Young adults Persons with reduced mobility
Public interest groups and associations	University student body, bicycle federation, business area interest group, medical centre
Decision-making authorities or regulators	Ministry of transport, Ballerup municipality (SHOW partner)
Operators (public transport operators, private fleet operators etc.)	Local TMC Movia (site leader)

Mobility service providers	eScooter and other mobility service providers in the area
Industry (AV manufacturers etc.)	AV manufacturers TBD

9.6.2.3.2 Pre demonstration study design, capturing and monitoring tools

Data collection during pre-demonstrations in Copenhagen is described in Table 53.

Table 53: Data collections during pre-demonstration in Copenhagen.

Capturing and monitoring tools	**Pre -demonstration Timing of data collections and number of answers**	**Demonstration Indicative timing of data collection***
User Surveys		
Long – Needs and wants and Acceptance - A Priori survey Short - Acceptance: 15 question survey – target groups: Satisfaction - 1 question survey	1 month before the pre-demo - *100 answers* The last week during the pre-demo Commuters – 10 answers Elderly– 10 answers Young adults– 10 answers Persons with reduced mobility – 5 answers The last week during the pre-demo – 10 answers	Middle and end of demonstration Continuously during demonstration
Observations		
As defined in Table 13 (page 90) and Table 18 (page 111).	Continuously monitoring during pre-demo, stored locally. Data submission at the end of pre-demo.	Continuously monitoring. Data submitted end of demonstration month 3, 6, 9 and 12.
Interviews with stakeholders		
Needs and wants and acceptance interview - Before Needs and wants and acceptance interview – During demonstration	I month before pre-demo: Public interest groups (tbd) Ministry of transport, Ballerup municipality – 1 interview Local TMC Movia – 1 interview eScooter provider– 1 interview mobility service providers – 1 interview AV manufacturers (tbd) – 1 interview End of pre-demo: Public interest groups (tbd) Ministry of transport, Ballerup municipality – 1 interview Local TMC Movia – 1 interview eScooter provider– 1 interview mobility service providers – 1 interview AV manufacturers (tbd) – 1 interview	Middle and end of demonstrations.

*Number of answers will be defined in D9.3.

9.6.2.4 Timeline

The timeline for Copenhagen is presented in Table 54.

Table 54: Copenhagen timeline.

	2020 (M1-M12)				**2021 (M13-24)**				**2022 (M25-M36)**				**2023 (M37-M48)**			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

The preparations to define routes, schedules and details for the on-demand service is on-going. This is also the case for the preparation of call for tender of safety assessors and the operator of busses.

9.6.3 Italy - Turin

The satellite site of Turin is in Northern Italy and is the 4th largest city in Italy, see Figure 39. The city has 870,000 inhabitants while the population of the urban area is 1,7 million inhabitants. The Turin SUMP (adopted in 2011) strategies are mainly oriented towards fostering multimodality and improving accessibility through actions to complete and improve the PT system (metropolitan rail services, metro lines 1 and 2, tramway network), the cycling and walking network and the ITS infrastructures and services.

Figure 39: The Site Turin.

9.6.3.1 Key objectives

The key objectives for Turin are as follows:

- Turin intends to trigger the penetration of autonomous mobility by fostering cooperation among private enterprises, local facilities, academia, and civil society and investing.
- Turin aims to foster multimodality and improving accessibility by completing and improving PT system, integrating it with the metropolitan, the railway, and ITS infrastructure and services.

9.6.3.2 Test cases

In total 5 use cases will be demonstrated. The site-specific test cases are as follows:

- Door-to-door transport of hospital patients in mixed traffic on public roads (UC 1.2)
  A patient books a visit at the hospital of the "City of Health and Science of Turin". At the same time, the patient will also have the possibility to book a shuttle service on a dedicated website. At the agreed time, the autonomous vehicle will pick up the patient at the pick-up point and take him to the hospital entrance. Along the way, it can also collect the other patients who have booked the service. At the end of the visit, the autonomous vehicle will bring the patients back.

- Presence of vulnerable road user on smart crossing equipped with C-ITS capabilities (UC 1.3).
  A C-ITS system composed by a smart RSU with sensors (e.g. camera and/or LiDAR, etc…) located at a crossing, detects the presence of pedestrians/cyclists in transit and communicates, in real-time, this

information is sent to the autonomous vehicle. The information is used to avoid an accident or to minimize its impact on the VRU.

- Traffic light priority to autonomous shuttle (UC 1.5)
  The autonomous shuttle is close to a traffic light junction managed by the TMC of the city of Turin. As the vehicle approaches, priority is given to the shuttle, which can then cross the intersection more quickly and safely.

- Tele-operated vehicle towards the hospital (UC 1.7)
  The booking system requires that the tele-operated car picks up a patient at a certain address to take him to the hospital at the visit time. A remote driver drives the tele-operated car to the specified address, the patient gets into the vehicle, and the car takes him/her to the hospital.

- Link between the railway station and the hospital (UC 1.10)
  A patient from outside the city booked a medical visit to the hospital of the "City of Health and Science of Turin". Being part of the target group, when booking the visit, he requested the autonomous transport service at the hospital. The patient travels to Turin by train, gets into the autonomous vehicle that awaits him at the agreed time outside the railway station, and is taken to the hospital entrance.

9.6.3.3 Evaluation methods

9.6.3.3.1 Stakeholders and end users

The involved stakeholders and the potential users of Turin demonstration site include patients at the hospital, ca 40% will be elderly, people with chronic diseases, other PRM (physical and rehabilitation medicine), employees at the hospital, TMC operator and the Tier 1 supplier for the C ITC solution, see Table 55.

Table 55: End users and Stakeholders in Turin.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator)	Patients at the hospital. Employees at the hospital. Safety drivers
Public interest groups and associations	No
Decision-making authorities or regulators	City of Turin Hospital (“City of Health and Science”)
Operators (public transport operators, private fleet operators etc.)	GTT
Mobility service providers	
Industry (AV manufacturers etc)	NAVYA

9.6.3.3.2 Pre demo study design, capturing and monitoring tools

Data collection during pre-demonstrations in Turin is described in Table 56. Surveys and vehicle data will be collected during the pre-pilot phase. Vehicle data will be collected continuously in all vehicles, visualised, and stored through the BESTMILE dashboard.

Table 56: Data collections during pre-demonstration in Turin.

Capturing and monitoring tools	**Pre -demonstration Timing of data collections and number of answers**	**Demonstration Indicative timing of data collection***
User Surveys		
Long – Needs and wants and Acceptance - A Priori survey	1 month before the pre-demo - *100 answers*	
Short - Acceptance: 15 question survey – target groups:	The last week during the pre-demo Patients at the hospital – 10 answers Employees at the hospital – 10 answers Safety drivers – 2 answers	Middle and end of demonstration
Satisfaction - 1 question survey	The last week during the pre-demo – 10 answers	Continuously during demonstration
Observations		
As defined in Table 13 (page 90) and Table 18 (page 111).	Continuously monitoring during pre-demo, stored locally. Data submission at the end of pre-demo.	Continuously monitoring. Data submitted end of demonstration month 3, 6, 9 and 12.
Interviews with stakeholders		
Needs and wants and acceptance interview - Before	I month before pre-demo: City of Turin – 1 interview Hospital ("City of Health and Science") – 1 interview GTT – 1 interview NAVYA – 1 interview	Middle and end of demonstrations
Needs and wants and acceptance interview – During demonstration	End of pre-demo: City of Turin – 1 interview Hospital ("City of Health and Science") – 1 interview GTT – 1 interview NAVYA – 1 interview	

*Number of answers will be defined in D9.3.

9.6.3.4 Timeline

The timeline for Turin is presented in Table 57.

Table 57: Turin timeline.

	2020 (M1-M12)				**2021 (M13-24)**				**2022 (M25-M36)**				**2023 (M37-M48)**			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																

	2020 (M1-M12)				2021 (M13-24)				2022 (M25-M36)				2023 (M37-M48)			
Pre-Demo																
Demonstration																

9.6.4 Greece - Trikala

The demo in Greece will take place in the city of Trikala and focuses both on passenger and freight transport. The population of Trikala is more then 92 000 persons, and the city host around 85 000 people commuting and during the winter there is more than 1 100 000 seasonal tourists visiting the area, see Figure 40.

The first use case in Greece focuses on autonomous traffic in a real city environment. The goal of this demo is to gradually replace an existing Public Transportation Operator (PTO) line by absorbing through an on-demand service (consisting of two shuttles) the transfer to the bus terminal. The demo will use 2 shuttles of >9 passengers provided through AVINT national project.

The aforementioned DRT service will be integrated and supported by a MaaS consisting of two passenger cars (2 BMW i3), that depending on the demand will be also able to operate in platooning mode. This mode will also make it possible to operate at higher speed, to connect peri-urban locations.

For the Automated LaaS demo, one freight vehicle by the University of Genova will be used. For the logistics demo, user groups will encompass SMEs in the area of UFT, local stores, city centre commuters, e-commerce users.

The first Public Transportation service area is on the city outskirts while the second is in the city centre, an area that integrates most of the city public services offices and the City Hall as well as a significant number of local retail stores.

Figure 40: The Site Trikala.

9.6.4.1 Key objectives

The key objectives for the Trikala site are as follows:

- For the passenger use case, the business model will include an automated on-demand service.
- For the cargo use case, there will be a business model for local retail companies to operate within night shifts and serve the city centre with cleaner and safer vehicles.
- Create a permanent PT line with AV.

9.6.4.2 Test cases

In total 7 use cases are demonstrated in Trikala. The site-specific test cases are as follows:

- Autonomous shuttles operation in real urban mixed-traffic environment connecting City Centre with central Intercity Bus Station. (UC 1.1a)
  The route of the automated shuttles runs between the city centre and the intercity bus station covering also specific points of interest of the citizens such as Hospital, Milk Factory, major suburbs and villages. The bus starts its route from the terminal at the city centre under normal traffic and environmental conditions with a maximum speed of 25km/h. The remote PT operator monitors continuously the bus via the fleet management software installed in the control centre. The bus follows the heavy traffic in front, adjusts accordingly its speed and brakes smoothly following the traffic in front. Passengers wait at the predefined bus stations and are informed for the bus arrival time via their mobile application. The bus stations are also equipped with the bus schedule. The bus follows the route and stops at each station where passengers are detected. The passenger enters the vehicle. The bus arrives at a signalised intersection and communicates with the traffic lights in order the green wave to be implemented. The bus stops at the next bus station upon the request of the passenger via the stop button installed inside the vehicle. The passenger exits the bus. The bus continues the route, follows the roundabout on the route with priority and reaches its final destination at the depot area.

- Autonomous cargo vehicle operation in real urban pedestrian city-centre environment (UC 1.1b)
  The cargo autonomous vehicle FURBOT will deliver goods within a pedestrian road at the centre of Trikala city. The operation of this vehicle will be performed at night with a duration of 2-3 hours with a maximum speed of 15km/h. The FURBOT vehicle load is packaged in freights boxes with the help of the vehicle operator. The safety driver on board monitors continuously the vehicle's route. The FURBOT follows its predefined route and stops at the fixed location to unload part of its cargo. The vehicle parks safely in an autonomous way. The local business stakeholder picks up the load via the robotised freight boxes. The vehicle continues its route, stops at every delivery location until all the goods are delivered. The vehicle parks at the depot area.

- Autonomous shuttles operation in real urban mixed and complex traffic environments involving intersections and roundabout connecting City Centre with central Intercity Bus Station (UC 1.2a)
  Two autonomous shuttles will operate on a fixed line. The route of the automated shuttles runs between the city centre and the intercity bus station covering also specific points of interest of the citizens such as Hospital, Milk factory major suburbs and Villages.

  The shuttle starts its route from the terminal under normal traffic and environmental conditions with a maximum speed of 25km/h. The remote PT operator monitors continuously the shuttle via the fleet management software installed in the control centre. The shuttle follows the heavy traffic in front, adjusts accordingly its speed and brakes smoothly whenever the vehicles in front are braking. Passengers wait at the predefined bus stations and are informed for the shuttle arrival time via their mobile application. The shuttle stations are also equipped with the bus schedule. The bus follows the route and stops at each station where passengers are detected. The passenger enters the vehicle. The shuttle arrives at a signalised intersection and communicates with the traffic lights in order the green wave to be implemented. The shuttle stops at the next bus station upon the request of the passenger via the stop button installed inside the vehicle. The passenger exits the bus. The shuttle continues the route, but another vehicle is blocking the road as the bus in not running in a dedicated lane. The shuttle detects this obstacle and is safely immobilised. The remote operator monitors the situation for the remote-control centre. After the vehicle moves and unblocks the road the shuttle continues its route. The routing schedule is updated, and the passengers are informed for the new arrival times at each station. The shuttle continues the route, delivers the rest of the passengers at the next stations and after all the passengers are exit, follows the roundabout on the route with priority and reaches its final destination at the depot area.

- Autonomous cargo vehicle operation and parking in real urban pedestrian city-centre environment (UC 1.2b)
  The cargo autonomous vehicle FURBOT will deliver goods within a pedestrian road at the centre of Trikala city. The operation of this vehicle will be performed at night with a duration of 2-3 hours with a maximum speed of 20km/h. The FURBOT vehicle load is packaged in freights boxes with the help of the operator. The safety driver on board monitors the vehicle's route. The FURBOT follows its predefined route and stops at the fixed location to unload part of its cargo. The vehicle parks safely in an autonomous way. The local business stakeholder picks up the load via the robotised freight boxes. The vehicle continues its route, stops at every delivery location until all the goods are delivered. The vehicle returns back at the depot area.

- Autonomous passenger vehicles operation in real urban mixed and complex traffic environments involving pedestrian crossings and VRUs connecting City Centre with central Intercity Bus Station (UC1.3a)

  Two autonomous passenger vehicles will operate on a fixed line between the city centre and the intercity bus station covering also specific points of interest of the citizens such as Hospital, Milk Factory, major suburbs and villages.
  The vehicle starts its route from the terminal under normal traffic and environmental conditions with a maximum speed of 25km/h. The remote PT operator monitors continuously the vehicle via the fleet management software installed in the control centre. The vehicle follows the traffic in front and reached a pedestrian crossing where people are waiting to cross the road. The vehicle adjusts accordingly its speed, brakes smoothly and stops until all the pedestrians cross the road. The vehicle starts again its operation, follows its route and stops at each station where passengers are detected. The passenger enters the vehicle. The vehicle arrives at a signalised intersection and communicates with the traffic lights in order the green wave to be implemented. The vehicle stops at the next station upon the request of the passenger. The passenger exits the vehicle. The vehicle in en route, but a cyclist is in front and illegally stops along the route as the vehicle in not running in a dedicated lane. The vehicle detects this obstacle and is safely immobilized. The remote operator monitors the situation for

the remote-control centre. After the cyclist moves and unblocks the road the vheicle continues its route. The routing schedule is updated, and the passengers are informed for the new arrival times at each station. The vehicle continues the route, delivers the rest of the passengers at the next stations and after all the passengers are exit, follows the roundabout on the route with priority and reaches its destination at the depot area.

- Autonomous cargo vehicle operation, smooth braking and immobilisation in real urban pedestrian city-centre environment (UC 1.3b).

  The cargo autonomous vehicle FURBOT will deliver goods within a pedestrian road at the centre of Trikala city. The operation of this vehicle will be performed at night with a duration of 2-3 hours with a maximum speed of 20km/h.

  The FURBOT vehicle load is packaged in freights boxes with the help of the operator. The safety driver on board monitors the vehicle's route.

  The FURBOT follows its predefined route and stops at the fixed location in order to unload part of its cargo. The vehicle parks safely in an autonomous way. The local business stakeholder picks up the load via the robotised freight boxes. The vehicle continues its route but a pedestrian is crossing the road. The vehicle detects the pedestrian, adjusts its speed and stops smoothly. The safety person on board activates also the emergency brake. After the pedestrian moves and the road is unblocked the vehicle continues its route towards every delivery location until all the goods are delivered. The vehicle parks at the depot area.

- Autonomous shuttles and cargo vehicle remote monitoring and emergency braking for immobilization mechanism via the connection with the remote-control centre (UC 1.7).
  The operations are described in 1.1-1.3, i.e. monitoring and focus on emergency brake and immobilisation.

- Autonomous shuttles DRT operation via a MaaS service within a fixed route in real urban mixed traffic environment connecting City Centre with central Intercity Bus Station (UC 1.10a).

  Two autonomous shuttles will operate on a fixed line on demand. The user requests a ride via its mobile application by setting the pickup bus station, its destination bus station and time of departure. The system collects all the relevant requests and performs the optimised route scheduling. The passengers are informed about their request (accept or deny). The bus starts its route from the terminal under normal traffic and environmental conditions with a maximum speed of 25km/h. The remote PT operator monitors continuously the bus via the fleet management software installed in the control centre. Passengers wait at the requested bus stations and are informed for the bus arrival time via their mobile application. The bus stations are also equipped with the bus schedule. The shuttle follows the route and stops at each station where the system has provided. The passenger enters the vehicle. The shuttle arrives at a signalised intersection and communicates with the traffic lights in order the green wave to be implemented. The bus stops at the requested by the system bus stations. The passenger exits the bus. The bus continues the route, follows the roundabout on the route with priority and reaches its destination at the depot area.

9.6.4.3 Evaluation methods

9.6.4.3.1 End users and stakeholders

The demonstration site in Trikala is for all citizens going to and from the intercity station. Of specific interest is the vulnerable road users and the workers at the hospital and the factory, see Table 58.

Table 58: End users and Stakeholders in Trikala.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator	Commuter to hospital Commuters to factory
Public interest groups and associations	-
Decision-making authorities or regulators	-
Operators (public transport operators, private fleet operators etc.)	Local operator
Mobility service providers	-
Industry (AV manufacturers etc.)	-
Other	Local stores e-commerce users

9.6.4.3.2 Pre demo study design, capturing and monitoring tools

Data collection during pre-demonstrations in Trikala is described in Table 59.

Table 59: Data collections during pre-demonstration in Trikala.

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
User Surveys		
Long – Needs and wants and Acceptance - A Priori survey	1 month before the pre-demo - *100 answers*	
Short - Acceptance: 15 question survey – target groups:	The last week during the pre-demo Commuters to the hospital – 10 answers Commuters to the factory – 10 answers	Middle and end of demonstration
Satisfaction - 1 question survey	The last week during the pre-demo – 10 answers	Continuously during demonstration
Observations		
As defined in Table 13 (page 90) and Table 18 (page 111).	Continuously monitoring during pre-demo, stored locally. Data submission at the end of pre-demo.	Continuously monitoring. Data submitted end of demonstration month 3, 6, 9 and 12.
Interviews with stakeholders		

Capturing and monitoring tools	**Pre -demonstration Timing of data collections and number of answers**	**Demonstration Indicative timing of data collection***
Needs and wants and acceptance interview - Before	I month before pre-demo: Local operator (tbd) – 1 interview Local stores (tbd) - 1 interview e-commerce users (tbd) - 1 interview	
Needs and wants and acceptance interview – During demonstration	End of pre-demo: Local operator (tbd) – 1 interview Local stores (tbd) - 1 interview e-commerce users (tbd) - 1 interview	Middle and end of demonstrations.

*Number of answers will be defined in D9.3.

9.6.4.4 Timeline

The timeline for Trikala is presented in Table 60.

Table 60: Trikala timeline.

	2020 (M1-M12)				**2021 (M13-24)**				**2022 (M25-M36)**				**2023 (M37-M48)**			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

The shuttles are coming from China and it is not clear how long the delay will be due to Covid-19.

9.6.5 Netherlands – Brainport, Eindhoven

The Brainport demonstration site is aimed for supporting public transport on bus lanes in Eindhoven (230,000 inhabitants) with automated driving. Eindhoven is the 5th largest city in the Netherlands, with a clear strategic interest in mobility innovations. Figure 41 shows the scope of the Brainport and Eindhoven.

Figure 41: The Site Brainport, Eindhoven.

9.6.5.1 Key objectives

The key objectives for Brainport are the following:

- to demonstrate cooperative automated driving technologies for bus lanes with solutions for smooth and safe intersection crossing with normal roads, aimed for PT buses, and platooning with shared passenger cars.
- to utilize day 1 C-ITS services for safe and informed intersection crossing.
- to support L4 and cooperative driving technologies for crossings intersections with presence of other vehicles and VRU.

9.6.5.2 Test cases

The specific test cases are as follows:

- Intersection crossing at normal operational speed (UC 1.1)

  The automated vehicle will start at point A (e.g. a bus stop and pick up a passenger) that needs to reach a destination in a point B. The vehicle will handle preceding traffic, will pass through intersections and for that it will be capable of handling information that comes from traffic light. The vehicle will stop at point B to drop off the passenger (e.g. another bus stop). The vehicle adjusts the speed in response to C-ITS services for traffic light status, red-light violation warnings, and emergency vehicles.

- Safety for VRU at intersections (UC 1.3)
- The vehicle will handle preceding traffic and will pass through intersections on a route. Specifically for this use case it is considered that VRU can violate the

traffic light at intersections. The vehicle will be capable to react to that by reducing its speed to ensure sufficient safety levels.

- Vehicle relocation for automated mobility using platooning (UC 1.8)

  At a bus stop or predefined point, empty automated vehicles will form a platoon. The leader of the platoon is a vehicle driven by a human. The platoon of vehicles will drive to a predefined destination, crossing an intersection. The platoon assembly will adjust to situations at intersections that it is crossing.

9.6.5.3 Evaluation methods

9.6.5.3.1 Stakeholders and end users

Targeted end users are commuters, students and visitors. For the evaluations also VRU is of specific interest, and the safety drivers experience. Stakeholders and end users are presented in Table 61.

Table 61: End users and Stakeholders in Eindhoven.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator	Commuters, visitors and students VRUs Safety drivers
Public interest groups and associations	No
Decision-making authorities or regulators	City of Eindhoven, City of Helmond
Operators (e.g. public transport operators, private fleet operators)	Hermes
Mobility service providers	Amber mobility (car sharing)
Industry (e.g. AV manufacturers)	AV manufacturer TBD

9.6.5.3.2 Pre demo study design, capture and monitoring tools

Vehicle data will be collected continuously in all vehicles, visualised, and stored locally. Data collection during pre-demonstrations is described in Table 62.

Table 62: Data collections during pre-demonstration in Eindhoven.

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
User Surveys		
Long – Needs and wants and Acceptance - A Priori survey Short - Acceptance: 15 question survey – target groups:	1 month before the pre-demo - *100 answers* The last week during the pre-demo Commuters – 10 answers Visitors – 10 answers Students – 10 answers VRUs – 10 answers Safety drivers – 2 answers	Middle and end of demonstration

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
Satisfaction - 1 question survey	The last week during the pre-demo – 10 answers	Continuously during demonstration
Observations		
As defined in Table 13 (page 90) and Table 18 (page 111).	Continuously monitoring during pre-demo, stored locally. Data submission at the end of pre-demo.	Continuously monitoring. Data submitted end of demonstration month 3, 6, 9 and 12.
Interviews with stakeholders		
Needs and wants and acceptance interview - Before	I month before pre-demo: City of Eindhoven, City of Helmond – 1 answer Hermes -1 answer Amber mobility (car sharing) -1 answer AV manufacturer (TBD) 1 answer	
Needs and wants and acceptance interview – During demonstration	End of pre-demo: City of Eindhoven, City of Helmond – 1 answer Hermes -1 answer Amber mobility (car sharing) -1 answer AV manufacturer (TBD) 1 answer	Middle and end of demonstrations.

*Number of answers will be defined in D9.3.

9.6.5.4 Timeline

The generic timeline for Eindhoven is presented in Table 63.

Table 63: Eindhoven (Brainport) timeline.

	2020 (M1-M12)				2021 (M13-24)				2022 (M25-M36)				2023 (M37-M48)			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

The discussions with potential suppliers of an AV bus and the technology developments is ongoing.

9.6.6 Czech Republic - Brno

Brno is situated in the southeast of the Czech Republic. The city has 380,000 inhabitants and is the 2nd largest city in the country, see Figure 42. In Brno a traffic centre that can control remotely automated driving over long distance (up to 200 km) will be available.

Figure 42: The Site Brno.

9.6.6.1 Key objectives

The key objective for Brno is the following:

- Autonomous traffic will interface with and complement an existing PT service. The PT service will connect places that are poorly served as well as optimize routes to provide the group of users with increased mobility, especially people with disabilities, elderly, students and under-aged people, but also goods.

9.6.6.2 Test cases

In total Brno demonstrate 5 use cases. Their site-specific test cases are as follows:

- Normal speed robotaxi service serving residential area (UC1.1)

  The goal is to demonstrate the possibility of semi-autonomous transport in the historic part of the city, which is inaccessible to ordinary urban transport. An electric shuttle will be used for this task. The goal is to demonstrate a DRT model where a site with a home for the elderly will be served on the basis of a scheduled order. An electric shuttle/or Robotaxi will be used for this task.

- Lower speed shuttle service (UC1.2)

  The goal is to demonstrate the possibility of semi-autonomous transport in the historic part of the city, which is inaccessible to ordinary urban transport. An electric shuttle will be used for this task.

- Lower speed shuttle service serving students, commuters, tourists (UC1.3)

  The goal is to demonstrate the possibility of semi-autonomous transport in the historic part of the city, which is inaccessible to ordinary urban transport. An electric shuttle will be used for this task.

- Traffic centre controlled remote automated driving over long distance (up to 200 km) (UC 1.7).

9.6.6.3 Evaluation Methods

9.6.6.3.1 End users and stakeholders

In Brno the target groups are users with disabilities (blind persons), elderly, students, young people, commuters and tourists, see Table 64.

Table 64: End users and Stakeholders in Brno.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator	Commuters Tourists Persons with reduced mobility (blind)
Public interest groups and associations	-
Decision-making authorities or regulators	x
Operators (e.g. public transport operators, private fleet operators)	x
Mobility service providers	x
Industry (e.g. AV manufacturers)	-

9.6.6.3.2 Pre demo study design, capturing and monitoring tools

In Table 65 the data collection for pre-demonstrations are defined.

Table 65: Data collections during pre-demonstration in Brno.

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
User Surveys		
Long – Needs and wants and Acceptance - A Priori survey	1 month before the pre-demo - *100 answers*	
	The last week during the pre-demo	
Short - Acceptance: 15 question survey – target groups:	Commuters – 10 answers Tourists – 10 answers Persons with reduced mobility (blind) – 10 answers	Middle and end of demonstration
Satisfaction - 1 question survey	The last week during the pre-demo – 10 answers	Continuously during demonstration
Observations		
As defined in Table 13 (page 90) and Table 18 (page 111).	Continuously monitoring during pre-demo, stored locally. Data submission at the end of pre-demo.	Continuously monitoring. Data submitted end of demonstration month 3, 6, 9 and 12.
Interviews with stakeholders		
Needs and wants and acceptance interview - Before	I month before pre-demo: Decision-making authorities – 1 interview Operators– 1 interview Mobility service providers – 1 interview	

Capturing and monitoring tools	Pre -demonstration Timing of data collections and number of answers	Demonstration Indicative timing of data collection*
Needs and wants and acceptance interview – During demonstration	End of pre-demo: Decision-making authorities – 1 interview Operators – 1 interview Mobility service providers – 1 interview	Middle and end of demonstrations.

*Number of answers will be defined in D9.3.

9.6.6.4 Timeline

The timeline for Brno is presented in Table 66.

Table 66: Brno timeline.

	2020 (M1-M12)				2021 (M13-24)				2022 (M25-M36)				2023 (M37-M48)			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

10 Conclusions

The evaluation of the SHOW ecosystem encompasses several layers, that to some degree are overlapping or integrated. It starts with the investigation of the expectations of travellers and stakeholders (layer 1) and are completed with the final evaluation of the ecosystem that results from the triangulation of the findings from the evaluations at demonstration sites.

The impact assessment framework denoted M3ICA (multi-impact, multi-criteria, and multi-actor) is specifically developed for the ecosystem of SHOW. It allows for the consistent analysis and evaluation of demonstration sites and simulations within the ecosystem of electric connected automated vehicles (e-CAV). Specifically, for the pre-demonstration and demonstrations data collections, the FESTA methodology is used as the starting point for setting up the framework of the demonstration evaluations. The outline of D9.2 is based around the FESTA stepwise approach with headings for systems and services, use case descriptions and the specific test cases that is defined per demonstration site, research questions, evaluations methods and capturing and monitoring tools for the collection of the final measures needed.

The research questions to address at each demonstration site are derived from the SHOW use cases and their scenarios, a work that has been finalised in month 9 of the project and is reflected in D1.2. SHOW cover a wide range of coordinated shared automated vehicle systems. Thus, the SHOW Demonstration sites will include automated PT (buses and metros), automated shuttles for DRT services and automated MaaS fleets for passenger transport as well as AVs for pure cargo delivery and for mixed passenger/ cargo transport. Combined automated transport of people and goods will be tested in spatial (same vehicle - different compartments) and temporal (different times of day) forms. In D9.2 a consolidation of the systems and services that will be used for demonstrations evaluations are described. This sets the so called “demonstration plans”. In addition, a more detailed description of the end user profile and the stakeholders to be evaluated at each site are described. For each demonstration site the experimental plan for pre-demo is then defined.

The work done is aimed to be of value for future CCAV evaluations frameworks. Following the generic stepwise structure going from Use Cases to Capturing and monitoring tools is the basic structure. The preparations of demonstration sites are done by using the FESTA methodology, and the M3MCA methodology is then used to define the impact analysis and to identify the connected KPIs and their related measurements per impact area. The generic structure is as follows, and all steps are described in D9.2.

Due to Covid -19 there are delays in the preparation of the demonstration sites, delays that also influence the Demonstration and experimental plans. What is found in this document is the most updated status as of November 2021. Corresponding updates will be summarised also on the pre-demo phase will be reported in D9.3, despite the fact that D9.3 focuses on the final demonstration/pilot phase.

References

Angreani, L.S., Vijaya, A., Wicaksono, H. (2020). Systematic Literature Review of Industry 4.0 Maturity Model for Manufacturing and Logistics Sectors. Procedia Manufacturing Volume 52, 2020, pp. 337-343.

Barfod, M. B. (2018). Supporting sustainable transport appraisals using stakeholder involvement and MCDA. Transport, 33(4), 1052–1066. https://doi.org/10.3846/transport.2018.6596

Barnard, Y., Innamaa, S., Koskinen, S., Gellerman, H., Svanberg, E., & Chen, H. (2016). Methodology for Field Operational Tests of Automated Vehicles. *Transportation Research Procedia*, 14, 2188–2196. https://doi.org/10.1016/j.trpro.2016.05.234

Behrendt, F., Lau, L. K., Muller, M. Assmann, T. and Schmidkte (2018). Development of a concept for a smart logistics maturity index. PROLOG 2018: International Conference on Project Logistics At: Kingston upon Hull

Campagna, A. (2013). The transferability issue. Discussion paper/rel.01. LIMIT4WEDA_C5_LazioRegion_Notes on Transferability.

Chen, F., Wang, J., & Deng, Y. (2015). Road safety risk evaluation by means of improved entropy TOPSIS–RSR. *Safety Science*, 79, 39–54. https://doi.org/10.1016/j.ssci.2015.05.006

Cohen, T., & Cavoli, C. (2019). Automated vehicles: Exploring possible consequences of government (non)intervention for congestion and accessibility. *Transport Reviews*, 39(1), 129–151. https://doi.org/10.1080/01441647.2018.1524401

Cohen, T., Stilgoe, J., & Cavoli, C. (2018). Reframing the governance of automotive automation: Insights from UK stakeholder workshops. *Journal of Responsible Innovation*, 5(3), 257–279. https://doi.org/10.1080/23299460.2018.1495030

Comi, A., Persia, L., Polimeni, A., Campagna, A. and Mezzavilla, L. (2020). A methodology to design and assess scenarios within SULPs: the case of Bologna. Transportation Research Procedia 46, DOI: 10.1016/j.trpro.2020.03.190, pp. 269-276

Damon, N. (1958). The action program for highway safety. *Annals of the American Academy of Political and Social Science*, 320(1), 15-26.

Elvik, R., Quddus, M., Papadoulis, A., Cleij, D., Weijermars, W., Millonig, A., Vorwagner, A., Hu, B., & Nitsche, P. (2019). A taxonomy of potential impacts of connected and automated vehicles at different levels of implementation [Deliverable D3.1 of the H2020 project LEVITATE]. LEVITATE Consortium. https://levitate-project.eu/wp-content/uploads/2019/10/D3.1-A-taxonomy-of-potential-impacts-final.pdf

Esztergár-Kiss, D., & Tettamanti, T. (2019). 9—Stakeholder engagement in mobility planning. In P. Coppola & D. Esztergár-Kiss (Eds.), *Autonomous Vehicles and Future Mobility* (pp. 113–123). Elsevier. https://doi.org/10.1016/B978-0-12-817696-2.00009-3

Facchini, F., Oleśków-Szłapka, J., Ranieri, L. and Urbinati, A. (2020). A Maturity Model for Logistics 4.0: An Empirical Analysis and a Roadmap for Future Research. Sustainability 12, no. 1: 86. https://doi.org/10.3390/su12010086.

Feys, M., Rombaut, E., Macharis, C., & Vanhaverbeke, L. (2020). Understanding stakeholders' evaluation of autonomous vehicle services complementing public transport in an urban context. IEEE Forum on Integrated and Sustainable Transportation Systems, Delft, The Netherlands.

Graf, A., & Sonnberger, M. (2020). Responsibility, rationality, and acceptance: How future users of autonomous driving are constructed in stakeholders' sociotechnical imaginaries. Public Understanding of Science, 29(1), 61–75. https://doi.org/10.1177/0963662519885550

Haddon, W. (1972). A logical framework for categorizing highway safety phenomena and activity. Journal of Trauma, 12, 193-207.

Holmgren, J., 2019. Using Cost–Benefit Analysis to Evaluate City Logistics Initiatives: An Application to Freight Consolidation in Small- and Mid-Sized Urban Areas. In City Logistics 2

Huang, H., Lebeau, P., & Macharis, C. (2020). The Multi-Actor Multi-Criteria Analysis (MAMCA): New Software and New Visualizations. In J. M. Moreno-Jiménez, I. Linden, F. Dargam, & U. Jayawickrama (Eds.), Decision Support Systems X: Cognitive Decision Support Systems and Technologies (pp. 43–56). Springer International Publishing. https://doi.org/10.1007/978-3-030-46224-6_4

Hughes, B. P., Newstead, S., Anund, A., Shu, C. C., & Falkmer, T. (2015). A review of models relevant to road safety. Accid Anal Prev, 74, 250-270. doi:10.1016/j.aap.2014.06.003

Innamaa, S., Smith, S., Barnard, Y., Rainville, L., Rakoff, H., Horiguchi, R., & Gellerman, H. (2018). Trilateral Impact Assessment Framework for Automation in Road Transportation. Trilateral Working Group on Automation in Road Transportation. https://connectedautomateddriving.eu/wp-content/uploads/2017/05/Trilateral_IA_Framework_Draft_v1.0.pdf

Kijewska, K. and Iwan, S. (2018). Adaptability/Transferability in the City Logistics Measures Implementation. CSUM 2018: Data Analytics: Paving the Way to Sustainable Urban Mobility, pp 622-630.

Koymans, A., Limão, S., Charlot, F., Parent, M., Holguin, C., & Giustiniani, G. (2013). Functional specifications of vehiclesand related services (Deliverable 15.1).

Kumar, R., Singh, S., Bilga, P. S., Jatin, Singh, J., Singh, S., Scutaru, M.-L., & Pruncu, C. I. (2021). Revealing the benefits of entropy weights method for multi-objective optimization in machining operations: A critical review. Journal of Materials Research and Technology, 10, 1471–1492. https://doi.org/10.1016/j.jmrt.2020.12.114

Lebeau, P., Macharis, C., Van Mierlo, J., & Janjevic, M. (2018). Improving policy support in city logistics: The contributions of a multi-actor multi-criteria analysis. Case Studies on Transport Policy, 6(4), 554–563. https://doi.org/10.1016/j.cstp.2018.07.003

Legacy, C., Ashmore, D., Scheurer, J., Stone, J., & Curtis, C. (2019). Planning the driverless city. Transport Reviews, 39(1), 84–102. https://doi.org/10.1080/01441647.2018.1466835

Litman, T. (2020). Autonomous Vehicle Implementation Predictions: Implications for Transport Planning (p. 45). Victoria Transport Policy Institute. http://www.vtpi.org/avip.pdf

Macharis, C., & Baudry, G. (2018). The Multi Actor Multi Criteria Analysis framework. Decision-Making for Sustainable Transport and Mobility. https://www.elgaronline.com/view/edcoll/9781788111799/9781788111799.00008.xml

Macharis, C., Milan, L., Verlinde, S., 2014. A stakeholder-based multicriteria evaluation framework for city distribution. Res. Transport. Bus. Manage. 11, 75–84.

Macharis, C., Turcksin, L., & Lebeau, K. (2012). Multi actor multi criteria analysis (MAMCA) as a tool to support sustainable decisions: State of use. Decision Support Systems, 54(1), 610–620. https://doi.org/10.1016/j.dss.2012.08.008

Macharis, C., Witte, A. de, & Ampe, J. (2009). The multi-actor, multi-criteria analysis methodology (MAMCA) for the evaluation of transport projects: Theory and practice. Journal of Advanced Transportation, 43(2), 183–202. https://doi.org/10.1002/atr.5670430206

Markvica, K., Rosenkranz, P., Loukea, M., Gaitanidou, E., Bekiaris, E., Giro, C., Orfanou, F., Vlahogianni, E., Yannis, G., Fassina, F., & Lenz, O. (2020). D1.1: User clusters, opinion, research hypotheses and use cases towards future autonomous vehicle acceptance. Drive 2 The Future. http://www.drive2thefuture.eu/wp-content/uploads/2020/09/Drive2theFuture-WP1-D1.1-User-clustersopinion-research-hypotheses-and-use-cases-towards-future-AV-acceptance.pdf

May, A. D., Shepherd, S., Pfaffenbichler, P., & Emberger, G. (2020). The potential impacts of automated cars on urban transport: An exploratory analysis. Transport Policy. https://doi.org/10.1016/j.tranpol.2020.05.007

Milakis, D., Van Arem, B., & Van Wee, B. (2017). Policy and society related implications of automated driving: A review of literature and directions for future research. Journal of Intelligent Transportation Systems: Technology, Planning, and Operations, 21(4), 324–348. https://doi.org/10.1080/15472450.2017.1291351

Milan, L., Kin, B., Verlinde, S., & Macharis, C. (2015). Multi-actor multi-criteria analysis for sustainable city distribution: A new assessment framework. International Journal of Multicriteria Decision Making, 5(4), 334–354. https://doi.org/10.1504/IJMCDM.2015.074088

Nathanail, E. (2018). A multi-stakeholders multicriteria decision support platform for assessing urban freight transport measures. Lecture Notes in Networks and Systems Volume 36, pages 17 – 312018.

Nathanail, E., Adamos, G. and Gogas, M. (2016). A novel approach for assessing sustainable city logistics. Transportation Research Procedia 25, pp. 1036–1045

Nathanail, E., Karakikes, I., Mitropoulos, L., Adamos, G. (2021). A sustainability cross-case assessment of city logistics solutions. Case Studies on Transport Policy 9(1), pp. 219-240.

Nathanail, E., Mitropoulos, L., Karakikes, I., Adamos, G. (2018). Sustainability framework for assessing urban freight transportation solutions. Logist. Sustain. Trans. https://doi.org/10.2478/jlst-2018-0007

Narayanan, S., Chaniotakis, E., & Antoniou, C. (2020). Shared autonomous vehicle services: A comprehensive review. Transportation Research Part C: Emerging Technologies, 111, 255–293. https://doi.org/10.1016/j.trc.2019.12.008

Nogués, S., González-González, E., & Cordera, R. (2020). New urban planning challenges under emerging autonomous mobility: Evaluating backcasting scenarios and policies through an expert survey. Land Use Policy, 95, 104652. https://doi.org/10.1016/j.landusepol.2020.104652

Novelog, 2016. Deliverable D3.1. Integrated assessment framework for UFT solutions.

Peden, M., Scurfield, R., Sleet, D., Mohan, D., Hyder, A., Jarawan, E., & Mhers, C. (2004). World health report on road traffic injury prevention. Retrieved from Geneva, Switerland:

Pettigrew, S., & Cronin, S. L. (2019). Stakeholder views on the social issues relating to the introduction of autonomous vehicles. Transport Policy, 81, 64–67. https://doi.org/10.1016/j.tranpol.2019.06.004

Rashidi, T. H., Najmi, A., Haider, A., Wang, C., & Hosseinzadeh, F. (2020). What we know and do not know about connected and autonomous vehicles. Transportmetrica A: Transport Science, 16(3), 987–1029. https://doi.org/10.1080/23249935.2020.1720860

Shibayama, T., Pungillo, G., Lemmerer, H., & Nocera, S. (2020). Stakeholder involvement in decision-making process: A test assessment towards transition to autonomous vehicles. Transportation Research Procedia, 48, 2550–2568. https://doi.org/10.1016/j.trpro.2020.08.255

Smith, S., Koopmann, J., Rakoff, H., Peirce, S., Noel, G., Eilbert, A., & Yanagisawa, M. (2018). Benefits Estimation Framework for Automated Vehicle Operations: Phase 2 Final Report. John A. Volpe National Transportation Systems Center U.S.

Stocker, A., & Shaheen, S. (2019). Shared Automated Vehicle (SAV) Pilots and Automated Vehicle Policy in the U.S.: Current and Future Developments. In G. Meyer & S. Beiker (Eds.), Road Vehicle Automation 5 (pp. 131–147). Springer International Publishing. https://doi.org/10.1007/978-3-319-94896-6_12

Sulpiter (2017). The Logistics Sustainability Index Handbook. CE222 SULPiTER, SULPITER LSI Handbook final.

Sun, H., Zhang, Y., Wang, Y., Li, L., & Sheng, Y. (2015). A social stakeholder support assessment of low-carbon transport policy based on multi-actor multi-criteria analysis: The case of Tianjin. Transport Policy, 41, 103–116. https://doi.org/10.1016/j.tranpol.2015.01.006

Taiebat, M., Brown, A. L., Safford, H. R., Qu, S., & Xu, M. (2018). A review on energy, environmental, and sustainability implications of connected and automated vehicles. Environmental Science and Technology, 52. https://doi.org/10.1021/acs.est.8b00127

Tubis, A.A., Werbińska-Wojciechowska, S. (2021). Risk management maturity model for logistic processes. Sustainability (Switzerland) 13(2), 659, pp. 1-19.

TURBLOG-WW (2011). Transferability of Urban Logistics Concepts and Practices from a World Wide Perspective. Handbook on Urban Logistics: Deliverables D5, D5.1, D5.2.

UITP. (2020). Toolkit chapter. SPACE: Chapter 1 Practical Scenarios and How to Get There. https://space.uitp.org/toolkit/practical-scenarios-and-how-to-get-there

Zhu, Y., Tian, D., & Yan, F. (2020). Effectiveness of Entropy Weight Method in Decision-Making. Mathematical Problems in Engineering, 2020, 1–5. https://doi.org/10.1155/2020/3564835

Appendix I: Demo Sites Contacts

Date: 20210111	Local Ethical Representatives (LER)			
Site #	**Country**	**City**	**Person**	**Email:**
1	France	Rouen	Sam Lysons	sam.lysons@transdev.com
2	France	Rennes	Isabelle Dussutour Florent Poiret	isabelle.dussutour@id4car.org florent.poiret@chu-rennes.fr
3	Spain	Scenario 1	Lucía Isasilucia.isasi@tecnalia.com	
4	Spain	Scenario 2		
5	Austria	Graz	Joachim Hillebrand	joachim.hillebrand@v2c2.at
6	Austria	Salzburg	Markus Karnutsch	markus.karnutsch@salzburgresearch.at
7	Austria	Carinthia	Alexander Fürdös	Alexander.Fuerdoes@austriatech.at
8	Germany	Karlsruhe	Juergen Weimer	Juergen.Weimer@dlr.de
9	Germany	Braunschweig	Katharina Karnahl	katharina.karnahl@dlr.de
10	Germany	Aachen	Helen Winter	Helen.Winter@mail.aachen.de
11	Sweden	Linköping	Anna Anund	anna.anund@vti.se
12	Sweden	Kista	Stig Persson	stig.persson@ericsson.com
13	Finland	Tampere	Pekka Eloranta	pekka.eloranta@sitowise.com
14	Denmark	Copenhagen	Anette Enemark	aen@moviatrafik.dk
15	Italy	Turin	Brunella Caroleo	brunella.caroleo@linksfoundation.com
16	Greece	Trikala	Anna Antonakopoulou	anna.antonakopoulou@iccs.gr
17	Netherlands	Brainport, Eindhoven	Sven Jansen	sven.jansen@tno.nl
18	Czech Republic	Brno	tomas.haban@cdv.cz	tomas.haban@cdv.cz

Appendix II: Questionnaires for Travellers

Needs & Wants & Acceptance (Extended questionnaire – Before the demonstration)

SHORT INTRO PARAGRAPH

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

Insert (on the home page or on the next page) a filter question confirming that the person is of legal age to answer the questionnaire (age to be defined in the project). For example, "I confirm that I am XX years old or older". If the person answers yes, s/he has access to the questionnaire, if the person answers no, s/he is redirected directly to the end page of the questionnaire.

Technology maturity

1. **What is your level of knowledge about autonomous vehicles?**

   ❍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 only heard about Google Car or Tesla)
   ❍Novice (e.g., I do not know this area at all)

2. **Would you like to test your knowledge on automation? Then please answer the 3 following questions:**

In order to be able to locate itself precisely in space, the autonomous vehicle uses: *[only one choice]*

❍Only conventional GPS, such as used in non-autonomous vehicles

❍GPS with better performance than traditional GPS systems

❍A set of sensors on board the vehicle, including a conventional GPS system

❍A set of sensors on board the vehicle, including a GPS that is more powerful than conventional GPS systems

❍None of the above

❍I do not know

Considering the actual technical advances, in which situations do you believe that autonomous vehicles currently available allow the driver to have an autonomous journey, i.e. without putting his/her hands on the steering wheel or his/her feet on the pedals: *[only one choice]*

❍In all types of environments (in the city, on the expressway, etc.)

❍Only in the city

❍Only in a car park

❍Only on expressways

❍None of these situations

❍I do not know

Which of these sensors is generally <u>not</u> on-board autonomous vehicles? *[only one choice]*

❍Camera

❍Lidar

❍Barometer

❍Odometer

❍Radar

❍I do not know

Travelling, preferences and experience

3. Do you have a public transport subscription?

❍ Yes

❍ No

If yes, is it an annual or a monthly subscription?

❍Annual

❍Monthly

❍Other (please specify)

4. Please complete this section about your actual travelling habits.

Under normal circumstances, for each activity, please provide the frequency, the main means of transport (used on the longest part of the trip), specifying the average fare for the journey, the average distance travelled (DIST), the door-to-door travel time (TT) and overview of your general experiences.

Remarks

- For public modes, if you have a transport subscription, please indicate the amount of the subscription price. Otherwise please indicate the price of the trip.
- The door-to-door travel time **(TT)** is the mean time in minutes that is required to reach your destination including:
    - **The access time**, as the time needed to access to stations and stops (for Public transport or Carpooling), or to the parking (for Private cars, Personal Motorcycle/ scooter/moped).
    - **The waiting time**, as the time spent waiting at stations and stops (only for Public transport or Carpooling).
    - **The in-vehicle time** represents only the time spent travelling on board the means of transport.

For	Frequency	Mode of transport	Fare (€)	TT (MN)	DIST (km)	...and, in general, the experience is...
Work (school/University)	❍Daily ❍Weekly ❍Monthly ❍Few times per year ❍Rarely ❍Never	❍Public transport				
		❍Carpooling				
		❍Private car				
		❍Motorcycle/scooter/moped				
		❍Bicycle, roller, etc.				
		❍Walking				
Shopping and errands	❍Daily ❍Weekly ❍Monthly ❍Few times per year ❍Rarely ❍Never	❍Public transport				
		❍Carpooling				
		❍Private car				
		❍Motorcycle/scooter/moped				
		❍Bicycle, roller, etc.				
		❍Walking				
Leisure	❍Daily ❍Weekly ❍Monthly ❍Few times per year ❍Rarely ❍Never	❍Public transport				
		❍Carpooling				
		❍Private car				
		❍Motorcycle/scooter/moped				
		❍Bicycle, roller, etc.				
		❍Walking				

5. **For you, which are the most IMPORTANT conditions for a GOOD travelling experience?** (please SELECT maximum 5 reasons and CLASSIFY them in order of IMPORTANCE 1 for the most important, 2 for the next most important, etc.).

Feature	Importance [1 to 5] *drop down menu*
Punctuality	
Good connection with other transport modes	
Minimum interchanges	
Real-time information during the journey	
Comfort/ Hygiene (e.g. seating, cleanliness)	
High perception of reliability	
Cost	
High service frequency	
High perception of security inside the vehicle	
Trust in the service provider	
Door-to-door travel time	
Physical accessibility	
No hassle searching for a parking space	
Availability of staff on-board to assist me	
Availability of online customer service to assist me	
Clear and easy use of ticketing and/or integrating ticketing	

6. An autonomous vehicle is capable of driving without the driver's intervention - during parts of, or the entire ride.

Have you ever seen an autonomous vehicle?

❍Yes

❍No

If yes, I have driven/ travelled with an autonomous...

Mode of Transport	Yes	No	I don't know	If yes, the experience was…
Train/Metro	❍	❍	❍	
Bus / Shuttle	❍	❍	❍	
Private passenger car	❍	❍	❍	
Other passenger car (taxi, sharing, pooling)	❍	❍	❍	

Expectations, Needs & Wants related to autonomous travelling experience

7. Why would you select an autonomous alternative (if it was available)?

(please SELECT maximum 5 reasons and CLASSIFY them in order of IMPORTANCE, 1 for the most important, 2 for the next most important, etc.).

Reasons	Importance [1 to 5]
I would be able to engage in other activities during my trips (like reading, working, relaxing)	
It would be punctual	
It would offer me better connection with other transport modes (e.g., between bus and train)	
It would be cheaper	
I do not like driving	
There would be fewer accidents because human errors will be significantly decreased.	
It would be more environmentally friendly	
It would cover parts of my journey that they are not covered until now (first-last mile)	
The journey would be more comfortable	
There would be more frequent service	
The journey would be faster	

8. Why would you avoid an autonomous alternative?

(please SELECT maximum 5 reasons and CLASSIFY them in order of IMPORTANCE, 1 for the most important, 2 for the next most important, etc.).

Reasons	Importance [1 to 5]
The journey would not be safe and/or secure	
It would be unreliable	
It would be expensive	
It would not be fast enough	
It would not be punctual enough	
I would trust humans more than the [autonomous solution]	
It would not be environmentally friendly	
I would be afraid that my personal data could be hacked	
It would be too complicated to use it	
I want to have control of the vehicle	
There would be no human contact on board	
It would not be frequent enough	
It would be difficult to access	
I enjoy driving	

9. I think the JOURNEY with one of the following AUTONOMOUS TRANSPORT MODES would be…

Mode of Transport			
Autonomous Train/Metro	Unpleasant Stressful Uncomfortable Dangerous Difficult Useless	❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍	Pleasant Relaxing Comfortable Safe Easy Useful
Autonomous Bus/ Shuttle	Unpleasant Stressful Uncomfortable Dangerous Difficult Useless	❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍	Pleasant Relaxing Comfortable Safe Easy Useful
Autonomous car without other passengers	Unpleasant Stressful Uncomfortable Dangerous Difficult Useless	❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍	Pleasant Relaxing Comfortable Safe Easy Useful
Autonomous car with other passengers (taxi, sharing, pooling)	Unpleasant Stressful Uncomfortable Dangerous Difficult Useless	❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍ ❍❍❍❍❍❍❍❍❍	Pleasant Relaxing Comfortable Safe Easy Useful

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

a. I would use an autonomous mobility service if it is shared.
b. I would use an autonomous mobility service if it is individual.
c. I would not use an autonomous mobility service.

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

12. **Indicate the type of environment where you think an autonomous mobility service would be the most useful:**

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

13. **You would use an autonomous transportation mode for ...** *[multiple choices possible]*

Mode of Transport	
Autonomous Train/Metro	☐Commuting ☐Business/ Work travel ☐Leisure ☐Shopping and errands ☐Going to/from School/University ☐Visiting family and friends ☐I would not take this means of transport
Autonomous Bus/ Shuttle	☐Commuting

Mode of Transport	
	☐Business/ Work travel ☐Leisure ☐Shopping and errands ☐Going to/from School/University ☐Visiting family and friends ☐I would not take this means of transport
Autonomous car without other passengers	☐Commuting ☐Business/ Work travel ☐Leisure ☐Shopping and errands ☐Going to/from School/University ☐Visiting family and friends ☐I would not take this means of transport
Autonomous car with other passengers (taxi, sharing, pooling)	☐Commuting ☐Business/ Work travel ☐Leisure ☐Shopping and errands ☐Going to/from School/University ☐Visiting family and friends ☐I would not take this means of transport

14. **For the autonomous mobility service, you would prefer to ...** *[9-point Likert scale]*
    a. … order your transport via an application
    b. … order your transport at a dedicated terminal on public roads
    c. … order your transport from a sales agent
    d. … not to make a reservation but to wait at a collection point with fixed passage times

15. **Before using an autonomous mobility service for the first time, you would prefer…**

Responses	**Importance [1 to 5 maximum]** *drag and drop*
A tutorial on a dedicated terminal	
A tutorial on the mobile phone or available on the internet	
Training carried out by the transporter	
Real person that accompanies you on the first trip and provides explanation	
A paper booklet	
Nothing, I prefer investigating it myself	

16. **You would prefer to …** *[9-point Likert scale]*
    a. … pay with your usual public transport card
    b. … pay using a mobile application
    c. … pay directly in the vehicle
    d. … receive an invoice and pay at a date chosen by you
    -

17. **If you had the choice when getting into an autonomous vehicle, to identify yourself (via a transport card or a bar code available on the mobile application, for example) or not identify yourself, you would prefer:** *[only one choice]*

- ❍ To identify myself
- ❍ Not to identify myself

[PREVIOUS ANSWER: Identify me] **How would you like to identify yourself?**

Responses	**Importance [1 to 3]** *drag and drop*

With my usual transport card	
With a digit code received by text message	
With a barcode received via the mobile application	

[PREVIOUS ANSWER: Not identify me] **Why would you not like to identify yourself?**

Responses	**Importance [1 to 3]** *drag and drop*
To keep my anonymity	
To avoid the hacking of my personal data	
To not complicate the management of the reservation	

18. I would prefer:

	Responses *[only one choice]*
When I get into the vehicle:	❍The doors to open automatically ❍To press a button for the doors to open
For the service to start:	❍Let it start automatically ❍Press a button to start it
Use the vehicle:	❍On expressways ❍On roads with mixed traffic ❍On dedicated lanes
When the service arrives at its destination:	❍The doors to open automatically ❍To press a button for the doors to open

19. If the service is shared, I would like...

a. a button to be available to keep the service waiting and allow other users to enter/exit (e.g., as in elevators)

❍Yes

❍No

b. a button to be available to allow me closing the doors more quickly (e.g., in elevators)

❍Yes

❍No

20. I would like to be able to evaluate the service (e.g., via a satisfaction questionnaire)?

❍ After each use
❍ Occasionally
❍ Never

A priori acceptance

21. For each of the following statements, please indicate your degree of agreement *[9-point Likert]*

1. I think a [autonomous solution] will become an important part of the existing public transport system.

2. I think using an [autonomous solution] in my day-to-day commuting would be better and more convenient than my existing form of travel.
3. I think an [autonomous solution] would be more efficient/faster than existing forms of public transport.
4. I think an [autonomous solution] would be easy to understand how to use.
5. It would not take me long to learn how to use an [autonomous solution].
6. The people around me think that I should use an [autonomous solution].
7. I think I am more likely to use an [autonomous solution] if my friends and family used it.
8. If it were affordable, I would use an [autonomous solution].

Preference and evaluation of autonomous shuttle service

Note for the survey administrator

Each respondent will have **two Trade-offs** for **each travel purpose** (work, Shopping and errands, Leisure) according to his or her **most used mode of transport**, already indicated in the fourth question of the survey (Travelling preferences part). In total each respondent will have **six Trade-offs.**

The list of trade-offs attributed to each Segment of respondents for each mode and each travel purpose are presented in **the Annex** of the questionnaire.

For instance, for the quarter (25%) of persons who chose private car as the main mode for working, Public transport for shopping trips and Bicycle for leisure trips, the trade-offs questions could be:

For work (school/University) trips:

22. You have indicated that **Private car** is your main mean of transport for **work (school/University)**

We offer you different scenarios for the evolution of the quality of service and the service fare of shared autonomous vehicle **(Shared AV)** and private autonomous vehicle **(Private AV).** Please choose the mode of transport you prefer according to each situation.

Reminder: the value associated with the private car trip fare is estimated according to the distance of your trip that you have already declared at the previous questions of this survey.

	Private car	**Shared AV**	**Private AV**
Fare (€)	0.2 * Distance (km)	0.12 * Distance (km)	0.28 * Distance (km)
Door-to-door Travel time (mn)	Actual	0.6 * Actual	0.6 * Actual
I prefer	❍	❍	❍

	Private car	Shared AV	Private AV
Fare (€)	0.2 * Distance (km)	0.2 * Distance (km)	0.2 * Distance (km)
Door-to-door Travel time (Mn)	Actual	0.6 * Actual	1.4 * Actual
I prefer	❍	❍	❍

	Private car	Shared AV	Private AV
Fare (€)	Actual	Actual	Actual
Door-to-door Travel time (Mn)	Actual	Actual	Actual
I prefer	❍	❍	❍

For Shopping and errands

You have indicated that **Public transport** is your main means of transport for **Shopping and errands** trips.

We offer you different scenarios for the evolution of the quality of service and the service fare of shared autonomous vehicle **(Shared AV)** and private autonomous vehicle **(Private AV).** Please choose the mode of transport you prefer according to each situation.

Reminder: The values associated with **Public transport** are those you indicated at the previous questions of this survey.

Remind respondents that they have specified in Part B, that they have a transit subscription, that the fare associated with the autonomous service is also a subscription price.

	Public transport	Shared AV	Private AV
Fare (€)	Actual	1.4 * Actual	1.4 * Actual
Door-to-door Travel time (Mn)	Actual	0.6 * Actual	0.6 * Actual
I prefer	❍	❍	❍

	Public transport	Shared AV	Private AV
Fare (€)	Actual	Actual	Actual
Door-to-door Travel time (Mn)	Actual	Actual	Actual
I prefer	❍	❍	❍

For Leisure

You have indicated that **Bicycle** is your main means of transport for **Leisure** trips.

We offer you different scenarios for the evolution of the quality of service and the service fare of shared autonomous vehicle **(Shared AV)** and private autonomous vehicle **(Private AV).** please choose the mode of transport you prefer according to each situation.

Reminder: the values associated with **Bicycle travel time** is that you indicated at the previous questions of this survey.

	Bicycle	**Shared AV**	**Private AV**
Fare (€)		1.5	2.5
Door-to-door Travel time (Mn)	Actual	4 * Distance	4 * Distance
I prefer	❍	❍	❍

	Bicycle	**Shared AV**	**Private AV**
Fare (€)		3.5	3.5
Door-to-door Travel time (Mn)	Actual	2.4 * Distance	1.7 * Distance
I prefer	❍	❍	❍

	Bicycle	**Shared AV**	**Private AV**
Fare (€)		Actual	Actual
Door-to-door Travel time (Mn)	Actual	Actual	Actual
I prefer	❍	❍	❍

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 ❍Prefer not to say

Do you need any type of assistance to support your mobility on any of these aspects? ☐ Motor ☐ Auditory ☐ Visual ☐ Mental ☐ Not applicable ☐ I prefer not to say

Household structure ❍ Single person household ❍ Multi-person household without children ❍ Multi-person household with children

Education ❍ Primary/Elementary/High School Degree ❍ Trade/technical training ❍ Bachelor Degree ❍ M.Sc ❍ Phd

Employment ❍Higher managerial, administrative and professional occupations ❍Intermediate occupations ❍Small employers and own account workers ❍Lower supervisory and technical occupations ❍Semi-routine and routine occupations ❍Never worked and/or long-term unemployed ❍Student ❍Pensioner

Geographical area: ❍ Urban ❍ Peri-urban ❍Rural

Thank you for your time!

Acceptance (15-questions survey – during the demonstration)

On demo sites with several services, add a question with a drop-down menu (menu to be built by the sites) proposing the different services. For example: **Select the service you have tested:** *[drop-down list].*

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 to be adapted by each site according to the use case (e.g., leisure, business/ work travel for general propositions and medical appointment if the autonomous mobility solution is deployed in a hospital)]*

3. **Indicate, in minutes, the duration of your journey: _______** minutes

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

5. **If yes, which problem(s)** *[multiple choices list to be adapted by each site according to the use case (e.g., technical problem such as "hard braking", "the doors did not open"; traffic problem such as "a cyclist who disturb the path of the autonomous solution")]*

Acceptance

[degree of agreement on 9-point Likert scale]

1. I am satisfied with using the [autonomous solution].
2. The [autonomous solution] is useful.
3. The [autonomous solution] is easy to use.
4. The [autonomous solution] is easy to learn.
5. The [autonomous solution] is reliable.
6. The [autonomous solution] is safe.
7. The [autonomous solution] corresponds to my needs.
8. The [autonomous solution] is comfortable.
9. I will make use of the [autonomous solution] again.
10. I would recommend the [autonomous solution] to a friend or a colleague.

Background information

Year of Birth (answer drop down with Years)

Gender ❍ Male ❍ Female ❍Other ❍Prefer not to say

Education ❍ Primary/Elementary/High School Degree ❍ Trade/technical training ❍ Bachelor Degree ❍ M.Sc ❍ Phd

Thank you for your time!

Satisfaction (One question – during the demonstration)

Indicate how satisfied you are with the [autonomous solution]: *[scale from 0 to 100 where the respondent answers with a slider].*

Appendix III: Interviews with Stakeholders

This is a generic 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.

Background information

1. **Age _____**
2. **Gender**

❍ Male ❍ Female ❍ Other ❍ Do not want to say

3. **Are you involved in the SHOW project?**

❍ Yes ❍ No ❍ Other (please specify)

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

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

5. **Organization type (optional)**

❍ Governmental ❍ Non-governmental organization ❍ Industry/ Supplier ❍ Non-governmental organization Insurance company/ association ❍ Research/ Academia ❍ Other (please specify)

6. **Number of employees in your organization**

❍ 1-10, ❍11-50, ❍51-100, ❍101-500, ❍501-1000, ❍1001-5000, ❍>5000

7. **Educational level**

❍ Primary/Elementary/High School Degree ❍ Trade/technical training ❍ Bachelor Degree ❍ M.Sc ❍ Phd

8. **Area of expertise: ____________________**
9. **What is you working experience?**

❍≤ 5 years ❍5-10 years ❍ >10 years

10. **How many years of experience do you have working with automated vehicles/ services?**

❍No Experience ❍≤ 5 years ❍5-10 years ❍ >10 years

The technologies/services

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

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

12. **How will your technologies/services help the travellers? *What is the target traveller(s) group(s)? (follow-up)***
13. **Have you integrated/offered your technologies/service(s) in other platform(s) and/or cities? *If Yes, which? (follow-up)***

Previous Experience/Actual Behaviour

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

a. Previous experience with other autonomous solutions (explicit knowledge)

14. **Do you have any previous experience with automation in transportation?**

Yes/ No

If answered Yes in Q.14: What is your general experience with similar [depending on stakeholder group: technologies/services/ implementations]?

b. Actual behaviour

15. **What are the most important aspects for a successful [depending on stakeholder group]: integration/ exploitation/ implementation?**

Constraints/Cost/Value

16. **What can SHOW offer to (you, your organization, city, to transportation, the environment, society, business)?**
17. **What are your major concerns for the SHOW implementations and why?**

Impact

18. **Would you like to be more involved in automation in few years? *Would you like to be involved in other new areas and/or other services? (follow-up)***

Thank you for your time!

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

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 in your organization**

❍ 1-100, ❍101-500, ❍501-1000, ❍1001-5000, ❍>5000

6. **Educational level**

❍ Primary/Elementary/High School Degree ❍ Trade/technical training ❍ Bachelor Degree ❍ M.Sc ❍ Phd

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 with automated vehicles/ services?**

❍No Experience ❍≤ 5 years❍5-10 years ❍ >10 years

Experience with SHOW and technologies

10. **If you have tested the [autonomous solution] …**

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

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

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

13. **What did you like MOST about SHOW project technologies/services/ implementations?**
14. **What did you like LEAST about SHOW project technologies/services/ implementations?**

Constraints/Cost/Value

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

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

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

Risk/Impact

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 would you like to be in your professional life in a few years? (e.g., Would you like to be more involved in automation or other new areas and/or other services?) (expectations as professionals, as themselves)**

19. **What do you believe will be the most important impact of automatic vehicles/services for travellers with disabilities?**

Thank you for your time!

Appendix IV: Checklist for pre-demonstrations

Part 1: (Pre-)Demo Evaluation activities guidance / tracking

Hint: the guiding questions below are meant as help for tracking Pre-Demo evaluations. This list is neither claiming to be exhaustive nor fully adequate for each demo site.
Please try to fill in as reasonable as possible.

Demosite: ____ **Status date:** ____ **No change compared to last staus report** ____

		Status							
	Guiding questions for Pre-Demo evaluation activities	considered	planned	ongoing - delay expected	issue (description)	Support needed	Issue solved	ongoing - will be completed in time	done / completed
1	Identification & alignment contributors & stakeholders								
2	Planning & scheduling (experimental plan) of Pre-Demo activities (incl. data aquisition and provision for evaluation)								
3	Event Diary (logbook for noteworthy events not covered by data logging)								
4	Information of the public about the Pre-Demo evaluation activities								
5	Ethical procedures / privacy (e.g.: surveys, interviews)								
6	Required authorizations								
7	Required resources / tools								
8	Data handling (aquisition, storage, analysis)								
9	Data delivery to SHOW								
10	Use of SHOW dashboard								

Part 2: Use Case coverage tracking

Status date: ____ **No change compared to last staus report** ____

				Status								
UC goup	**UC ID**	**UC short name**	**Test case short description**	considered	planned	ongoing - delay expected	issue (description)	support needed (by whom?)	solution (description)	issue solved	ongoing - will be completed in time	done / completed
UC1		**Automated mobility in cities**										
	UC1.1	Automated passengers/cargo mobility in Cities under normal traffic & environmental conditions										
	UC1.2	Automated passengers/cargo mobility in Cities under complex traffic & environmental conditions										
	UC1.3	Interfacing non equipped vehicles/travellers (VRU)										
	UC1.4	Energy sustainable automated passengers/cargo mobility in Cities										
	UC1.5	Actual integration to city TMC										
	UC1.6	Mixed traffic flows										
	UC1.7	Connection to Operation Centre for tele-operation and remote supervision										
	UC1.8	Platooning for higher speed connectors in people transport										
	UC1.9	Cargo platooning for efficiency										
	UC1.10	Seamless autonomous transport chains of Automated PT, DRT, MaaS, LaaS										
UC2		**Automated mixed mobility in cities**										
	UC2.1	Automated mixed spatial mobility										
	UC2.2	Automated mixed temporal mobility										
UC3		**Added Value services for Cooperative and Connected Automated mobility in cities**										
	UC3.1	Self-learning Demand Response Passengers/Cargo mobility										
	UC3.2	Big data/AI based added value services for Passengers/Cargo mobility										
	UC3.3	Automated parking applications										
	UC3.4	Automated services at bus stops										
	UC3.5	Depot management of Automated Buses										

Part 3: Vehicle tracking

Status date:

No change compared to last staus report

Vehicle						test phase						
Vehicle No.	ADAS level	Vehicle description	planned	available	instrumented	started	ongoing - delay expected	issue (description)	Support needed	Issue solved	ongoing - will be completed in time	done / completed

Appendix V: Relationship of KPIs to Use Cases

Use Cases (UC) and corresponding sub-UCs:

- UC1: Automated mobility in cities
  - UC1.1: normal traffic & environmental conditions
  - UC1.2: complex traffic & environmental conditions
  - UC1.3: interfacing non automated vehicles/ travellers (VRU)
  - UC1.4: energy sustainability
  - UC1.5: actual integration to city TMC
  - UC1.6: mixed traffic flows
  - UC1.7: operation centre connection for tele-operation & remote supervision
  - UC1.8: platooning for passenger mobility
  - UC1.9: cargo platooning for efficiency
  - UC1.10: Seamless autonomous transport chains of Automated PT, DRT, MaaS, LaaS
- UC2: Urban delivery services
  - UC2.1: mixed spatial mobility
  - UC2.2: mixed temporal mobility
- UC3: Added Value services
  - UC3.1: Self-learning Demand Response Passengers/Cargo mobility
  - UC3.2: Big data/AI based added value services
  - UC3.3: Automated parking applications
  - UC3.4: Automated services at bus stops
  - UC3.5: Depot management of automated buses

Table 67: List of KPIs and their relationship to Use Cases

			UC1										UC2		UC3				
Impact category	**KPI #**	**Impact**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**1.10**	**2.1**	**2.2**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**
Traffic safety	1	Road accidents leading to injury	√	√	√	-	√	√	√	-	-	√	-	-	-	-	-	√	√
	2	Conflicts	√	√	√	-	√	√	√	√	-	√	-	-	-	-	-	√	-
	3	Safety enhancement	√	√	√	-	√	√	√	√	-	√	-	-	-	-	-	√	-
	70	Traffic flow	√	√	-	-	√	√	√	√	√	√	-	-	-	-	-	-	-
	71	Vehicle occupancy	√	√	-	-	-	√	√	√	-	√	√	√	√	√	-	-	-
	72	Illegal overtaking	√	√	√	-	-	√	√	-	-	-	-	-	-	-	-	-	-
	74	Lateral and longitudinal headways	√	√	√	-	-	√	√	√	-	-	-	-	-	-	-	-	-
	75	harsh cornering	√	√	√	-	-	√	√	√	-	-	-	-	-	-	-	-	-
	76	Road accidents leading to material damage	√	√	√	-	-	√	√	√	-	-	-	-	-	-	-	-	-
Traffic efficiency	4	Average speed	√	√	√	√	√	√	√	√	√	√	-	-	√	√	-	-	-
	5	Acceleration variance	√	√	√	√	√	√	√	√	√	√	-	-	√	√	-	-	-

			UC1										UC2		UC3				
Impact category	**KPI #**	**Impact**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**1.10**	**2.1**	**2.2**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**
	6	Hard brake events	√	√	√	-	-	√	√	√	√	-	-	-	-	-	-	-	-
	7	Non-scheduled stops	√	√	√	-	√	√	√	√	√	√	√	√	-	-	-	-	-
	9	Service reliability	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√	√
	12	Speed per vehicle type	√	√	√	-	-	√	√	√	√	√	√	√	√	-	-	-	-
	13	Vehicle delay	√	√	√	-	-	√	√	√	√	√	√	√	√	√	-	-	-
	14	Vehicle stops	√	√	√	-	-	√	√	√	√	√	√	√	√	√	-	-	-
	16	Total intersection delay	√	√	√	-	-	√	√	√	√	-	√	√	-	-	-	-	-
	17	Total network travel time per vehicle type	√	√	-	-	√	√	√	√	√	√	√	√	√	√	-	-	-

			UC1										UC2		UC3				
Impact category	**KPI #**	**Impact**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**1.10**	**2.1**	**2.2**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**
	19	Total mileage	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓
	20	Total network delay	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓
	21	Average network speed	✓	✓	-	-	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	-	✓	-
Travel and passenger patterns	10	Distance travelled with travellers	✓	✓	-	-	-	✓	-	✓	-	✓	✓	✓	✓	✓	-	-	-
	11	Distance travelled without travellers	✓	✓	-	-	-	-	-	-	-	-	✓	✓	-	-	-	✓	-
	8	Scheduled number of stops	✓	✓	✓	-	-	✓	-	✓	✓	✓	✓	✓	-	-	-	-	-
	18	Modal split	✓	✓	-	-	-	-	-	-	-	✓	✓	✓	✓	✓	-	✓	-

			UC1										UC2		UC3				
Impact category	**KPI #**	**Impact**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**1.10**	**2.1**	**2.2**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**
	22	Number of trips	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	-	-
	23	Increase in vehicle distance travelled	✓	✓	-	✓	✓	✓	✓	-	-	-	-	-	-	-	-	-	-
	24	Average vehicle occupancy	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓
	25	Enhancement of PT's quality of service	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	✓	✓
	34	Amount of travel	✓	✓	✓	✓	-	-	-	-	-	✓	-	-	✓	✓	✓	-	-
	35	Shared mobility rate	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	-	✓	✓	✓	-	-
	36	Vehicle utilisation rate	✓	✓	✓	✓	-	✓	-	✓	✓	✓	-	-	✓	✓	✓	-	-
	37	Number of passengers	✓	✓	✓	✓	-	✓	-	✓	✓	✓	✓	✓	✓	✓	✓	-	-
	39	Persons km travelled	✓	✓	✓	✓	-	-	-	✓	✓	✓	-	-	✓	✓	✓	-	-
	43	Inequality in transport	✓	✓	✓	-	-	-	-	✓	✓	✓	-	-	-	-	-	-	-

			UC1										UC2		UC3				
Impact category	**KPI #**	**Impact**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**1.10**	**2.1**	**2.2**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**
	40	Resolving inequality in transport (target)	√	√	√	√	-	-	-	√	√	√	-	-	√	√	√	-	-
	41	Empty vehicle km	√	√	√	√	-	√	-	√	√	√	√	√	√	√	√	-	-
Passenger perception	47	User reliability perception	√	√	√	-	√	√	√	√	√	√	√	√	√	√	√	√	√
	49	User safety perception	√	√	√	-	√	√	√	√	√	√	√	√	√	√	√	√	√
	50	Travel comfort	√	√	√	-	√	√	√	√	√	√	√	√	√	√	√	√	√
	52	Perceived usefulness	√	√	√	-	√	√	√	√	√	√	√	√	√	√	√	√	√
	53	Willingness to pay	√	√	√	-	√	√	√	√	√	√	√	√	√	√	√	√	√
	54	Willingness to share a ride	√	√	√	-	-	√	-	√	-	√	√	√	√	√	-	-	-
	55	Traveller acceptance	√	√	√	-	√	√	√	√	√	√	√	√	√	√	√	√	√
Environment and energy efficiency	26	Energy use	√	√	√	√	√	√	√	√	√	√	√	√	-	-	√	√	√
	27	CO_2, PM, NOx emissions	√	√	-	√	√	√	√	√	√	√	√	√	√	√	-	-	-

			UC1										UC2		UC3				
Impact category	**KPI #**	**Impact**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**1.10**	**2.1**	**2.2**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**
	28	Air quality	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
	29	Noise	✓	✓	-	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	-	-	-
	30	Reduction in CO_2	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
	31	Reduction in noise level	-	-	-	-	-	-	-	-	-	✓	-	-	-	-	-	-	-
	32	Reduction in energy consumption	-	-	-	✓	-	-	-	-	✓	✓	-	-	-	-	✓	-	✓
	33	Reduction in energy consumption	-	-	-	✓	-	-	✓	-	✓	✓	✓	✓	-	-	✓	-	✓
Urban delivery services or logistics	38	Cargo transported	-	-	-	-	-	-	-	-	✓	-	✓	✓	-	-	-	-	-
	81	Precision of deliveries	-	-	-	-	-	-	-	-	✓	-	✓	✓	-	-	-	-	-
	82	Customer satisfaction	-	-	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-
	83	Unit cost of delivery	-	-	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-
	84	Load factor patterns	-	-	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-

			UC1										UC2		UC3				
Impact category	**KPI #**	**Impact**	**1.1**	**1.2**	**1.3**	**1.4**	**1.5**	**1.6**	**1.7**	**1.8**	**1.9**	**1.10**	**2.1**	**2.2**	**3.1**	**3.2**	**3.3**	**3.4**	**3.5**
	85	Public acceptance	-	-	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-
	86	Willingness to pay for AV urban deliveries/logistics	-	-	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-
	87	Number of accidents on site	-	-	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-
	88	Accidents in AV UFT facility	-	-	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-
	89	Incidents of crime / theft in AV UFT facility	-	-	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-
	90	Number of incidents involving vandalism in AV UFT facility	-	-	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-
	91	Loss and damage parcels at the AV UFT facility	-	-	-	-	-	-	-	-	-	-	✓	✓	-	-	-	-	-