SHared automation Operating models for Worldwide adoption

SHOW

Grant Agreement Number: 875530

D9.1 Evaluation Framework

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Legal Disclaimer

Executive Summary

One important part of the SHOW ecosystem evaluation framework is the framework of the evaluation of the demonstrations. Deliverable 9.1 - evaluation framework is the first version of the common parametric evaluation framework for SHOW demonstrations and includes a description of the methodological approach including horizontal descriptions of vehicles, users and environments to be included in the pre-demonstrations and real life demonstrations.

The methodological approach for the demonstration evaluation is described in Chapter 2. In SHOW, a methodology has been created for this denoted M^3ICA (multi-impact, multi-criteria, and multi-actor). It allows for the 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. 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 pilots will cover various geographical areas, city sizes, weather conditions, socioeconomic and cultural issues. The functions and systems to be evaluated at the pilot sites are defined and described in Chapter 4 and an overview of vehicles and infrastructure to be included in demonstrations at each pilot site are provided. Preliminary use cases and a description of the target groups for the evaluation are provided in Chapter 5. Thereafter, the research questions connected to the use case groups are given in Chapter 6. These will be updated in the next version of the evaluation framework as the Use Cases are finalized. Chapter 7 describes the method employed for the evaluation to be performed at the pilot sites across Europe. Evaluation tools will be developed for this purpose as described in Chapter 8. Chapter 9 introduces the procedure to be followed by the pilot sites when performing the data acquisition during their demonstrations. Related to this, ethics, data handling and approval processes are addressed in Chapter 10-12. In Chapter 13, the pilot sites are presented more in detail. Chapter 14 describes roles and responsibilities and Chapter 15 provides the conclusion.

The main outcome of this deliverable is the evaluation framework that will be used for the demonstration sites both for the pre-demonstrations and the real-life demonstrations. Those all start with identifications of the target users, use cases and its priorities scenarios. Based on this the research questions will be possible to formulate, to which the KPIs used for impact analysis can be correlated. When this is clear the design of the data collection can be made, and tools be developed and used.

The framework will be updated twice to cover the full experimental design for pre-demo evaluation in D9.2 (M11) and for the final demonstrations in D9.3 (M23).

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2.0	30/06/2020	Updated based on reviewers' comments.	Anna Anund, VTI

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Abbreviation List

Abbreviation	Definition
AaaS	Automation as a Service
AI	Artificial Intelligence
AV	Autonomous Vehicle
AVP	Automated Valet Parking
DRT	Demand Responsive Transport
CAV	Connected and Autonomous Vehicle
CCAM	Cooperative, Connected & Automated Mobility
CCAV	Cooperative Connected Automated Vehicle
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
M^3ICA	Multi-Impact, Multi-Criteria, and Multi-Actor).
OEM	Original Equipment Manufacturer
PT	Public transport
SoS	System of systems
SMU	Soft Mobility Users
VEC	Vulnerable to Exclusion
WoZ	Wizard of Oz

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 autonomous 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.

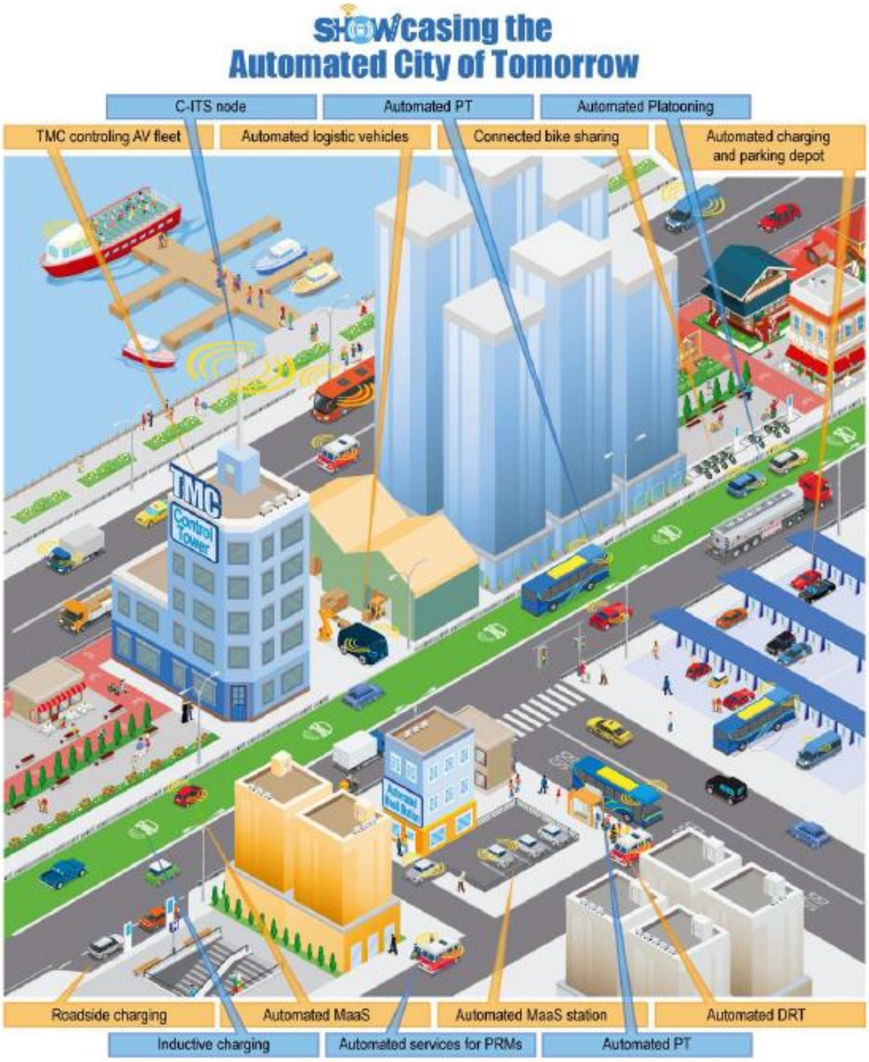

Figure 1. ShowCasing the Automated city of tomorrow.

Each system mentioned above (e.g. PT, DRT) and presented in Figure 1 , is a system within the eco system and as such will be represented and evaluated. The ecosystem involves the 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, but something different.

SHOW aims to demonstrate and evaluate a complex System of Systems (SoS). The SHOW ecosystem includes 8 different systems: the 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.

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 when taking into consideration several stakeholder perspectives described in SHOW D1.1 “Ecosystem actors needs, wants & priority users experience exploration tools”. The indicative list of stakeholders for SHOW consists of the following groups:

- OEMs and transport/mobility operators, Tier 1 suppliers, telecom operators, technology providers, SMEs
- Research & academia,
- Passengers and other road users encompassing VEC,
- Umbrella associations,
- Road operators, Authorities (Cities, Municipalities, Ministries) & policy makers.

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 a 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 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.

The SHOW project has eight identified objectives, among those nr 5 and 6 are the main targeted in the evaluation framework, but the outcome of the evaluation results will be used to cover 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.

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

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, personalized and shared electric Cooperative Connected Automated Vehicle (CCAV) services for all travellers in real urban and peri-urban traffic 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 part 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 18 cities across Europe. In Chapter 13 an overview of each site is presented. In addition, there are and 3 Follower Pilot sites, those will not do demonstrations but are used as replication sites, adopting business models, selected technologies, and tools from SHOW.

The evaluation framework provides a common methodology for these demonstrations, 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, hence a strong link to the KPIs and the measurements is needed.

Several other project-wide objectives are also related to the evaluation framework. One objective is to identify and specify priority urban automated mobility use cases (UC) that will be covered in the Pilot sites (#2). To allow the demonstration UCs to be realized, necessary functionalities of all vehicle types 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 pilot site data (#3). Data collected at the Pilot 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).

1.1 Purpose of the document

The purpose of this deliverable is to present a generic framework for the evaluation of the demonstrations sites. This deliverable is named D9.1 Evaluation Framework and is the first version of the common evaluation framework the demonstrations. When the licensing and approvals and technical verifications are done, a first pre-demonstration will happen, this is to be considered as rehearsal. After that the real life demonstrations will take place with real users. The framework covers the details of all planned evaluations of Pre-demonstration and real life Demonstrations, including a description of the methodological approach. A consolidation of of vehicles, users and environments to be included in the pre-demos and real-life demonstrations are also presented with the aim to get an overview of all demonstrations sites that will perform evaluations. In D9.1 the indicative KPIs are described in Chapter 7.1.

The deliverable will be updated twice over the course of the project and will cover the full experimental design for pre-demo evaluation (D9.2 in Month 11 and the same but for the real life demonstrations in D9.3 (Month 24). Both D9.2 and D9.3 will include the full experimental design of the project encompassing clear definitions of research hypotheses (for each test site), liaison to KPIs defined in A9.4 "Impact assessment framework, tools & KPIs definition", objective (i.e. logging tools) and subjective measuring tools (questionnaires, focus groups, etc.) 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 will abide to a common parametric evaluation framework that will be defined to reflect clear liaisons to the impact assessment framework of A9.4 Ethical and privacy issues (D3.2) will be instantiated herein in each test 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. 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.

As such, the framework will make evident from the beginning and through the association of the KPIs with demonstration 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 pilot sites, will ensure that the key priority use cases and impacts targeted will be answered by all test sites of the project.

The detailed experimental plans will define and associate carefully the varying testing contexts – in particular the type of roads, the size of penetration, the automation readiness of the region/city, the tests' seasonality, the type of vehicles involved, the passenger volumes, etc. – identifying the common and changing parameters in each case. This will further on be used to define the impact assessment (WP13) and the projections done by simulations (WP10). This will 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 conclusions.

1.2 Intended Audience

This deliverable has two groups of intended audience, people outside the SHOW consortium and SHOW partners working with the pilot. The deliverable is public and is seen as the first 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 first version of the evaluation framework covering both pre-demos and real-life demonstrations. The audience is therefore the pilot site partners that will use this as the first step towards the planning of the oncoming preparations.

1.3 Interrelations

The Evaluation Framework (D9.1) is closely related to several activities, not only to the WP9 Pilot plans, tools and eco-system engagement. In Figure 2 the main interrelationships are highlighted.

The work in WP1 (A1.2, A1.3) sets up the core of what to demonstrate in terms of Use Cases and scenarios. In addition, WP2 (A2.1) will provide the 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 the input about what to consider. Moreover, the evaluation framework of the SHOW ecosystem is not only about the performance of the single demonstrations' 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 update of D9.1 is the D9.2 that will include all the details on Pilot plans, KPIs and impact assessment per demonstration site for the pre-demonstrations of WP11 (A11.3) and D9.3 will cover the real-life demonstrations of WP12 (A12.2-A12.7). The results from the demonstrations will then be consolidated 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).

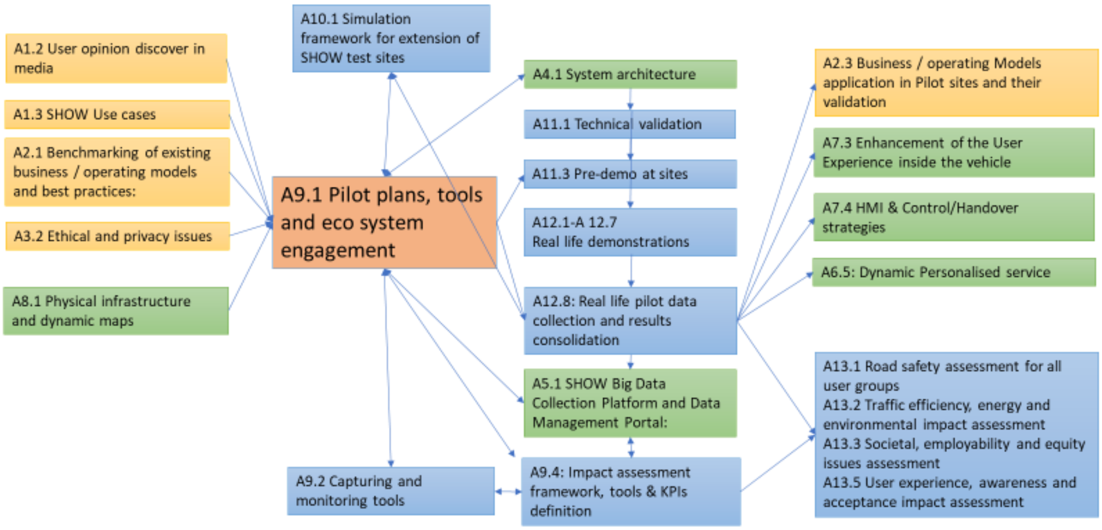

Figure 2. Interrelations between A9.1 (Amber) and other WP/A, different color per SP (Yellow= SP1, Green=SP2 and Blue for SP3).

2 Methodological Approach

2.1 Evaluation of the SHOW eco system

In this section the evaluation methods adopted per evaluation type in the project are briefly addressed to highlight the multi-faceted nature of evaluation activities in the project. However, even if the evaluation of the SHOW ecosystem is outside the scope of WP9 it is relevant to describe since it sets the scope of all evaluation-oriented WPs (WP9, WP11, WP12) together in the project.

In SHOW the high-level depiction of the evaluation framework and its layers is shown in Figure 3. The framework encompasses several layers, that to some degree are overlapping or integrated, that start with the investigation of the expectations of travellers and stakeholders (layer 1) and are completed with the final evaluation of the ecosystem (System of Systems; SoS) that results from the triangulation of the findings from the user tests (WP11 and WP12) (FESTA implemented methodology), the impact assessments (M^3ICA methodology; WP13) and the simulations conducted within WP10. Each method (i.e. sub-framework) addresses the common denominators, of which some are common (e.g. actors and data sources as well as some RQs and KPIs) and others will be diverse (i.e. the methods, the indicators, the instruments and the analyses).

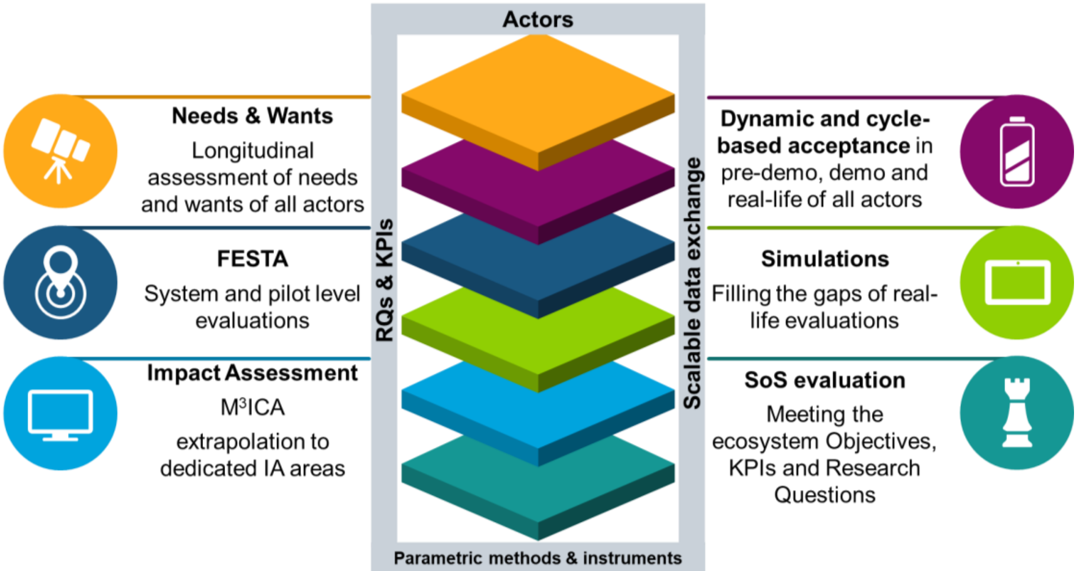

Figure 3. High-level description of the layers of the SHOW eco system evaluation framework

2.2 Evaluation framework for demonstration activities

For the evaluation framework addressing the pre demonstrations and the real life demonstrations a methodology denoted M^3ICA (multi-impact, multi-criteria, and multi-actor) will be used. The M^3ICA methodology was specifically developed for SHOW and an overview is presented in Figure 4. . It allows a consistent analysis and evaluation of pilots and simulations within the ecosystem of electric connected automated vehicles (e-CAV). The M^3ICA has two main aspects to it. On one hand, it incorporates the Multi-Actor Multi-Criteria Analysis (MAMCA) which evaluates the use cases and scenarios directly by stakeholders. Maximising participation of stakeholders ensure a policy that is well-balanced and will support a broad acceptance by society. The stepwise MAMCA approach quantifies stakeholder objectives and a criteria-based evaluation of scenarios that delineate rollout strategies of AV mobility and logistics. The approach considers stakeholder objectives. It starts with identifying stakeholder groups and establishing their objectives into a decision tree (which is an outcome of A1.3 "SHOW Use cases). Groups of objectives (that are linked to a stakeholder) are then weighted. They are in turn associated to one or more measurable indicators. An overall ranking of the scenarios follows using a multi-criteria tool, and results can then be visualised, allowing a comprehensive understanding of the essential stakeholder trade-offs.

On the other hand, a performance indicator framework that considers scenarios of AV development and its impact on various socio-economic facets is developed based on a thorough review of literature. For example, (Milakis, Bart, & Bert, 2017) defines order of impacts on broad clusters of indicators (e.g. mobility or safety) and differentiates it in terms of direct (1st order), indirect (2nd order) and societal/land-use (3rd order) impacts. For each criterion and impact area, one or more indicators are constructed e.g. direct quantitative.

The M^{3}ICA can be summarized in 6 iterative steps, which are presented in Figure 4.

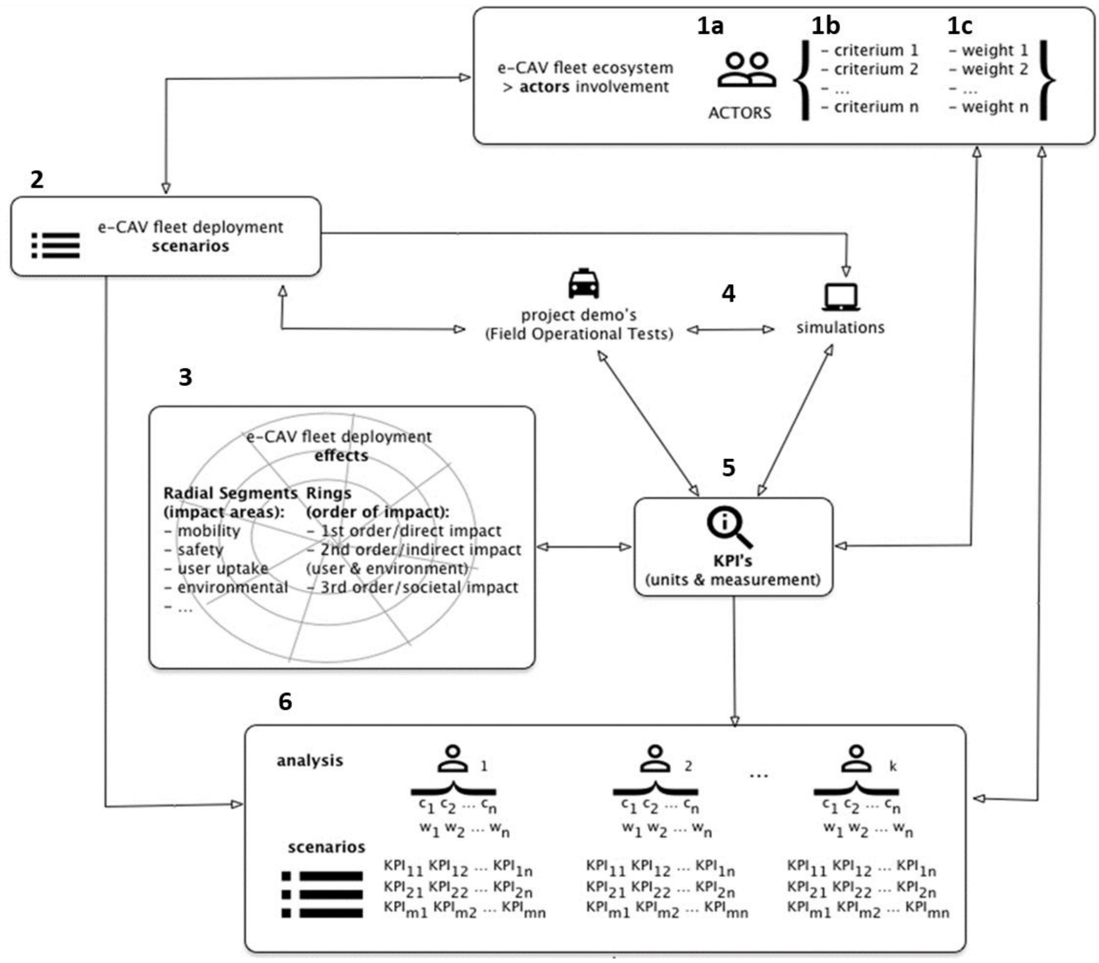

Figure 4. The pre and real-life demonstration evaluation framework.

Steps 1 and 2

Actors (or stakeholders) are identified (1a, A15.2 - Stakeholder forum, major events and demo events organisation), and key objectives of each stakeholder group are defined and referred to as criteria (1b) which are in turn given a weight by relevant stakeholders (1c). Scenarios of the f AV mobility and logistics systems are defined in consultation with stakeholders and will be aligned to pilot projects (A1.3).

Step 3

Following a literature review on AV deployment, effects and the outcomes of Cooperative, Connected & Automated Mobility (CCAM) are delineated by impact areas and order of impacts and will support defining KPIs (step 5) The work on the KPIs is done in A9.4 - Impact assessment framework, tools and KPIs definition.

Steps 4 and 5

In step 4, a pilot specific performance indicator framework will be introduced, see also the 'V-diagram' in **Figure 5.** This work is mainly done in A9.1 - Plans for pilot evaluations.

More in detail, in step 4 the focus is on demonstrations and simulations.

Data collections will be done under real life conditions in the demonstrations, and in simulations. The evaluation of the Demonstrations in SHOW uses the methodology developed for Field Operational Tests (FOTs) by the European union funded project FESTA (Field opErational teSt supporT[2] and the Trilateral Impact Assessment Framework [3]. The FESTA project developed a handbook on FOT methodology to improve comparability and significance of results at national and European levels.

A FOT is here 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 systems and functions than the transport systems evaluated in SHOW, the FESTA methodology provides a way of harmonizing the preparations and testing across pilot sites to facilitate a consolidated evaluation.

Figure 5 shows a modified version of the FESTA methodology, i.e. the steps that will be carried out during the evaluations in SHOW presented as a V-diagram. This version of the demonstration evaluation framework (D9.1) will focus on the preparation part on the left-hand side of the diagram.

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[2] http://fot-net.eu/wp-content/uploads/sites/7/2017/04/FOT-Net-D5.4-Updated-Version-of-the-FESTA-Handbook-v1-1.pdf

[3] https://connectedautomateddriving.eu/wp-content/uploads/2017/05/Trilateral_IA_Framework_Draft_v1.0.pdf

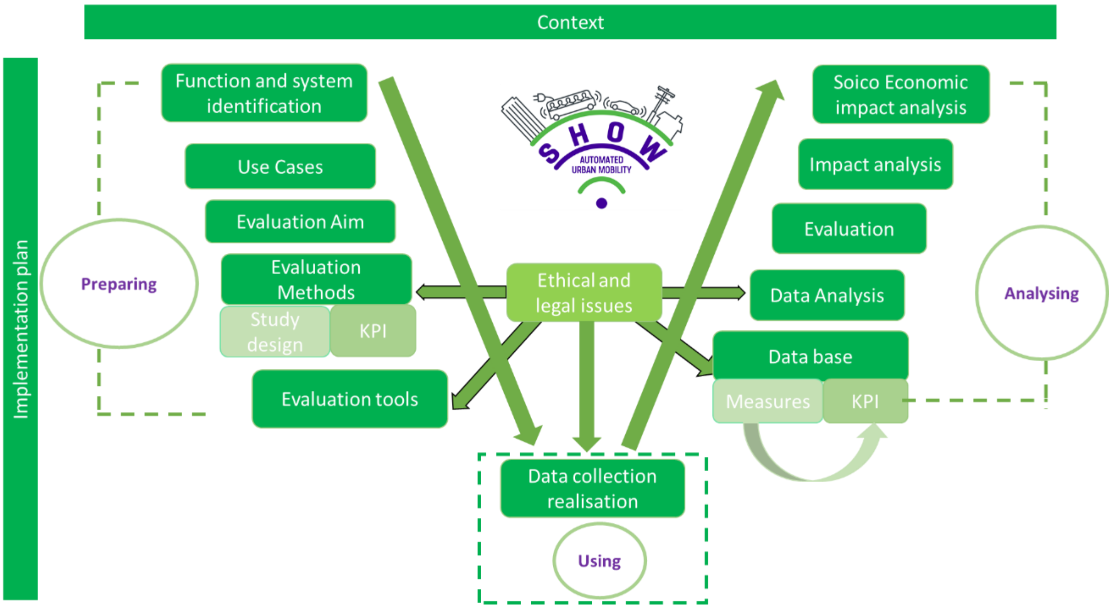


Figure 5. V-diagram modified from the FESTA handbook.

Step 4 also includes simulations. They are done in WP10 "Operations simulation models platform and tools" and will cover various kinds of simulations associated with urban mobility. 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 6, 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.

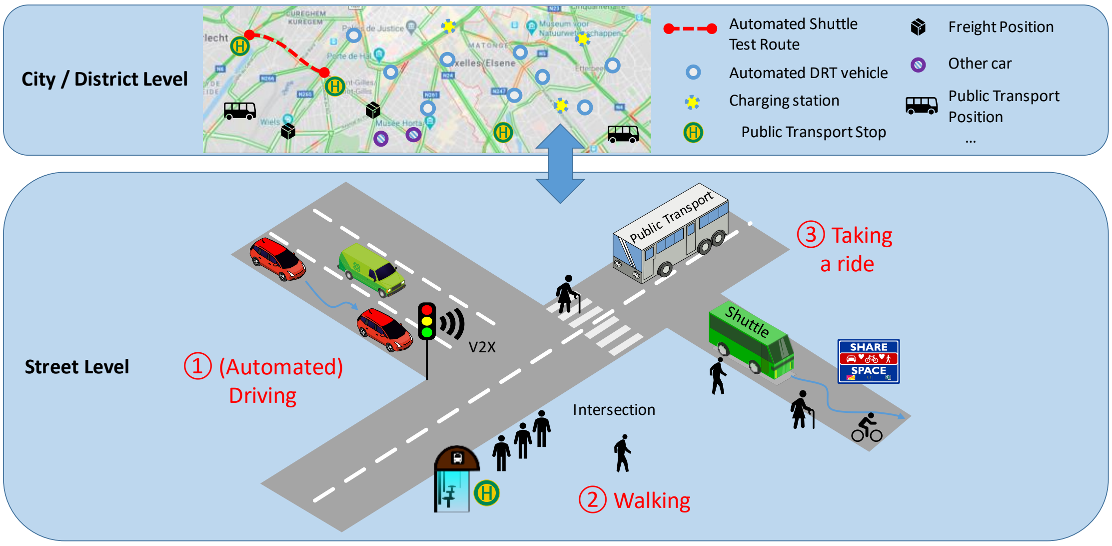


Figure 6. Classification of simulation activities in SHOW (according to D10.1)

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 (to be published in October 2020).

Step 6

The M^{3}ICA is the evaluation framework of the demonstrations (pre and real life) and FESTA is used as the framework for the Demonstration evaluation that will provide data to use together with the simulations. The systems that will be evaluated are incorporated in the scenarios. In step 6 the analysis takes place that will serve as input for the understanding of the use cases.

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

The SHOW project includes Mega Sites, Satellite Sites and Follower Sites, see Figure 7. In total 18 areas will be involved in Demonstrations activities. In Chapter 13 an overview of each demonstration site is presented.

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

- France: Rouen and Rennes
- Spain: Madrid (2 areas)
- Austria: Graz, Salzburg, Vienna
- Germany: Karlsruhe, Mannheim and Aachen.
- Sweden, Linköping and Kista

The **Satellites** include the following countries and cities:

- Finland: Tampere
- Denmark: Copenhagen
- Italy: Torino
- Greece: Trikala
- Netherlands: Eindhoven (Brainport)
- Czechia: Brno

In addition, three **followers** are identified, where Post-demo services replication will take place. These are not addressed in D9.1 but will be included in next versions of the framework.

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

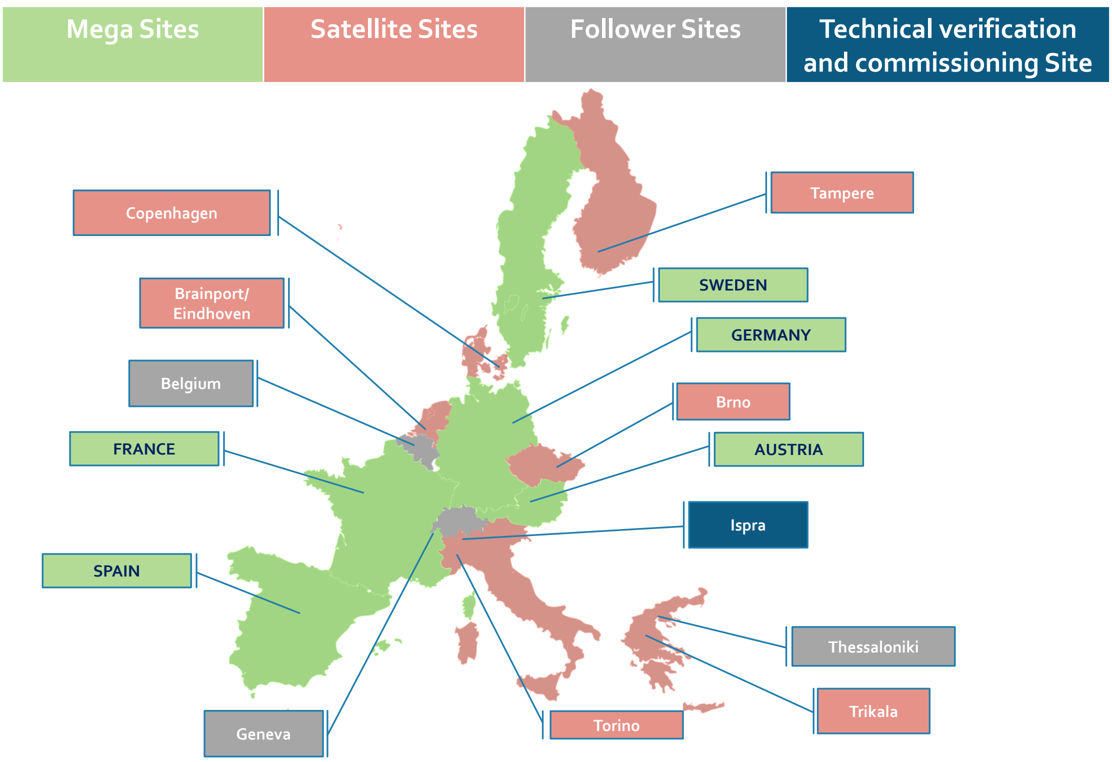


Figure 7. Mega Sites and Satellites in SHOW.

The SHOW piloting and demonstration plan 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-demo evaluation** 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 can be seen as rehearsals for the Real-life demonstrations. The planning work of the evaluations will be done in WP 9 Pilot plans, tools and ecosystem engagement and the realisation will take place in WP 11 Technical verification and pre-demo evaluations.
- **Real-life demonstration** is where the actual real-life demonstrations will take place at the demo 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.
- **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.

The Pre-demonstrations and Real-life demonstrations will take place during roughly 24 months; the first 9 months as pre-demonstrations to secure the safe and reliable operation and commit relevant services in a modular manner, followed by full-scale Real-life Demonstrations taking place for almost 18 months in total. The pre-demonstrations are considered as "rehearsals" for the Real-life Demonstrations. The generic time plan for the period when the preparations, pre-demonstrations, real-life demonstrations and post-demos will take place is presented in Figure 8.

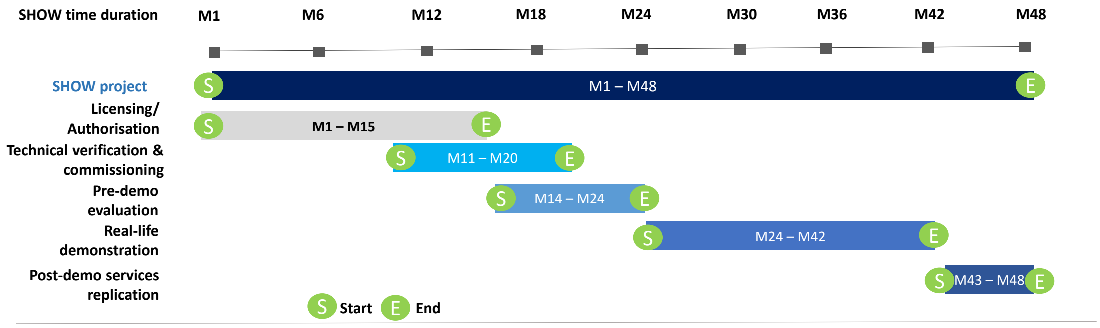


Figure 8. SHOW demonstration time plan

4 Function and system identification

In Step 4 and Step 5 in M[3]ICA analysis, Figure 4 data collections in demonstrations and simulations will take place.

SHOW will cover a wide range of coordinated shared automated vehicle systems. Thus, the SHOW Pilots will include automated Public Transportation (PT) (buses and metros), automated shuttles for Demand Response Traffic (DRT) services and automated Mobility as a Service (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.

At several 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, 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 pilot sites will support a mix of both fixed time-table solutions and on-demand solutions with flexible bus stops along the road-side. Connected MaaS solutions will integrate not only motorised solutions but also prioritised infrastructure for pedestrians and cyclists. The technical aspects of these automated functions and systems will be described below.

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 demonstration sites are electric and are presented in Table 1.

Table 1. Vehicles per site

Megasite/ satellite	City	Vehicles	
France	Rouen	5 I-Cristal (Shuttle) 4 Renault Zoe (Robo-taxi)	 
	Rennes	3 Navya (Shuttle) 3 Easymile (Shuttle)	
Spain	Madrid, Depot	1 IRIZAR - i2eBus – (Coach Electric L3)	
		2 TECNOBUS - EMT - Gulliver (Electric Minibus L2)	
	Madrid	2 RENAULT - TECNALIA - Twizzy (Passenger car – L2)	

Austria	Graz	1 Ford Fusion (Passenger car) 1 Kia e-Soul (Passenger car)	 
	Salzburg	1 EasyMile EZ10, Gen 3 (Shuttle) 1 PT bus/shuttle (subject to negotiations)	
	Vienna	2 Navya ArmaDL4 (Shuttle) 1 Navy Autonomous Cab (Robo-taxi)	
Germany	Karlsruhe	2 EasyMile EZ10, gen 2 (Shuttle) Audi Q5 (Passenger car) 1 modular vehicle from DLR (in planning)	 
	Mannheim	5 (brand tbd) (Shuttles)	
	Aachen, DE	1 BMW i3, 2 vehicles - retrofitted for ADF / V2V testing 2 e.GO Movers	 Quelle: e.GO MOOV GmbH
Sweden	Linköping	1 Navya Autonomous DL4 (Shuttle) 1 EasyMile EZ10 gen 2 (Shuttle) 1 tbd (hopefully - large electrified AV bus)	 
	Kista	1 t-engineering CM7 2 state of the art AV (Shuttle)	
Finland	Tampere	2-3 Sensible 4 (Shuttle buses) 2-3 Pods (alternatively all vehicles may be shuttles)	
Denmark	Copenhagen	3 brand tbd (Shuttles) 2 brand tbd (City mid-sized Buses)	
Italy	Turin	1 AV Shuttle - NAVYA DL4 1 retrofitted tele-operated car (still to be defined, provided by the Municipality of Turin)	
Greece	Trikala	2 AMANI Swiss Cyprus Limited (iDriverPlus, Zhongtong Bus) 1 FURBOT cargo vehicle UNIGENOVA 2 BMW i3 (Passenger cars – Platooning)	

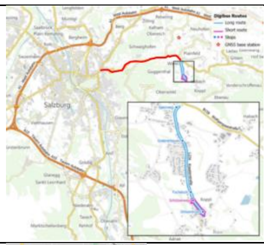
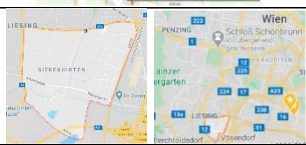
			
Netherland	Eindhoven	1 tbd (E-Bus) 3 Renault Scenic (Passenger cars)	
Czechia	Brno	1 EasyMile (Shuttle) 1 tbd (Shuttle) 1 Hyundai i40 Retrofitted (Robo-Taxi)	

4.1.2 Environment

The SHOW Pilots 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 first draft of type of environment to use is seen in Table 2. This will be revised in the updated deliverable (D9.2) using the work of WP8 "Infrastructure and functions".

Table 2. Overview of the environment at different sites.

Mega site/ Satellites	City	Environment	Map
France	Rouen	Four different solutions will be demonstrated: 1. Automated Vehicles on open road in complex situations (thin blue line) 2. Automated PT line connecting activity zone to the centre (bold blue line) 3. Robo-taxi service within the historic area (green area) 4. Connected to the biggest multi-modal hub of the city (dotted line)	
	Rennes	A hospital area with transportation of patients.	 

Spain	Madrid, Depot	Restricted area - a modern depot with different bus technologies (CNG, Hybrid, Electric). Semi-Controlled Area Interaction with other non-autonomous buses and vehicles.	
	Madrid	Urban and suburban: La Nave (Madrid City Innovation Hub) <– > Villaverde Bajo-Cruce Metro Station 800 m per journey (1,6 km line), driving in open traffic, including roundabouts. Maas concept will be used.	
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. With help from traffic infrastructure (e.g. guiding through traffic lights), vehicles will perform actions automated.	
	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.	
	Vienna	Urban quarter in the city of Vienna travelling to industrial/commercial park.	
Germany	Karlsruhe	Urban and peri-urban city areas and quarters with digital and connected infrastructure and HD-mapping.	 Final route choice currently being evaluated.
	Mannheim	Peri-urban housing area, calmed traffic zone, subordinate access roads, barrier-free access to AVs.	

	Aachen	Peri-urban Campus.	 
Sweden	Linköping	Urban Campus area (the red area at the top) and a residential area (bottom right red area).	
	Kista	An urban area with mainly office buildings.	
Finland	Tampere	The new automated light rail between Hervanta suburb and TAYS University Hospital Campus area will be connected with automated buses.	
Denmark	Copenhagen	The test area is at Lautrupgaard site, in Ballerup.	
Italy	Turin	The demonstration will take place in the City of Turin at the Health and Science area.	
Greece	Trikala	Trikala site is 330 km from Athens and includes both a suburban and an urban part. The same site as in City Mobile 2 will be used.	
Netherland	Eindhoven	Urban area. A part of the city that is one of the front-runner cities for C-ITS deployment.	
Czechia	Brno	Urban area. The setting from the former project C-ROADS CZ will be partly used.	

4.1.3 Digital infrastructure

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 3.

Table 3. Overview of digital infrastructure at different sites

Country	City/Site	Digital Infrastructure/sensors and systems
France	Rouen	ITS 5G networks, secure telecommunication networks, 4G+/5G, lidars, connected cameras, connected traffic lights. A supervision center integrated in the PT control room in Rouen. A user app to request transportation, smart infrastructure and secure telecommunications networks.
	Rennes	ITS 5G networks, secure telecommunication networks, 4G+/5G, lidars, connected cameras, connected traffic lights.
Spain	Madrid, Depot	RSU ETSI-G5, 4G, EGNOS/Galileo OBU Lidar.
	Madrid	C- ITS (CCAM concept): Hybrid communication (RSU-ETSI ITS G5 – 5G), V2V, V2I. DGPS, Cameras, Radars, Lidars.
Austria	Graz	ITS-G5, 4G or 5G
	Salzburg	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
	Vienna	V2X will use ITS G5
Germany	Karlsruhe	Roadside units (WLAN 802.11p ITS-G5), e.g. CAM, DENM, SPaT and MAP messages; LTE
	Mannheim	LTE network. 5G, Cellular V2X required
	Aachen	4.5G network
Sweden	Linköping	SAFE platform: connected Traffic Tower with remote monitoring & tele-operation
	Kista	Scalable 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
Denmark	Copenhagen	C-ITS, 5G
Italy	Turin	TM system (TOC operated by 5T): traffic sensors, Intelligent Traffic Light Systems (51Centralised TLs; 39 TLSwith PT Priority; 7 existing TLA-Traffic Light Assistant Enbled; 10 planned TLA Enabled), PMVs and 5G to be deployed completely by 2021.
Greece	Trikala	4G, 5G, optic fibers network, Proximity sensors on traffic lights
Netherland	Eindhoven	L5 technology enhanced by hybrid ITS G5/cellular C-ITS services, full 4G coverage, early 5G deployment and IoT service networks.
Czechia	Brno	4G. 6 Roadside units for C-ITS infrastructure

4.2 Functions

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-friendly 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 PT to DRT, connected MaaS and LaaS.

4.2.1 Public Transport (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.

4.2.2 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 will be used. 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.

4.2.3 Mobility as a Service (MaaS)

For first/last mile connection as well as covering all types of user needs, SHOW 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.

4.2.4 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.

4.3 Type of automated transport

Based on the Trilateral Impact Assessment Framework for Automation in Road Transportation an Automated transport systems classification was made (Koymans et al., 2013). This was used to classify the automated system included in the SHOW eco-system to get an overview of what is targeted in the overall evaluation of SHOW, see Figure 9.

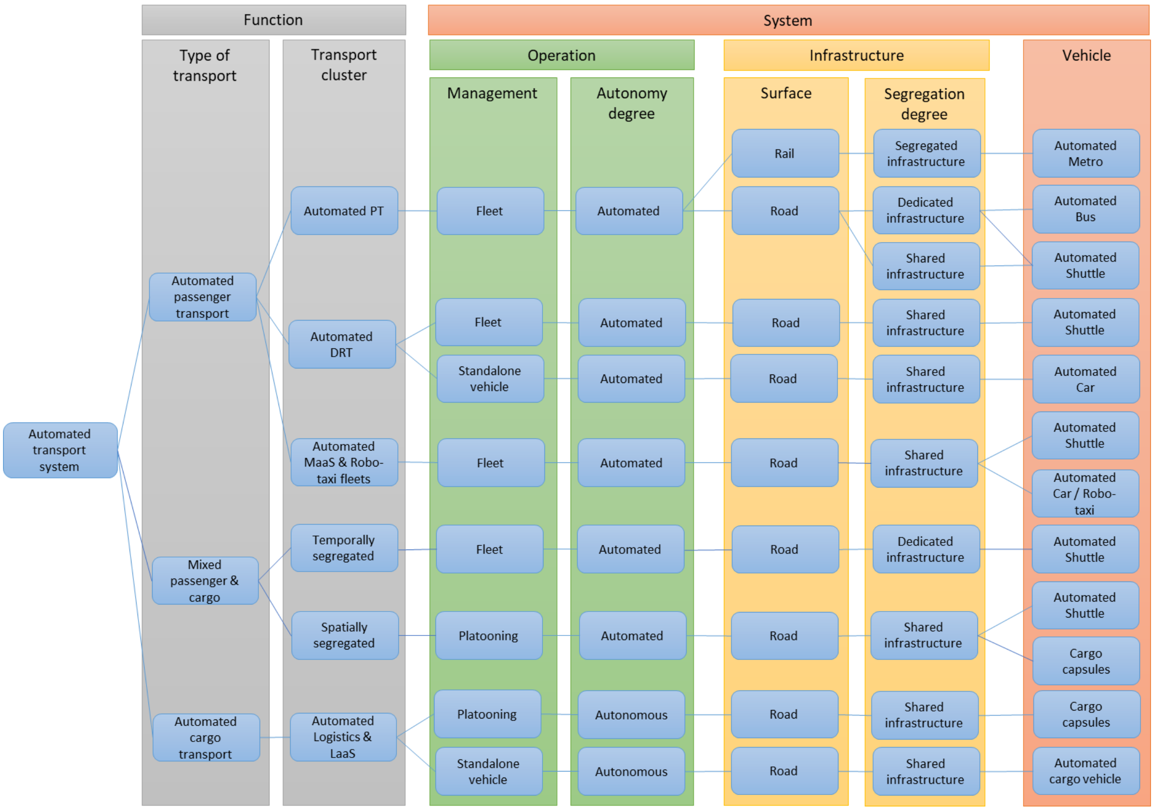


Figure 9. Automated transport systems classification modified from CityMobil2 project.

5 Use Cases and target groups

In SHOW indicative Use Cases were identified already in the proposal phase. Those Use Cases are being further developed and prioritized in WP1 – Ecosystems view & SHOW UCs. The final use cases of SHOW and its scenario will be ready month 9 and included in Deliverable D1.2 SHOW Use Cases. The evaluation framework (D9.1) will use the indicative Use Cases as a starting point and in the updated version (D9.2) the final Use Cases will be described and matched to Demonstrations sites and KPIs.

5.1 Use cases

Seven indicative use case families and 23 single use cases have been defined to describe the conditions under which the automated functions and systems will be tested (from DoA). Those are coming from the different test sites involved and has been group as below in order to focus the use cases. They will be updated for the next version of the Evaluation Framework (D9.2) using the input from D1.2 SHOW Use Cases that will be ready in Month 9.

UC1: Autonomous traffic in real city environment:

- UC1.1: Under “normal” (higher) speed
- UC1.2: In complex environments with real curvatures in roundabouts
- UC1.3: Interfacing non-equipped vehicles/ travelers (VRU)
- UC1.4: In an energy sustainable way
- UC1.5: For passengers and cargo (including automated cargo delivery at warehouse)
- UC1.6: Actual integration to City TMC
- UC1.7: Mixed traffic flows
- UC1.8: Connection to Operation Centre for tele-operation and remote supervision

UC2: Multi-actor business environments:

- UC2.1: With different operators
- UC2.2: With different vehicle types
- UC2.3: With different infrastructures (5G, G5, IoT, none)
- UC2.4: All connected in terms of data and business cases

UC3: Seamless autonomous transport chains of Automated PT, DRT, MaaS, LaaS

UC4: Mixed passenger/cargo automated transport:

- UC4.1: Spatial within the same vehicle
- UC4.2: Spatial with a towed vehicle (platooning)
- UC4.3: Temporal

UC5: Platooning for efficiency:

- UC5.1: Urban passenger platooning for higher speed traffic during connection (city centre to peri-urban, at the city ring, etc.)

- UC5.2: Cargo platooning for efficiency

UC6: Operational services in semi-controlled environment:

- UC6.1: Automated service at bus stop
- UC6.2: Depot management of Automated Buses (servicing, cleaning, maintenance)
- UC6.3: Parking applications

UC7: Enhanced services:

- UC7.1: Self-learning DRT (planning, routing, operation)
- UC7.2: Added value services based upon big data and AI algorithms (metadata)

The indicative use case groups are mapped to the Demonstration sites as described in Table 4. This will be update when the final use cases are decided.

Table 4. Overview of use cases in focus at each site.

Mega site/ Satellite		Use Case groups						
	City	UC 1	UC 2	UC 3	UC 4	UC 5	UC6	UC7
France	Rouen	x	x	x			x	x
	Rennes	x	x		x			
Spain	Madrid - Depot	x					x	
	Madrid	x	x	x		x	x	
Austria	Graz	x	x				x	x
	Salzburg	x	x					x
	Vienna	x	x			x		x
Germany	Karlsruhe	x	x		x			
	Mannheim						x	x
	Aachen	x	x	x			x	
Sweden	Linköping	x	x				x	
	Kista	x	x				x	x
Finland	Tampere	x	x					x
Denmark	Copenhagen	x					x	x
Italy	Turin	x	x	x				
Greece	Trikala	x	x	x		x		
Netherland	Eindhoven	x	x				(x)*	
Czechia	Brno	x	x					x

* Depending on Associate partner

5.2 End users

In SHOW a wide range of user categories will be included in the evaluations. The indicative description of target stakeholders is found in D1.1 Ecosystem actor's needs, wants & priorities & user experience", Appendix 1.

In this first step the end users in focus are identified, see

Table 5. The other stakeholders will be matched per site as soon as the use cases are finally decided and included in the updated version (D9.2).

Table 5. Overview of target end user groups at each site.

Mega site/ Satellites	City	End Users								
		Commuters	Residents (urban/ peri urban	Students	Children/ young adults	Elderly	Tourist /visitor city centre	Hospital visitors	SMU	PWD
France	Rouen	x		x			x		x	
	Rennes	x		x				x		x
Spain	Madrid Depot									
	Madrid		x		x		x			
Austria	Graz								x	x
	Salzburg	x	x				x			
	Vienna	x	x			x	x			x
Germany	Karlsruhe	x	x							
	Mannheim	x	x							
	Aachen	x	x	x						
Sweden	Linköping	x	x	x	x	x				x
	Kista	x	x				x			
Finland	Tampere	x*		x		x	x			x
Denmark	Copenhagen				x	x				x
Italy	Turin		x			x		x		x
Greece	Trikala	x		x		x			x	x
Netherland	Eindhoven	x		x		x				
Czechia	Brno	x		x	x	x	x			x **

Comment: SMU=Soft mobility users (cyclist, pedestrians, kickboard users etc., PWD=persons with disabilities; * immigrants; ** blind.

6 Evaluation aims and 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 autonomous 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. This deliverable contains the first version of RQs, that will be revised when the final Use Cases are ready (D1.2 SHOW Use Cases).

RQ 1 (UC1)

How will road safety, traffic efficiency, mobility, and user acceptance be affected by AV traffic in a real city environment when operated at normal speed, in roundabouts, in interactions with VRUs, in an energy efficient way, as a combination of passenger and cargo transportation, in mixed flows and integrated to TMC or connected to operation service/remote supervision?

RQ2 (UC2)

Can a multi-actor business environment considering different operators, type of vehicles, type of road infrastructure and digital infrastructure improve quality, efficiency and safety of operation?

RQ3 (UC3)

What will be the societal, economic, safety, and environmental effects of using seamless autonomous transport chains of Automated PT, DRT, MaaS, LaaS?

RQ4 (UC4)

What will be the effect of mixed passenger/cargo automated transport on passenger and cargo delivery in terms of traffic efficiency, energy consumption, and user experience?

RQ5 (UC5)

Can platooning of passenger and cargo transport at higher speed contribute to improved traffic efficiency, energy consumption and environmental impact in transport?

RQ6 (UC6)

Are operational services in semi-controlled environments like bus stops, depots and parking on servicing, cleaning, maintenance and parking feasible and efficient?

RQ7 (UC7)

Can transportation services be enhanced by using self-learning DRT for planning, routing, operation, or by using services based upon big data and AI algorithms?

7 Evaluation methods

7.1 Key Performance Indicators

In this work the indicative KPIs are still what we are based around. The final list of KPIs, to be collected by the demonstration sites and simulations will be the result of a list compiled through an iterative feedback loop by the SHOW partners.The impact assessment work package is divided into 5 impact assessment activities corresponding to impact areas. The different impact areas are (1) road safety, (2) traffic efficiency, energy and environment, (3) societal, employability and equity, (4) logistics and (5) user experience, awareness and acceptance. The list of KPIs will in the next phase be connected to use cases and to different stakeholders..

A first draft was defined based on relevant literature. As part of the impact assessment framework work package, 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. Finally, the final list of KPIs will be determined by matching the KPIs from this essential list to the KPIs from the Grant Agreement, which are given in Table 6. The values for the KPIs will be collected either through observations at the demonstration site, simulations or user questionnaires and also success criteria will be added.

Table 6. Indicative list of KPIs in the Grant Agreement

Success target	Impact	Description
> 15 (out of 22)	number of UCs success	Number of SHOW UCs successfully deployed and tested in pilots
realisation of UCs > 70%	realisation of each UC	Realisation of each UC under the pre-defined in section 1.3 (of proposal) operational and functional requirements
minimum 1500000 passengers	number of passengers	Number of citizens transported throughout the project per automated vehicle/service type
minimum 350000 containers	number of cargo	Number of cargo transported throughout the project per automated vehicle/service type
mean value > 7	traveller acceptance	Traveller acceptance rating
> 10%	safety enhancement	% of expected safety enhancement (from WP10 simulations)
> 20% person kilometres travelled by special groups (in total, 5% each group)	person km travelled	Person km travelled by special groups of citizens (elderly, PRMs, children) per type of AV service type
load factors of vehicles up to 70%	ratio of average load	ratio of average load to total vehicle freight capacity
empty haulage 20% or lower	empty vehicle km	percentage of vehicle-km run empty
> 20% reduction before-after pilots	operative cost	operative cost of the travelled km

90% for CO_2 at city level	reduction in CO_2	percentage reduction in CO_2 and air polluted emissions
30% reduction	reduction in noise level	percentage reduction in noise level
20% for passenger transport, 40% for freight	reduction in energy consumption	percentage reduction in energy consumption compared to existing conventional alternatives
10% reduction	reduction in energy consumption	percentage reduction in energy consumption compared to non-use of SHOW energy management services
35% increase compared to before pilots	single vehicle km travelled	percentage increase in single vehicle km travelled
at least 25% in low density areas	increase in average vehicle occupancy	percentage increase in average vehicle occupancy
20% in area coverage and 10% in time-to-target	PT quality of service enhancement	percentage of PT quality of service enhancement
> 5	business models	number of novel business models created and tested
> 3 internal, 15 external	SMEs using SHOW marketplace	number of SMEs that will use the SHOW services marketplace to develop services (during project's duration)
> 15	MoUs for services sustainability created	number of MoUs for services sustainability created between various stakeholders at SHOW or new follower cities
> 3	business models	number of business models adopted that promote strategic partnering opportunities for local synergies
> 50 vehicles in at least 10 cities	SHOW deployed fleets	number of SHOW deployed fleets remaining at service after project end
> 200 vehicles	future AV fleets after SHOW	number of AV fleets planned to be deployed within 3 years after the project by SHOW sites and liaised followers (with relevant funding secured)
> 3 different schemes	alternative infrastructure schemes	number of alternative infrastructure schemes to support deployment

7.2 Study design

SHOW pilots (pre-demonstrations and the real-life demonstration) will follow the plan presented in Figure 8 . Thus, the SHOW pilots are not only going to demonstrate their automated transport systems but there is also a need for technical verification and evaluation of what is demonstrated.

The technical verification and pre-demo evaluation will take place in WP 11. The aim is to ensure a satisfying level of robustness, reliability and safety of all types of vehicles which are part of the SHOW fleet across the demonstration sites, considering the use cases included in the different pilot sites, prior to the beginning of the real-life demonstrations. A verification and the evaluation framework methodology will be developed and employed at each pilot site. The pre-demo evaluation can be seen as a semi-real life demonstration phase that will encompass all value chain stakeholders. Users for 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 and they might go with the solutions or given the opportunity to remotely experience it. The experimental plans, including number of participants, design of the study, variables, measurements etc., and the impact assessment framework will be used in detail across all technical and user experience aspects defined therein. The work of WP11 will result in the final set-up for real-life demonstrations in WP12.

The real-life demonstrations will then be performed by SHOW demonstration sites. WP12 activities will perform data gathering during the Pilots and provide detailed reporting of Pilot results to 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 collected from the sites and other awareness initiatives, such as questionnaires, log files, interviews, video recordings, etc., will be analysed using the evaluation tools developed in A9.2. All data collected will be shared across partners and needs to comply with the Ethics and Data Protection Policy in (D3.2) and the data flows needs to be reported in the Data management plan (D14.2 and its update 14.3).

For each demonstration site there will be a clear description of **Why, What** and **How** data collection for evaluation will take place. The Demonstration will run for a specific time, and during this time data collection will take place both continuously and at pre-defined occasions in line with specific study design. The study design has its starting point in the use cases and the KPIs.

From an end user perspective SHOW aims to take into account 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, and children.

8 Evaluation tools

The subjective and objective data analysis tools for the Pilots will be defined and developed in A9.2. The goal is to find tools which are at the same time suitable for many pilot sites and theoretically available at all demonstration sites. They will all be connected to the A5.1 “SHOW big data Collection Platfomr and Data Management portal” as well as to the dashboard developed in A4.3, to allow data to be collected and used both for impact assessment as well as for added value services creation.

Suitable questionnaire and interview forms, observation approaches, and focus groups for all pilots will be derived and described in D9.2. Subjective tools will include online and printed questionnaire and interview forms (to be disseminated to AV fleet passengers and other travelers), observation approaches, focus groups and even WoZ trials protocols for traveler requirements collection. They will be based upon relevant existing tools (from AUTOPILOT, AVENUE and Drive2thefuture) and will cover both AV passengers and surrounding traffic participants as well as operators and other stakeholders’ opinions (gathered through expert walkthroughs). Usage of objective tools which collects data from on-board vehicle sensors and central devices (CAN-bus) will be considered for a selection of sites and be subject to technical feasibility. Relevant data to be collected will be identified according to WP13 impact assessment requirements. The assignment of subjective and objective capturing and monitoring tools to the Pre-demonstrations and their connection with the dashboard and data collection platform will be explained in D9.2 and for the Demonstrations they will be defined in D9.4.

In principle the following tools will be used for data collection.

1. **User surveys** (US), to be completed at pre-defined times per each site. The surveys will focus on experience, usability, user acceptance, trust and socio-economic questions and will be performed by using the respective questionnaires integrated in a web tool.

2. **Direct observations** (DO) of user behaviour, user performance or system performance through log files, video recordings or objective measurements that will be collected during both pre-demonstrations and Demonstrations at pre-defined times per site.

3. **Events diaries** (ED), which will be used to obtain request-by-request data from the driver or operator during the pre-demonstration and Demonstration at pre-defined times per site.

4. **User interviews** (UI), such as workshops, focus groups and one-on-one interviews performed during the pre-demonstration and Demonstration at pre-defined times per site, which will be analysed qualitatively.

The specific tools and templates for the evaluations will be described in D9.2 Pilot Experimental plans, KPIs definition and impact assessment framework for the final demonstration.

9 Realisation of Data Acquisition

The procedure for technical verification and pre-demo evaluation will be defined in WP11 and delivered to the sites for their implementation. The sites will report the information and test results requested by the procedure which will be then assessed and reviewed within WP11. A guidance checklist will also be developed for the pre-demo evaluation phase to help the demonstration sites in the set-up of the real-life demonstrators and the evaluations. This checklist will be 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 (WP12).

The real-life demonstrations are intended to provide seamless service operation in each of the 5 mega sites and 7 satellite sites for at least 12 months. Data collections will take place at pre-defined time points during the demonstrations.

The approach for all sites is common and consists of the following steps:

1. Detailing of the use cases that will be defined in A1.3 and decomposition of implementation actions for each of them for each site in the context of the preparation. This will include the mapping of technical and functional requirements, correlations between vehicles and infrastructure of the pilot site as well as functional requirements constructing the framework for the pilot. This will involve all partners of each pilot site community and will incorporate the different requirements on behalf of the different stakeholders (operators, vehicle providers, travellers, etc.). At the end of this phase, full alignment of each demo community party with regard to the goals will have been achieved.
2. Obtaining permissions and setting the legal framework (WP3): a strong focus on preparation for AV approval procedures and collaboration with the authorities is eminent from the beginning of the project, cities and legal entities are being engaged early on.
3. Preparation of the demonstrators, physical and digital infrastructure of the project, upon the principles and the technologies that will be defined and implemented in WP4 – WP8 as well as the experimental plans and mechanisms that will be defined in the next iteration of the experimental plans (D9.2). This includes the data collection activities that are related to the performance KPIs of the project. Also, herein, the detailing of the technologies to be utilised: specific technologies are partly dependent on existing technologies in vehicles and infrastructure;
4. Optimisation as of the technical validation and pre-demo evaluation activities of WP11. In this phase, specific conditions, dependencies and restrictions for pilot sites and tests will be also identified. Also, iterations and revisions of the planning of the pilot activities will take place. In the context of the iterative nature of the project, updates/ changes against the original plans may emerge. After the pre-test phase in WP11, iterations and revisions may become necessary. A structured planning for these revisions will take place accordingly.
5. Establishment of a simulation framework under WP10 guidance. This framework takes the approaches of the involved partners into account in order to ensure a correlation.

Continuous assessment of the demonstration activities' progress will be pursued during the course of the demonstration activities, using specific mechanisms to be defined 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 stakeholder but also on a performance basis through the tools that will be developed in SP2 and upon the impact and simulation assessment framework of WP13 and WP10 respectively.

Datasets will be gathered (logs and performance indicators, questionnaires, and documentation) from pilots and their lessons learned and other main pilot demonstration results will be documented (such as the final number of users and cargo transported, key challenges identified, etc.). Each Demonstration 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.

Data from the pilots will be collected and managed by the Big Data Collection Platform and Data Management Portal developed in A5.1. The Big Data Collection Platform and Data Management Portal constitute an important part of the SHOW ecosystem since they aim to define the storage platform of the system as well as the open data portal, along with appropriate data management techniques.

10 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 first version of Ethics Manual, D3.2: "SHOW Ethics Manual and Data Protection policy" 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.

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.

Data collection during demonstrations in SHOW will be conducted in 18 cities across Europe across both during pre-demonstration and Demonstration. The Informed Consent mechanisms are discussed in D3.2, 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.

In deliverable 3.2 the structure of the ethical procedures to guarantee a sound and correct ethical treatment of human participants are described. The 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.

D3.2 will be updated twice and the next version Deliverable (D3.4) will present the national Ethics profile of each demonstration site with reference to national legislation and guidelines. Later on also the Data Privacy Impact Assessment (DPIA) will be conducted in collaboration with the data collectors and processors at each pilot site, the data manager, the project DPO (and local DPO), as identified in D18.2, the Data Management Plan (DMP) team (D14.2) will be involved in this future work.

11 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].

Most 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 will be clearly defined in the Data management plan (D14.2 & D14.3)

12 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.

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 is presented in Figure 10.

In general, during the different steps: It is important to have a red tread in the application. It is a way to prove what 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 Driving 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 is a one-day test with the Swedish Transport Agency to check everything before getting the real permit.

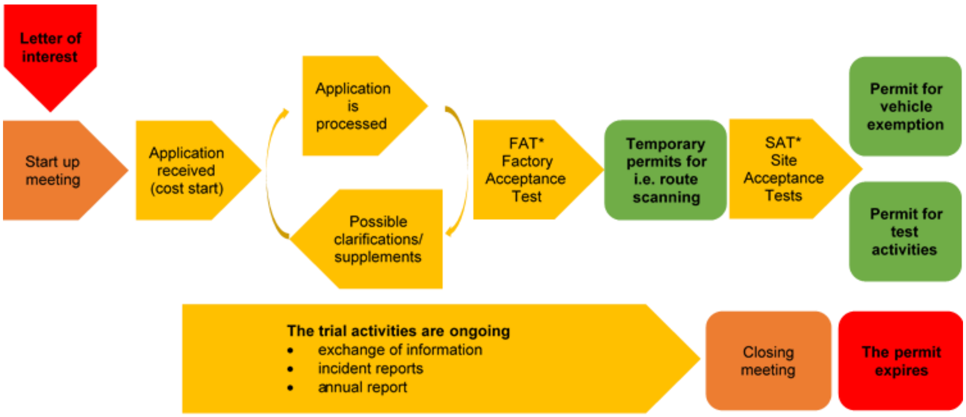


Figure 10. Illustration of the Swedish application process for trials with self-driving vehicles

13 Pilot Site Description

In the following section an overview of each demonstration site is given including key objectives, indicative use cases and equipment to use and a first version of the time plan. This is based on information received by the demonstration sites, and will be update continuously.

13.1 Mega site France

The French site combines demonstrations in Rouen and Rennes which are two regional metropolises, see Figure 11. For both cities connected and automated mobility is in the centre of their SUMP policies.

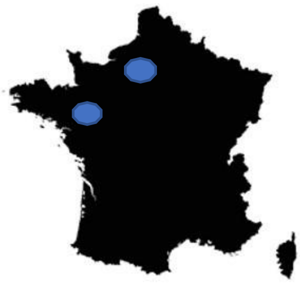


Figure 11. The sites Rouen and Rennes

13.1.1 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. There are more than 80 buses (level 2 SAE) and 4 robot-taxis (level 4 SAE) in service. 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, see Table 7.

13.1.1.1 Key objectives

- Use of a single fleet control management system for multiple brands of vehicles.
- Integrate the fleet control of the AVs with the Operations Control Centre of the city of Rouen to facilitate the global management of the traffic.
- 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 SAELK 4 shuttles and robot taxis (today TRL6)

13.1.1.2 Use Cases

- Integrated and automated PT demo (UC1.1; 1.2; 1.3;1.6; 1.7; 2.1; 2.2; 2.3; 2.4; 3). In both cases, the automated DRT service will connect an automated PT link (bus in Rouen) through automated DRT with a special point of interest

(Hospital, City centre) and will also be integrated in a MaaS ecosystem with automated cars/robotaxis (Rouen)/a LaaS one with cargo vehicles (Rennes).

- Automated driving with the support of tele-operated manoeuvres demo (UC1.8). Rouen will have remote assistance to manoeuvres. The system will be controlled from the existing TCM and rely on enhanced perception and connected infrastructure.
- Fully automated service at bus stop demo (UC 6.1). Autonomous fleet of shuttles on regular bus lane marking all bus stops or only on demand demo.
- Self-learning DRT demo (UC7.1). Fleet monitoring of mixed fleet in Rouen, using fixed lanes and at dedicated stops. Both pre-booked and random orders will be accepted, vehicles will be accessible through a mobile application. Optimization algorithms are developed to maximize the service quality and the fleet profitability.
- Interface to TMC demo (UC1.6), the vehicle to infrastructure feature developed allow a direct communication with the connected traffic lights, and grant priority at crossroads on the dedicated bus line.
- Energy application demo (UC1.4), energy optimization of overall operation will be integrated in the vehicle and the supervisor.

Table 7. Overview Rouen

Vehicles	Users	Road Infrastructure	Digital infrastructure
5 autonomous shuttles (i-Cristal)	Commuters, students	Urban and suburban	ITS 5G networks, secure telecommunication networks, 4G+/5G, lidars, connected cameras, connected traffic lights. A supervision center integrated in the PT control room in Rouen. A user app to request transportation, smart infrastructure, and secure telecommunications networks
1 bus (I-Cristal)		Urban and suburban	
4 robot taxis (Renault Zoe)	Tourists, commuters, residents, scholars, vulnerable road users, persons with disabilities.	Urban (city)	

Table 8. Rouen Time Line

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation	1					18										
Pre-Demo				12				24								
Demonstration									25			36				
Post Demo												34				48

13.1.2 Rennes

Rennes aims for new mobility modes in the future CHU (University Hospital Centre). Rennes have been investing in autonomous transport systems (metro and shuttles) and innovation in Mobility. The chosen location for the project is the existing and future CHU which will become a car free zone and a hub for connection with the automated light rail system, buses and soft modes, see Table 9.

13.1.2.1 Key objectives

- Management of intersections, pedestrian (slow), emergency vehicles, overpassing.
- Speed adaptation (day/night, hours, type of use)
- Real-time route adaptation.
- Use of AI for real time reactivity.
- Road signs and sensors complementarity.
- Energy management (peak hours)
- Acceptability and proper use.
- Compliance to hospital regulation (transfer of persons and goods)
- Reach TRL 8/9 with the existing fleet of SAE L4 shuttles (today TRL4/5 for cargo and 6 for people).

13.1.2.2 Use Cases

- Integrated and automated PT demo (UC1.1; 1.2; 1.3; 1.6; 1.7; 2.1; 2.2; 2.3; 2.4). In both cases, the automated DRT service will connect an automated PT link (metro in Rennes) through automated DRT with a special point of interest (Hospital, City centre) and will also be integrated in a MaaS ecosystem with automated cars/robotaxis (Rouen)/a LaaS one with cargo vehicles (Rennes).
- Mixed passenger – cargo transport demo (UC4), demos will focus on the full hybrid use of shuttles (daytime and night-time) for passengers and cargos transport on the CHU site using the automated shuttles 24/24H completely adapted to the needs of the hospital: blood transport, pharmaceuticals, medical equipment, light laundry.

Table 9. Overview Rennes

Vehicles	Users	Road Infrastructure	Digital infrastructure
3 autonomous shuttles (Navya)	Visitors, users of the hospital, medical staff, support staff, logistic staff, students. Travellers with disabilities.	CHU (University Hospital Centre)	ITS 5G networks, secure telecommunication networks, 4G+/5G, lidars, connected cameras, connected traffic lights.
3 autonomous shuttles (EasyMile)			

Table 10. Rennes Time Line

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation	1					18										
Pre-Demo				12				24								
Demonstration									25			36				
Post Demo												34			44	

13.2 Mega site Spain

The Spain Mega site enables and provides safe, sustainable, integrated people and freight mobility, see Figure 12. The environment includes intersections and roundabouts. It includes platooning solutions, and will take place in urban, suburban, and restricted areas. A Mobility as a Service (MaaS) solution will also be included, with the aim to simply travelling with shared solutions. The project will deploy a fleet of up to 5 passenger vehicles, to complement the existing service offers. The fleet will be mixed, composed of shuttles (mini-buses, and a 12 m long bus), and of passenger cars for people transport. The vehicles will follow complex trajectories with difficult manoeuvres in various real traffic conditions.

In Madrid, there are two centres for the demos: Carabanchel Depot and La Nave Boetticher, see Figure 12. Carabanchel Depot is a semi-controlled area with interactions with other non-autonomous buses and vehicles. It is a modern depot with different bus technologies (CNG, Hybrid, Electric). Here autonomous docking and parking applications are in focus. The other demo area is located in Villaverde district, linking La Nave (Madrid City Innovation Hub) with - Villaverde Bajo-Cruce Metro Station, a journey of 1,6 km, driving in open traffic including roundabouts. Here Seamless autonomous transport chain demo, AD and teleoperation, self-learning DRT and Convoy and platooning in real road setting will take place.

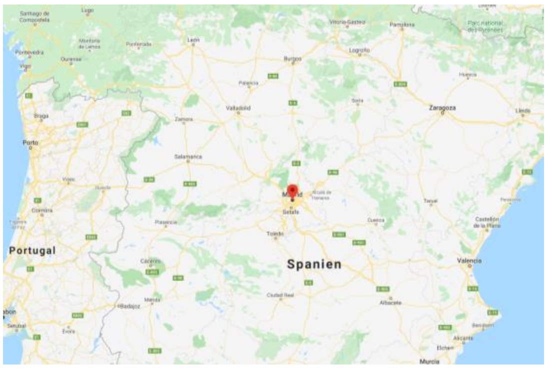


Figure 12. Madrid, Carabanchel Depot and La Nave Boetticher, Madrid

13.2.1 Carabanchel depot

13.2.1.1 Key objectives

- Interaction with the daily operations at the depot (manoeuvring, moving goods, people, etc.).
- Buses should enter into the depot and find their parking lot.

- Busses should be called to a different work areas.
- Teleoperation from staff office.

13.2.1.2 Use cases

- Autonomous docking and parking applications demo (UC6.2; 6.3) will be done. An automated-docking-charging parking operation will be the implemented. This will include autonomous parking, cleaning, and other operations, with interaction to other no – automated buses and service personnel.
- Automated driving and teleoperation demo (UC1.2; 1.7; 1.8). These capacities will be tested in the depot UCs with the buses, auto-parking-docking, manoeuvre and in the final bus stops.

Table 11. Overview of the Carabanchel depot

Vehicles	Users	Road infrastructure	Digital infrastructure
One Irizar i2e bus One Tecnobus Gulliver (microbus)	Operator	Depot	C- ITS (CCAM concept): Hybrid communication (RSU-ETSI ITS G5 – 5G), V2V, V2I.

Table 12. Electric bus, Madrid, Time Line

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation	1						20									
Pre-Demo					14			24								
Demonstration								24								

13.2.2 La Nave Boetticher

13.2.2.1 Key objectives

Enable and provide safe, sustainable, and integrated people and freight mobility, see Table 13, by:

- Deploying a mixed fleet of five AVs (passenger vehicles)
- Following complex trajectories with difficult manoeuvres (intersections, roundabouts or platooning),
- In various traffic conditions (urban, sub urban and restricted areas)
- Supervised by one single interoperable system with a high TRL (8), which is the MaaS-Madrid-Platform.

13.2.2.2 Use cases

- Seamless autonomous transport chain (UC 1.1; 1.2; 1.3; 1.7; 2.1; 2.2; 2.3; 2.4; 3). Existing PT services in Villaverde, Madrid, will be integrated into the passenger's transport management for autonomous passenger's services. The new line will be an automated PT service that will connect automated PT service to a regular transport link of metro and connecting with La Nave where you can take the train to the centre of Madrid or any of the lines regular that the EMT has there. The bus will leave garages or La Nave and will do the proposed route and when finished will return back. A MaaS app will provide the time-table regular service, and an on-demand service, with links to the rest of the PT lines.

- Convoy and platooning (UC5.1). The Platooning functionality will be implemented in one ie2 IRIZAR 12-m long electric bus and 2 Renault Twizy electric cars for people mobility.
- Autonomous docking and parking (UC6.2; 6.3). Test autonomous docking for 12m long Irizar bus and Gulliver minibus

Table 13. Overview La Nave Boetticher, Madrid

Vehicles	Users	Infrastructure	Digital infrastructure
One Irizar i2ebus One Tecnobus Gulliver (microbus) Two passenger car Renault twizy (Tecnalia)	For all citizens with focus on tourists	Urban and suburban	C- ITS (CCAM concept): Hybrid communication (RSU-ETSI ITS G5 – 5G), V2V, V2I. DGPS ,cameras ,radars ,Lidars

Table 14. La Nave Boetticher, Madrid, Time Line

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation	1						20									
Pre-Demo					14			24								
Demonstration								24								

13.3 Mega site Austria

The Austrian mega site consists of Graz, Salzburg and Vienna, see Figure 13. 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 13. The Sites Graz, Salzburg and Vienna

13.3.1 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, see Table 15.

13.3.1.1 Key objectives

- Integrate automated & connected shuttles into existing mobility services
- Enable automated vehicles to enter highly frequented public transport bus stops
- Safe detection of pedestrians and shuttle passengers in bus stops
- Construction of an automated shuttle line demonstrator linked to a bus stop

13.3.1.2 Use cases

- An automated shuttle service between a suburban train station in Graz and a shopping centre with connection to PT lines will be established with automated vehicles. With help from traffic infrastructure (e.g. guiding through traffic lights) vehicles will perform actions autonomously upon user request (e.g. smart phone app). Services will focus on passenger transport covering the following topics:
- Automated driving in complex environments (UC1.1). In Graz this will be the passage through a frequented bus station, crossing of railway lines as well as crossing of intersections.
- Interfacing non-equipped vehicles / travellers (UC1.3): Automated vehicles need to interface with pedestrians and passengers at stops and to communicate to other vehicles like public transport busses in order to free bus stops.
- Multi-actor business environments with different vehicle types (UC2.2): Automated driving in cooperation with public transport will be implemented with two different vehicle types to ensure vehicle independence.
- Automated service at bus stop (UC6.1): Automated vehicles will serve and pass through existing bus stops from public transport.

- Added value services based upon big data and AI algorithms (UC7.2): The detection of pedestrians and handling of frequented bus stops gives added value to other bus stops served by automated vehicles.

Table 15. Overview Graz

Vehicles	Users	Infrastructure	Digital infrastructure
2 passenger cars (1 Ford Fusion, 1 Kia e-Soul)	"Soft mobility" users and persons with reduced mobility or without their own motorized vehicle/driving licenses.	Shuttle transport between a suburban train station and a shopping centre (low speed)	ITS-G5, 4G or 5G

Table 16. Graz Time Line

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation	1			12												
Pre-Demo					13			24								
Demonstration									25							46

13.3.2 Salzburg

The city of Salzburg is heavily affected by traffic congestion. Every day, 60 000 commuters enter the city centre from the hinterland, a high percentage of them in private cars. To fight 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. The C-ITS roadside units along the corridor connected to C-ROADS will be used. The solution provide a connection from the city centre to the hinterland, see Table 17.

13.3.2.1 Key objectives

- Enable and provide safe, sustainable and integrated transport.
- Build upon existing trials, tests and learning environments in Austria.
- Integrate automated & connected shuttles 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.
- Achieve efforts for legal enablers.

13.3.2.2 *Use cases*

- Automated demand responsive transport (DRT) for peri-urban regions connecting them to city centres via intermodal mobility hubs (UC1.2; 1.3; 1.7; 2.4; 7.1).
  The aim is to test automated DRT for connecting peri-urban regions to intermodal mobility hubs (bridging first/last miles in PT). Testing the challenges of automated DRT, MaaS-integration, self-learning, seamless integration with automated and non-automated PT, C-ITS support for higher automation levels.

Table 17. Overview Salzburg

Vehicles	Users	Infrastructure	Digital infrastructure
1 EasyMile EZ10 Gen 3 shuttle	Specific user groups: commuters/ peri-urban residents, tourists.	C-ITS enhanced bus fleet, automated DRT shuttle (max. 20 km/h on public roads)	GNSS correction system available; RSUs (related and not related to TLC) and OBU; Communication technology: RSU ETSI-G5, 3GPP 4G (LTE);
1 PT bus/shuttle(subject to negotiations)			

Table 18. Salzburg Time Line

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

13.3.3 Vienna

In Vienna, automated DRT, using on-demand service business models will be the focus, especially operation of on demand public transport services within urban quarters, see Table 19.

13.3.3.1 *Key objectives*

- Enable and provide safe, sustainable, and integrated transport.
- Build upon existing trial, tests and learning environments in Austria.
- Integrate automated & connected fleets into the existing mobility services (e.g. DRT, PT).
- Enhance MaaS platforms & frameworks and make use of existing steering groups e.g. ITS Austria.
- Achieve efforts for legal enablers.

13.3.3.2 Use cases

- On-Demand Use Case: Semi-automated DRT for flexible mobility services including C-ITS aspects (UC1.1; 1.7; 2.3; 2.4; 7.1; 7.2). Testing a semi-automated DRT in urban fringe in Vienna including mixed traffic and existing lanes. Fully flexible and with virtual stops. Mixed use of pre-booked travelling and travelling by chance, based on a learning algorithm. Self-learning DRT for first/last mile. In addition, testing one or two Connective ITS solutions (C-ITS) in a defined part of the larger Pilot area.

Table 19. Overview Vienna

Vehicles	Users	Infrastructure	Digital infrastructure
2 AV shuttles (Navya ArmaDL4 shuttle)	Specific user groups: Citizens /visitors of selected urban quarters, commuters, staff of industrial/ commercial park, students, persons with disabilities/ elderly, employees of Wiener Linien.	Selected area of urban district(s)	The prime V2X communication to be used will be ITS G5
1 Robotaxi (Navya Autonomous Cab) Searching for alternatives, since based on information from Navya, Robotaxis cannot be delivered until the start of the pilot activity.			
2 Electric Shuttles			

Table 20. Vienna Time Line

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

13.4 Mega site Germany

The Germany Mega site includes three cities, see Figure 14. Karlsruhe is a regional centre with a big share of commuter traffic. The test area Baden-Württemberg setup in Karlsruhe is located in the city centre. Mannheim Franklin is a new development suburban area in the peri-urban space and Aachen is a cross-border area with neighbouring Belgium and the Netherlands, see Figure 14. 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.

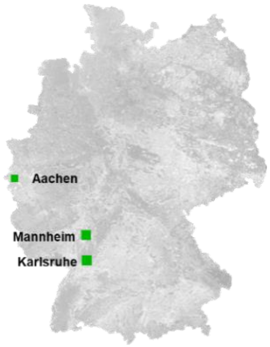


Figure 14. The Sites Karlsruhe, Mannheim and Aachen

13.4.1 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. In order 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, see Table 21
Table 21.

13.4.1.1 Key objectives

- The focus of 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.

13.4.1.2 Use cases

- Tele-operated manoeuvres demo (UC1.1; 1.2; 1.7; 1.8; 2.2; 2.3). Handling complex traffic scenarios with the support of tele-operated manoeuvres. Integration with the existing operational control centre of the PT operator will be demonstrated, to demonstrate level 5 operation in complex scenarios.
- Mixed passenger – cargo demo (UC4.1; 4.3) integrating all types of users including a new approach with passenger and goods capsules. It will also demonstrate an urban platooning function between two vehicles.

Table 21. Overview Karlsruhe

Vehicles	Users	Infrastructure	Digital infrastructure
2 electric, automated and connected shuttles (EasyMile EZ10 gen2)	All users (commuters, residents)	urban & peri-urban areas	The test area transmits local traffic information with several Roadside units (WLAN 802.11p ITS-G5), e.g. CAM, DENMs, SPaT and MAP messages.
1 automated and connected car (Audi Q5)			
1 modular vehicle, not yet decided.			

Table 22. Karlsruhe Time Line

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation				11				24								
Pre-Demo					14			24								
Demonstration								24							44	
Post Demo															43	48

13.4.2 Mannheim (Franklin)

Population 309,000. Franklin is a former military base in the peri-urban space of Mannheim. The area of 144 hectares is under construction for housing, will be home for 9000 inhabitants by 2021 and is publicly accessible, but privately owned. Thus, permits for autonomous driving can be obtained more easily. New electric and demand responsive mobility services are part of the Green City Masterplan of Mannheim, see Table 23.

13.4.2.1 Key objectives

- In the demo area Mannheim, it is expected to integrate the automated shuttles as a part of the daily PT services under condition of public service obligation, duty to carry and integration into tariff and schedule.

13.4.2.2 Use cases

- Automated bus stop demo (UC6.1) where shuttles will operate on flexible lines and serve barrier-free stops.
- Self-learning DRT demo (UC7.1). The fleet management platform matches vehicle and grid, driver (or vehicle operator) and passengers in several demand responsive scenarios. It is planned to add features for predictive fleet management. AI-based service features will be based on behavioural analysis and smart-phone sensor data of users.

Table 23. Overview Mannheim

Vehicles	Users	Road Infrastructure	Digital infrastructure
5 shuttles (subject to public procurement, not yet definitely fixed)	All users (commuters, residents)	A suburban traffic calmed area	The area is covered by LTE netwok. 5G is required for Cellular V2X to enable remotely controlled DRT with automated shuttles.

Table 24. Mannheim Time Line

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

The pre-demo is planned with 1 rented automated shuttle on fixed line. Based on experiences from this 6-month test, the procurement of the fleet for DRT services in the entire FRANKLIN area will be done.

13.4.3 Aachen

Population 247 000. Aachen is Germany's most western city with cross-borders to Belgium and the Netherlands. The city of Aachen can be characterized as both a science hub with the RWTH Aachen and several other universities of applied sciences, representing 57,000 students in MINT disciplines, and as a major touristic destination. The test site Campus Melaten Nord is a peri-urban environment centred in the heart of the university's innovation drivers, see Table 25.

13.4.3.1 Key objectives

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

13.4.3.2 Use cases

- Autonomous traffic in real city environment demo (UC1.1; 1.7; 2.2; 2.3; 2.4) in the peri-urban area. Ring feeder as on-demand service in a campus environment, based on automated people mover vehicles interfacing PT.
- Integrated automated PT with automated DRT and Automated MaaS demo (UC3) in the peri-urban area. Interfacing to connected intelligent DRT/MaaS applications in Aachen.
- Energy-applications demo (UC1.4; 6.1) in the city centre. Predictive/collaborative driving manoeuvres based on V2V communications on bus stops (flowing traffic merge-out and merge-in), to reduce energy consumption through longitudinal control of multiple vehicles to avoid stationary traffic.

Table 25. Overview Aachen

Vehicles	Users	Infrastructure	Digital infrastructure
1 BMW I3 (Passenger car) 1 e.GO Mover (Shuttle)	All users (commuters, residents, students)	A campus, a peri-urban environment.	Aachen's Campus Melaten Nord features a 4.5G network with specific enhancement for the test operations, realized through T-systems and Ericsson. The 5G-Industry Campus Europe is being established here.

Table 26. Aachen Time Line

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo (tbc later)																
Demonstration																

13.5 Mega site Sweden

The Mega site Sweden includes the sites Linköping and Kista, approx. 200 km apart, see Figure 15. The main innovation is a 5G control tower concept that can remote monitor and tele operate a fleet of vehicles on both Kista and Linköping sites.

Figure 15. The Linköping and Kista sites, Sweden.

13.5.1 Linköping

The site Linköping is on Campus Area with Linköping University, Ericsson, Combitech and 370 more companies as well as schools, elderly and child-care centres and residential houses. There are two shuttles running in the Campus area. The operation will be extended to also cover the residential area that was used for the living exhibition 2017 (https://nordregio.org/sustainable_cities/vallastaden/). This area also hosts a residential home for elderly people and a school for children with bilities, see Table 27
Table 27.

13.5.1.1 Key objectives

- Prove a robust, safe, and reliable operation of a fleet of electric autonomous vehicles with a solution for connected traffic tower for last/first mile service, using the SAFE platform.
- Improve user experience for all users.
- Test cooperation including multiple OEMs and multiple operators.

13.5.1.2 *Use cases*

- Autonomous traffic in real city environment demo (UC1.2; 1.3; 1.7). Operation of integrated platform for optimisation of transport systems in Linköping, interfaced to various MaaS schemes.
- Connection to actual TMC and centralised teleoperation demo (UC1.8). Dynamic route planning, multi-sensor situation awareness and system integration with city TMC and AV Control Tower in Linköping.
- Multi actor business environments demo (UC2.2; 2.4). Integration and connection of multi-brand vehicles to control tower. Data collection from AV, PT, users & additional data sources.
- Operational services in bus stops (UC6.1). Platform and services to get on and off the AV that make it possible for all types of users to travel, encompassing bus stop designs facilitating AV operation and flexible bus stops for AV's.
- Enhanced service (UC7.1; 7.2). Customer interfaces giving higher visibility for travellers about the traffic situation, using AI and self-learning algorithms. Predictive analytics, multi-sourced data e.g. weather, traffic situation, time-tables.

Table 27. Overview Linköping

Vehicles	Users	Road Infrastructure	Digital infrastructure
1 AV shuttle (Navya DL4)	Commuters, residents, and tourists. Special users in focus: Persons with special needs. - Children (< 15 years) - elderly (66-90 years)	Urban area with a campus and residential area for a mix of people. Elderly, families, and students.	SAFE platform Connected Traffic Tower with remote monitoring & tele-operation Public access – design for all.
1 AV shuttle (EasyMile EZ10gen2)			
1 AV vehicle (Cargo or maintenance)			

Table 28. Linköping Time Line

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation	1				15											
Pre-Demo					16	18										
Demonstration								22		30						

13.5.2 Kista

The Kista site is an urban area, a world leading ICT centre with 40 000 commuting every day to Ericsson, Stockholm University and Royal Institute of Technology and approx. 1000 other companies. Today there are no AV operations in the area.

13.5.2.1 Key objectives

- Prove a robust, safe, and reliable operation of a fleet of electrical autonomous vehicles with a 5G connected traffic tower for last/first mile service.
- Improve user experience for all.
- Test cooperation including multiple OEMs and multiple operators.

13.5.2.2 Use cases

- Autonomous traffic in real city environment demo (UC1.1; 1.2; 1.3; 1.7). Separate on-demand service to be integrated in AV-fleet set-up in Kista.
- Connection to actual TMC and centralised teleoperation demo (UC1.8). Integration via 5G control tower in real traffic in Kista.
- Multi actor business environments demo (UC2.1; 2.2; 2.4). Integration and connection of multi-brand vehicles to control tower. Data collection from AV, PT, users & additional data sources.
- Operational services in bus stops in Kista (UC6.1). Platform and services to get on and off the AV that make it possible for all types of users to travel, encompassing bus stop designs facilitating AV operation and flexible bus stops for AV's.

Table 29. Overview Kista

Vehicles	Users	Road Infrastructure	Digital infrastructure
1 AV t-engineering CM7	Commuters, residents and tourists. Special users in focus: adults (19-65 years).	Urban area	Scalable 5G Connected Traffic Tower with remote monitoring & tele-operation Public access – design for all.
1 AV vehicle (tbd)			
1 AV vehicle (tbd)			

Table 30. Kista Time Line

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration									25					42		

13.6 Satellite sites

13.6.1 Finland - Tampere

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, see Figure 16. In the Tampere site real operations under adverse weather conditions will take place, see Figure 16 and Table 31.

Figure 16. Site Tampere, Finland

13.6.1.1 Key objectives

- Tampere Regional Transport offers a complete regional bus services and route network with connections to main national services. Starting 2021 autonomous buses and city bikes 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 introduce also DRT services. 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 6 vehicles used in the pilot, to about 20 after the project.

13.6.1.2 Use cases

- Seamless automated transport demo chain (UC2.4; UC3). Demonstrations carried out in connection with the new automated light rail corridor between Hervanta suburb and TAYS University Hospital Campus area with electrified automated DRT services both in Hervanta and TAYS campus.
- Automated driving with the support of tele-operated manoeuvres demo (UC1.2; 1.7; 1.8; 2.2, 2.3; 2.4). 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 demo (UC7.1; 7.2). DRT services to be developed and piloted 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.

Table 31. Overview Tampere

Vehicles	Users	Infrastructure	Digital infrastructure
2-3 shuttles (tbd)	Elderly, disabled & handicapped, immigrants, housewives and tourists.	Hervanta - suburb	LTE/5G and ITS G5, if needed. Existing technologies (ITS-G5 devices, 5G & 4G network, intelligent lightning systems etc.) will be complemented whenever required. LoRaWAN is available in Tampere and covers the whole city area.
2-3 pods or shuttles (tbd)	Mainly students, workers and business travellers.	Hervanta – Hermia Science Park and Tampere University of Technology	

Table 32. Tampere Time Line

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

13.6.2 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 Table 33 and Figure 17.

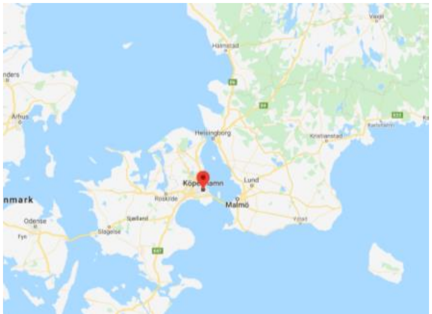


Figure 17. Site Copenhagen, Danmark

13.6.2.1 Key objectives

- 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).

13.6.2.2 Use cases

- Autonomous BRT supplementing/replacing regular PT demo (UC 1.1; 1.2; 1.3; 1.7; 2.2; 2.4). The small and medium-sized buses will operate in L4 as an integral part of the existing PT bus service. The objective is to replace at least one regular bus per hour during the demo period. This is expected to lead to new affordable level of service in the thin hours such as night-time.
- Interface to TMC demo (UC 1.6; 1.8). All buses will be connected to critical infrastructure i.e. road signals, through interface to the local TMC. The objective is to be able to monitor and re-direct AV buses in the demo site area according to actual traffic flows.
- Energy optimization demo (UC 1.4). The operator-neutral intelligent planning and dispatching of vehicles in DRT mode will optimize energy and take into account the optimal charging pattern. The objective is to demonstrate efficient and energy-optimized traffic flows.
- Self-learning demo (UC 7.1; 7.2). The participating AV buses will shift between route and DRT mode according to time of the day and demand. The objective is to demonstrate the intelligent, real-time planning and dispatching of the AV buses combined with real-time information to passengers.
- Fully automated service at bus stop demo (UC6.1). Adjust all bus stops in the area to accommodate AV buses. Loading/unloading of passengers from AV buses together with normal 12m buses.

Table 33. Overview Copenhagen

Vehicles	Users	Infrastructure	Digital infrastructure
5m AV Shuttles (Navya Arma/Easymile EZ10 type)(tbd)	Focus are on commuters, also elderly, young adults and PRM.	Peri-urban area	Will be equipped with C-ITS infrastructure and traffic control centre. Road signs will be prepared to communicate with autonomous buses. Also a 5G network will be utilised.
8m AV midsize buses (tbd)			

Table 34. Copenhagen Time Line

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo (will be decided later)																
Demonstration									25						45	

13.6.3 Italy - Turin

The satellite site of Turin is located in Northern Italy and is the 4th largest city in Italy, see Figure 18. 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 18. The Site Turin

13.6.3.1 Key objectives

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

13.6.3.2 Use cases

- Cross-domain integrated, automated and flexible services (UC1.1; 1.3; 1.6; 1.8; 2.2; 2.4; 3). In the pre-pilot phase (2020) 1 autonomous shuttle will be tested in the city in order to assess implementation barriers and impacts. The results of the pre-pilot will be used to steer the development of the pilot (2022), where 2 DRT vehicles (1 autonomous shuttle and 1 retrofitted tele-operated car) will provide flexible PT services in the area of the City of Health and Science to special categories.

Table 35. Overview Turin

Vehicles	Users	Infrastructure	Digital infrastructure
Shuttle DL 4 (pre-pilot)	Visitors and employees	Fenced area in Turin	TM system (TOC operated by 5T): traffic sensors, Intelligent Traffic Light Systems (51Centralised 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.
DRT Shuttle (NAVYA DL4)	Employees at the hospital, students, patients and visitors to the hospital, i.e. 40% will be elderly, people with chronic diseases, other PRM (physical and rehabilitation medicine).	Mixed traffic infrastructure in the hospital district	
Teleoperated DRT car (retrofitted)	Employees at the hospital, students, patients and visitors to the hospital, i.e. 40% will be elderly, people with chronic diseases, other PRM (physical and rehabilitation medicine).	Mixed traffic infrastructure in the hospital district	

Table 36. Turin Time Line

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

13.6.4 Greece - Trikala

The demo in Greece will take place in the city of Trikala and focuses both on passenger and freight transport, see Figure 19.

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, in order 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 19. The Site Trikala

13.6.4.1 Key objectives

- 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.

13.6.4.2 Use cases

- Autonomous traffic in real city environment demo (UC1.2; 1.3; 1.6; 1.8; 2.4). On demand dynamic route service, ticketing integration, integration with the PTO backend. The goal is to gradually replace an existing PTO line by absorbing through an on-demand service the transfer to the bus terminal, operation will be within mixed traffic and with no segregation. Overtaking manoeuvres will be examined. Remote operations will be applied, with full integration at the local TMC.
- Seamless autonomous transport chain of automated DRT and MaaS demo (UC1.1; 1.2; 1.3; 1.6; 1.7; 1.8; 2.4; 3; 5.1). The above DRT service will be integrated with a MaaS consisting of two passenger cars, that depending on the demand will be also able to operate in platooning mode. This mode will allow then also to operate in higher speed, in order to connect peri-urban locations.

- Automated LaaS demo (UC1.2; 1.3; 1.5; 1.6; 1.8; 2.4). Automated docking and undocking change business models to enable time shifts, integration with logistic ERPs, modification of vehicle interior to cope with freight requirements. Automated freight delivery for both palletised and non-palletised goods.

Table 37. Overview Trikala

Vehicles	Users	Infrastructure	Digital infrastructure
Shuttles of > 9 passengers, (iDriverPlus ,Zhongtong Bus)	Passengers	Transportation between the city bus terminal and the city outskirts (sub-urban).	5G/4G and proprietary fibre optic network.
2 BMW i3	Passengers (MaaS)		
1 freight vehicle (FURBOT cargo vehicle)	Local stores, e-commerce users (Freight)	City centre	

Table 38. Trikala Time Line

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo																
Demonstration																

13.6.5 Netherlands - Brainport

The overview of the Brainport site (750,000 inhabitants) demonstration will take place in Eindhoven city (230,000 inhabitants). Eindhoven is the 5th largest city in the Netherlands, with a clear strategic interest in mobility innovations, see Figure 20.

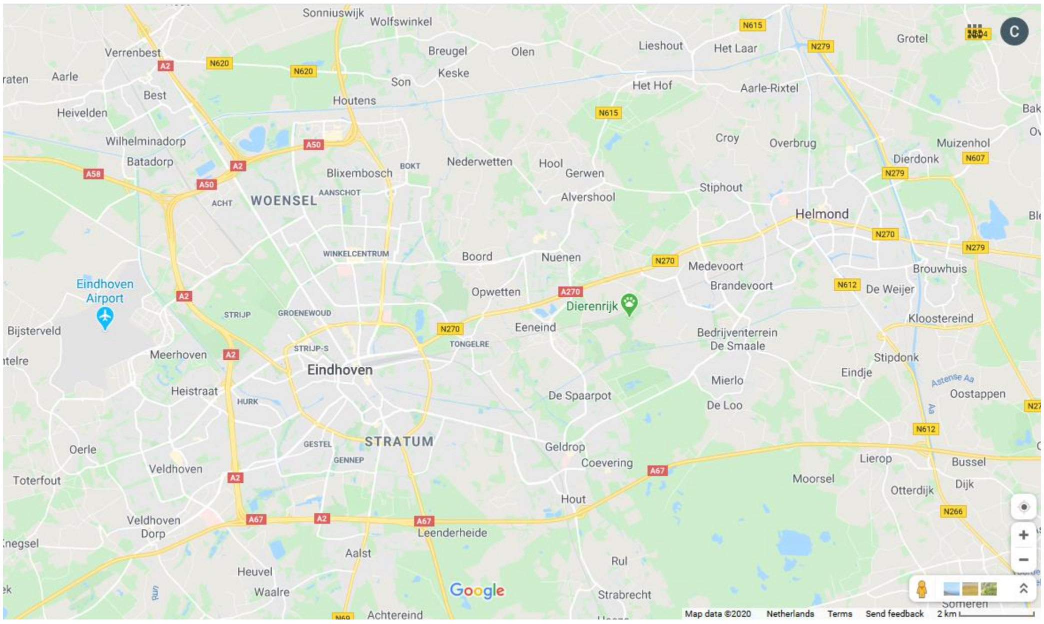


Figure 20. The Site Brainport

13.6.5.1 Key objectives

- The focus of the Brainport pilot site is to demonstrate automated driving on bus lanes in Eindhoven, with solutions for smooth and safe intersection crossing with normal roads, involving PT buses and shared passenger cars.
- L4 urban driving requires functions for environmental perception and interaction with C-ITS traffic lights. Furthermore, it needs to have scalable decision making for strategies to tackle many scenarios that can be encountered during intersection crossing.
- This satellite site will support L4 technology.
- The pilot will study multi-modal transport (including shared vehicles and bicycles) to anticipate on their choice of travel in the future mobility system.

13.6.5.2 Use cases

- Integration of automated DRT with MaaS demo (UC1.1; 1.3; 2.3; 5.1). Demonstration of vehicle relocation capability for DRT. A fleet of three passenger cars are used to execute platooning on bus lanes, allowing future unmanned vehicles to follow lead vehicles at short distance. This will lead to efficient use of the bus lanes, and minimizes the impact of crossing traffic at intersections.
- Operational services in semi-controlled environment demo (UC1.1; 1.3; 1.4; 2.2, 2.3). An L4 automated bus will operate in conjunction with a fleet of three passenger vehicles owned by TNO and will be demonstrated on a specific bus lane in Eindhoven, negotiating in real conditions an intersection crossing, and collision avoidance, by simulating traffic conditions in real-world.

Table 39. Overview Eindhoven (Brainport)

Vehicles	Users	Infrastructure	Digital infrastructure
One full electric bus (tbd), L4	Travellers (e.g. students, pensioners, commuters.)	Bus lanes in city environment	L5 technology enhanced by hybrid ITS G5/cellular C-ITS services, full 4G coverage, early 5G deployment and IoT service networks.
3 passenger cars (Renault Scenic), L4			

Table 40. Time line - Eindhoven (Brainport)

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation			9			18										
Pre-Demo							19	23								
Demonstration									26						45	

13.6.6 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 21.

In Brno a traffic centre that can control remotely automated driving over long distance (up to 200 km) will be available.

Figure 21. The Site Brno

13.6.6.1 Key objectives

- In the site Brno 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.

13.6.6.2 *Use cases*

- Autonomous traffic in real-city environment (UC1.1; 1.2; 1.3; 1.7; 2.2; 2.4). A DRT and robo-taxi service will interface with and complement an existing PT service. They will augment its functioning and connect places that are poorly served, as well as user groups that were usually omitted. A close cooperation between all vehicles is planned. The DRT and robo-taxi service will focus on the transportation of disadvantaged traveller groups, such as elderly, blind, and young travellers that have limited access to personal transportation and lack the first/last mile connection to the PT network.
- Automated driving with tele-operations demo (UC1.2; 1.7; 1.8). Based on previously conducted research and demonstrations with remote driving over distance of up to 200 km, now using 4G network, will gradually move to the 5G. Tele-operations will be involved in numerous ways: as a safety measure; as a back-up for situations the vehicle won't be able to handle, and as a pure business model for a wholly new segment of remotely operated cars.
- Self-learning DRT demo (UC7.1; 7.2). The DRT service will be optimised both in terms of prediction as well as scheduling and re-scheduling through AI logarithms.

Table 41. Overview Brno

Vehicles	Users	Road Infrastructure	Digital infrastructure
2 AV Shuttles (EasyMile)	Users with disabilities (blind persons), elderly, students, under-aged people, commuters, tourists.	Urban area	4G, 5G. 6 Road Side Units (RSUs) of the C-ITS infrastructure on the planned route.
1 AV Taxi (Hyundai i40)			

Table 42. Brno Time Line

	2020				2021				2022				2023			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Preparation																
Pre-Demo (tbd later)																
Demonstration									26						45	

14 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 Demonstrations 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 for the following aspects and what support that can be expected from other partners involved in the site.

- **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.
- **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 Demonstrations.
    - **The evaluation** of the pre-demonstration will follow the Pilot plans defined in WP9 D9.1 “Evaluation framework” and its updates (D9.2

and D9.3). The leader of the evaluation is recommended to be an independent party (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 an independent part (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.

Conclusions

The evaluation of the SHOW ecosystem encompasses several layers, that to some degree are overlapping or integrated. It start with the investigation of the expectations of travellers and stakeholders (layer 1) and are completed with the final evaluation of the ecosystem (System of Systems; SoS) that results from the triangulation of the findings from the user tests (FESTA implemented methodology), the impact assessments (M^3ICA methodology; WP13) and the simulations conducted within WP10. Each method (i.e. sub-framework) addresses the common denominators (e.g. actors and data sources as well as some RQs and KPIs) and others will be diverse (i.e. the methods, the indicators, the instruments and the analyses).

The evaluation framework for the demonstration in SHOW will be based on the methodology denoted M^3ICA (multi-impact, multi-criteria, and multi-actor) 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.

The research questions to address at each demonstration site are derived from the SHOW use cases and their scenarios, a work that will be finalised in month 9 of the project. SHOW will 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.

The demonstration sites will support a mix of both fixed time-table solutions and on-demand solutions with flexible bus stops along the road-side. Connected MaaS solutions will integrate not only motorised solutions but also prioritised infrastructure for pedestrians and cyclists. In this first version of the evaluation framework the technical aspects included at each demonstration site will be described.

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Appendix I – Main contact persons at each pilot site

Table 43. Main contact person/s at each pilot site

City	Main contact person/s at each pilot site
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