SHared automation Operating models for Worldwide adoption

SHOW

Grant Agreement Number: 875530

D9.3: Pilot experimental plans, KPIs definition & impact assessment framework for final demonstration round

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Executive Summary

The SHOW project aims to support the migration towards effective and sustainable urban transport through technical solutions, business models and priority scenarios for impact assessment. This will be achieved by deploying shared, connected and electrified fleets of automated vehicles in coordinated Public Transport, Demand Responsive Transport, Mobility as a Service and Logistics as a Service operational chains in real-life urban pilots.

One important part of the SHOW ecosystem is the detailed framework of the evaluation of the planned pilots. This Deliverable is the updated version of the common evaluation framework for SHOW pre-demonstration phase (1st pilot phase, with internal passengers, not being open to public) and includes a description of the methodological approach for the final pilot evaluation (2nd pilot phase, open to public).

The new elements here are the experimental plans for the final public large-scale phase of SHOW. Details on pre-pilots are not included in D9.3 at all, hence we refer to D9.2. Lessons learned from pre-pilot phase are incorporated in D9.3. Among other, the experience gained during the pre-demo phase has resulted in the radical optimisation of the acceptance surveys (the final ones are provided in Appendix III of the current document) and the addition of new ones (safety driver survey, VRU dedicated survey, logistics dedicated surveys).

In addition, in SHOW, a methodology for impact analysis has been created from the beginning, denoted M3ICA (multi-impact, multi-criteria, and multi-actor). It allows for consistent analysis and evaluation of pilots and simulations within the ecosystem of electric connected automated vehicles. Specifically, for the evaluation and data collection, the FESTA Handbook for field operational tests is used in an adjusted manner as the starting point for setting up the framework. The SHOW's M^{3}ICA framework describes how data collected will be used for the impact analysis, including baseline data along with dimension of measurement of the Key Performance Indicators (KPIs) per vehicle, per service etc. and the aggregation rule (sum or average). In the current issue, apart from the revision of the impact assessment framework and the presentation of its first application in Linkoeping, the final list of the project KPIs that have been revised during this period, is provided in Appendix IV.

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

This document is public but at the same time serving as a guideline for the pilot sites of SHOW on how to plan and perform the evaluations. In order to give a public overview of all pilot sites, a general description of the pilot sites is given in Chapter 2. The overview is an update of what was presented in D9.2 (which covered the pre-pilot evaluation phase). An overview of the use cases and the relationship to research questions is presented in Chapter 3. In Chapter 4 the evaluation framework including methods to be used, type of stakeholders and end users to include and capturing and monitoring tools are described. Here also a short support on important practical things

to think about as a site leader is presented. In Chapter 5 the final impact assessment is briefly described together with an example from one of the pre-pilots (Linkoeping), whilst more details about the impact analysis can be found in Appendix II. The detailed experimental plan per site, together with their test cases and the visualisation of them are presented in Appendix I. This issue is going to be updated to include the plans of the test sites that are not final yet – in any layer – as well as to include the plans of the newcomers test sites of the project which are yet subject to formal acceptance of Amendment 2. Still; the generic evaluation and impact assessment framework is considered as final.

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Abbreviation List

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

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. This will be done by deploying shared, connected, electrified fleets of automated vehicles in coordinated Public Transport (PT), Demand Responsive Transport (DRT), Mobility as a Service (MaaS) and Logistics as a Service (LaaS) operational chains in real-life urban pilots. Each system included is a system within the urban transport ecosystem. The ecosystem involves dynamic interactions among the different stakeholder groups (e.g., the fleet operator, the leader in a platoon and passengers) and therefore it is not the same as the addition of its systems.

SHOW aims to demonstrate and evaluate a complex System of Systems (SoS), taking advantage not only of systems at a specific test site, but also the integration of several test sites into a cross-site evaluation that will allow to draw more generalised conclusions on the future of automated mobility. The SHOW ecosystem includes systems and services such as: Fleet Management controlling AV fleet, Traffic Management encompassing AV fleet management along with other modes of mixed transport, advanced vehicles for passenger mobility and logistics, connected bike sharing, automated charging and parking depot, automated MaaS and DRT, mixed logistics and passenger mobility, etc..

The goal is to establish a European roadmap with short and long-term targets for testing and deployment of Cooperative, Connected and automated mobility (CCAM)[1] CCAM initiatives focus on finding possible frameworks to rely on.

Comprehensive frameworks to be used for evaluations of such an ecosystem, that SHOW aims to build, with layers of safety, energy and environmental impact, societal impact, logistics and user experience, awareness and acceptance, are still not yet available. Taking multiple stakeholder perspectives into consideration as described in SHOW D1.1: "Ecosystem actors' needs, wants & priority users experience exploration tools" is the starting point in the evaluation. The list of stakeholders for SHOW consists of the following key groups (see chapter 4.4 for further information):

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

The SHOW project has 8 identified 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] Mobility and transport (europa.eu)

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

Objective number 5 and number 6 are the main targeted in the evaluation framework, but the outcome of the evaluation results will be used to address more or less all objectives.

Objective number 5 is related to the deployment of pilot 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. Pilots will take place in 5 Mega Pilots and 6 Satellite sites. A Mega Pilot site is a site in a country where different cities or parts of a city are working together addressing the majority of the SHOW use cases. A satellite is a pilot site that is more focused and is not covering all use cases. An overview of systems and services for all pilot sites is presented in Chapter 2.

In Appendix 1, each pilot site is described together with the experimental plan for the pilots.

In addition, there are Follower Pilot sites that are used as replication sites but will not be covered by the evaluation framework in D9.3 as they will not typically follow it. The follower sites plans and actions will be reported in *D12.8: Follower sites multiplication plans and actions.*

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

1.1 Purpose and structure of the document

This deliverable is titled *D9.3: Pilot experimental plans, definition of KPIs and impact assessment framework for the final demonstrations*. This is a follow up of *D9.2: Pilot experimental plans, KPIs definition and impact assessment framework for pre-demo evaluations*. This document includes an update of the vehicles, infrastructure and systems to be included in the final pilots, and also the pilot site description details and the experimental plans for the final pilot - open to public - phase of the project. The experience of the pre-demo phase has been reflected both in the design of the final experimental plans but also the evaluation tools that are going to be used.

Chapter 2 provides an overview of pilots that will take place in Mega Pilots and Satellite Pilots. The pilots will cover various geographical areas, city sizes, weather conditions, socioeconomic and cultural issues. Use cases and the research questions in focus for the evaluation are provided in Chapter 3. The generic framework and its methodological approach using the evaluation results are described in Chapter 4. This includes the study design, stakeholders and end users that will be in focus in the evaluations but also the capturing and monitoring tools developed for this purpose. Those cover a mix of qualitative (questionnaires, interviews) and quantitative measures (raw data/ observations). The impact assessment framework was described in detail in D9.2, in D9.3 an update is done, and an overview is presented in Chapter 5. This chapter also covers the impact analysis and the key performance indicators (KPIs), the final list of which is provided in Appendix IV. In Appendix I, the final experimental plans for each of the pilot sites are presented in more detail.

A correct ethical and privacy handling during the evaluation at the sites is important and is described in detail in D3.5: Final SHOW Ethics manual, Data Protection Policy and Data Privacy Impact Assessment; discussed in short in section 4.9.

The evaluation framework and experimental plans will ensure that the key priority use cases and impacts targeted will be answered by all pilot sites of the project.

1.2 Intended Audience

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

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

1.3 Interrelations

The Evaluation Framework described in D9.3 is closely related to several activities, not only to the *WP9: Pilot plans, tools, and eco-system engagement*. In **Error! Reference source not found.**, the main interrelationships between A9.1 and other WP/A are highlighted.

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

The work in WP1 (A1.1, A1.2, A1.3) sets up the core of what to demonstrate, and hence also evaluate, in terms of Use Cases and how to assess stakeholder and AV user needs and acceptance. In addition, WP2 (A2.1) will provide input about existing models and best practices to make sure the focus is on innovations, that is also important for the selection of the final UCs and scenarios to be evaluated. WP3 (A3.2) then provides the guidance for the pilot 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 pilot activities. The pilot sites will use different physical infrastructure and the work in WP8 (A8.1) will provide input about what to consider. Moreover, the evaluation framework of the SHOW ecosystem is not only about the performance of the single pilot 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. The pilot sites local architectures have been already described in WP4 (A4.1), whereas technical verification and validation has been the very first (mandatory) phase preceding the pre-demo and final demo phase WP11 (A11.1).

The realisation of the pilots will be done in WP12 with a consolidation of the results done in A12.8. Raw data and in some cases for specific test sites, ready KPIs calculated will be stored in the big data collection platform in WP5 (A5.1) that will serve as the tool for all data and KPIs storage that will be finally visualised in the project Dashboard. 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 consolidated results from the pilot sites will then be used for analysis of business models in WP2 (A2.3), for the development of AI services in WP5, for the execution of simulations in WP10 as well as for impact analysis in WP13 (A13.1, A13.2, A13.3 and A13.5). All data will be collected in alignment with the principles described in the Data Management plan (D14.2 and its update D14.3).

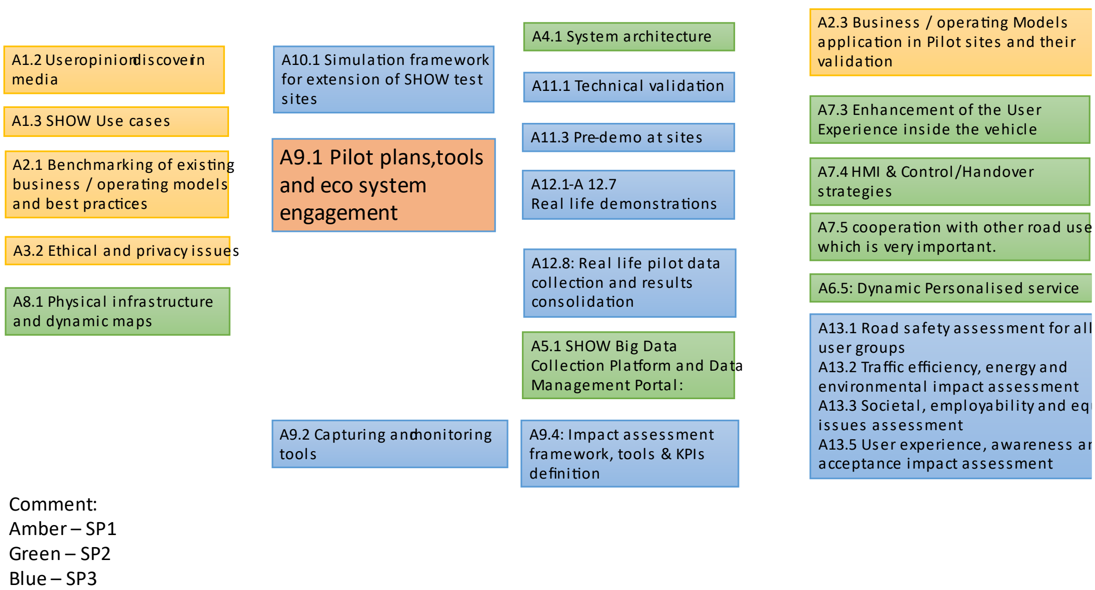


Figure 1: Interrelations between A9.1 (Amber) and other WP/A, different colour per SP (Yellow= SP1, Green=SP2 and Blue for SP3).

2 Pilot sites

2.1 Overview of Pilot sites

The SHOW project includes Mega Sites, Satellite Sites and Follower Sites. When all sites are ready there will be in total 17 areas will be involved in pilot and evaluation activities. This chapter aims to provide an overview of what all pilot sites bring together.

A **Mega Sites in SHOW** are when areas in the same country come together to cover almost all the use cases addressed in SHOW. These are the following countries and cities:

- France: Rouen new site: Les Mureaux
- Spain: Madrid (area of Carabanchel and Villaverde)
- Austria: Graz, Salzburg, Carinthia (Pörtschach and Klagenfurt)
- Germany: Karlsruhe, Monheim
- Sweden: Linköping and Gothenburg

The **Satellite Sites**, here defined as cities addressing a sample of use cases in SHOW, include the following countries and cities:

- Finland: Hervanta in Tampere (Tampere will be extended and in addition City of Lahti will be added as a replacement of Copenhagen test site; subject to acceptance in the context of Amendment 2)
- Italy: Turin
- Greece: Trikala
- The Netherlands: Brainport, Eindhoven
- Czech Republic: Brno

In addition, 11 Follower Sites are identified. Apart from Brussels that has already conducted pilots and Thessaloniki and Geneva that are also going to perform SHOW specific short-term evaluations, the rest of the follower sites are external to the project and are subject to specific type of collaboration with SHOW aiming at the multiplication of its impact, that is going to be described in D12.8.

- **Brussels**
- **Thessaloniki**
- **Geneva**
- Venice
- Istanbul
- Sarajevo
- Varna
- Paris
- Helmond
- Barcelona
- Oxford

Comparing the presentation of the pilot sites in D9.2 with those included in D9.3, some changes have been done. In general, the replacement of three sites will take place. The details are not in this version of D9.3, as soon as the formal decision is taken, they will be added in a subsequent version.

Still, as being reflected in the above list, the major changes – all subject of the submitted Amendment 2 – are as follows:

- Replacement of Rennes by Crest Val de Drome

- Replacement of Aachen by Frankfurt site
- Replacement of Copenhagen by the extended Tampere site

Also, the new Rouen test site (Les Mureaux) that will be complemented by a new test site, outside Rouen, and the revisited operational plans of Brainport will be subject of most probably a subsequent amendment. In addition, there have been major updates for some sites regarding vehicles and use cases. Those are namely Turin, Trikala and Brainport; changes in this respect are reflected in the following section. Nevertheless, the subsequent version of D9.3 will include the final detail for all test sites of SHOW.

SHOW covers a wide and varying range of automated vehicle systems and services. 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 into the city traffic management solutions covering interfaces to 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 roadside. Connected MaaS solutions will integrate not only motorized solutions but also prioritized infrastructure for pedestrians and cyclists. The technical aspects of these automated functions and systems will be described below, to provide an overview of what will be included at the pilot sites and, hence, evaluated. This is the starting point for the evaluations and the experimental plans describing the details on what to evaluate, what stakeholders to focus on, which research questions to answer, using what tool and where to provide the data (Appendix 1).

2.1 Vehicles

SHOW will utilize an overall fleet of over 70 AVs of all types (mid-size buses, shuttles, pods, cars) at the mega and satellite sites. They will be operated as PT, DRT or as MaaS/ LaaS. They are on SAE L4 or L4+ 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. All test vehicles to be used at Mega and Satellite sites are presented in **Error! Reference source not found.**.

Table 1: Vehicles per site.

Country	City/Site	Vehicles	
France	Les Mureaux	2 Easy-Mile Gen III	
Spain	Madrid–Villaverde	• TECNOBUS–EMT–Gulliver (Electric Minibus L3-4) • 2 Renault–TECNALIA–Twizzy (Passenger car – L3-4)	

Country	City/Site	Vehicles	
Spain	Madrid - Carabanchel	• 2 TECNOBUS–EMT–Gulliver (Electric Minibus L3-4) • 1IRIZAR – i2eBus – (Coach Electric L3-4) • 2 Renault–TECNALIA–Twizzy (Passenger car – L3-4)	  
Austria	Graz	• 1 retrofitted Ford Fusion (Passenger car) • 1 retrofitted Kia e-Soul (Passenger car)	 
	Salzburg	• 1 retrofitted electric passenger minivan L4 • 1 L4 shuttle (intensive coordination processes are ongoing within the Austrian Megasite. Under discussion is a Navya Arma Shuttle that will be deployed in Carinthia in addition to the foreseen fleet) • 2 PT buses with C-ITS capabilities	
	Carinthia (Pörtschach) and Klagenfurt)	2 Navya ArmaDL4 (shuttles) *+ 1 additional vehicle to be defined (see in Salzburg)*	

Country	City/Site	Vehicles	
Germany	Karlsruhe	• 2 EasyMile EZ10, gen 2 (AV Shuttles) • 1 Audi Q5 (AV Passenger car) • 1 modular vehicle from DLR	  
	Monheim	5 Shuttles: EasyMile EZ10 Gen 2	
Sweden	Linköping	• 1 Navya Autonomous DL4 (Shuttle) • 2 EasyMile EZ10 gen 2 (Shuttles)	
Sweden	Gothenburg	• 2 Navya Arma shuttles • 1 additional shuttle to be added for the final pilots in 2022 > Navya Arma or another shuttle model	
Finland	Tampere/Hervanta	• 2 Toyota ProAce vans by Sensible 4 (Phase I) • 1 AuveTech electrical shuttle (Phase II) • 3 more shuttles (2 Auvetech shuttles and one EasyMile) will be added in 2022 supervised by remote centre • In 2023 there will be some 7 additional vehicles (the brands are still open and discussed)	  

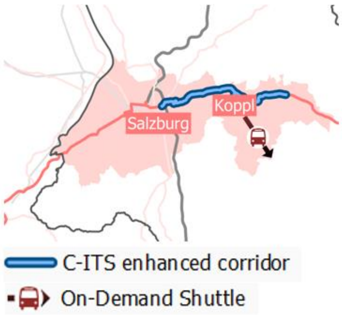
Country	City/Site	Vehicles	
Italy	Turin	2 AV Shuttles–- NAVYA DL4	
Greece	Trikala	• 5 Yape delivery robots for small freight (UNIGENOVA) • 2 AV shuttles • 2 first/last mile passenger vehicles by CERTH/HIT; one L4 retrofitted by VIF (subject to acceptance in Amendment 2)	
Netherlands	Brainport, Eindhoven	• 3 Renault Scenic (Passenger cars on L4 level) • 1 AuveTech shuttle	 
Czech Republic	Brno	• 1 Hyundai i40 Retrofitted (Robo-Taxi), • 1 Robotic Delivery Platform (Logistics), • 2 Retro fitted Esagono, Energia, GRIFO	 

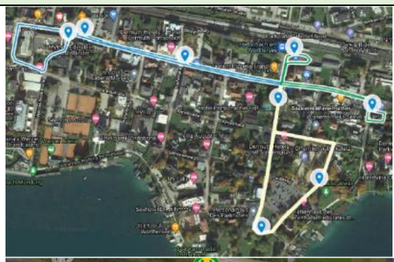
2.2 Environments

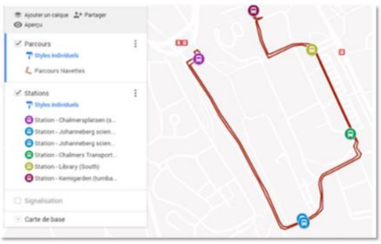
The SHOW pilots and evaluations will take place in dedicated lanes but also in mixed flows, under real-life conditions. All urban traffic environments are represented, from dense city traffic to remote peri-urban areas and neighbourhoods, specific environments (University campus, hospital areas, business districts, cargo depot, link to key multi-modal hubs as airports or rail stations). The type of environment at the different sites is presented in Table 2 as a complement to the use cases that elaborate more precisely the intended pilot cases in each site.

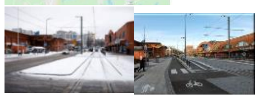
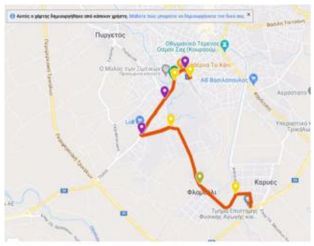
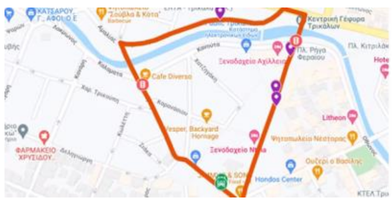
Table 2: Overview of the environment/ infrastructure at different sites.

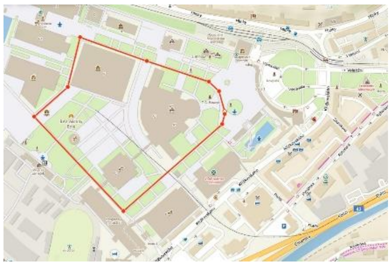
Country	City/Site	Environment/ Infrastructure	Maps
France	Les Mureaux	Urban area with mixed traffic (cars, bikes, pedestrians) on Ariannegroup private industrial site. 6,7 km of road parameterized with 3 different routes depending on mobility needs. Complex ODD with 6 round-about, 42 pedestrians crossing and 16 intersections. No infrastructure change is possible on site which means shuttles are deployed in the existing environment. The priority is not given to the shuttle. Operations will be conducted without safety operator on-board by the end of the year (this and an additional site that will be introduced by TRANSDEV will be soon be included in a formal amendment to the GA, as it is a change to the initial plans of TRANSDEV).	
Spain	Madrid–Carabanchel	Restricted area–- a modern depot with different bus technologies (CNG, Hybrid, Electric). Semi-Controlled Area: Interaction with other non- automated buses and vehicles.	  
	Madrid – Villaverde	Urban and suburban: Villaverde round trip, from La Nave (Madrid City Innovation Hub) to Villaverde Bajo-Cruce Metro Station (800 m per journey- 1,6 km line). This is an open traffic urban route, including roundabouts, mixed traffic, mixed lanes and dense traffic.	

Country	**City/Site**	**Environment/ Infrastructure**	**Maps**
Austria	Graz	The automated vehicles service will run between a suburban train station of Graz and a destination with high traffic demand (shopping centre). In this urban scenario the automated vehicles will stop at the terminal, pick up people and drive through the public stops where there are many pedestrians. With help from traffic infrastructure (e.g. guiding through traffic lights), vehicles will perform automated actions.	
	Salzburg	For the DRT service, a public road in a rural area will be used of 1.4 km length one-way, paved, with an inclination of 8 %, two separate driving lanes, 4 stops in each direction. Field trials with the C-ITS PT buses will run 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.	  

Country	City/Site	Environment/ Infrastructure	Maps
	Carinthia (Pörtschach and Klagenfurt)	There are two test sites: Klagenfurt and Pörtschach. The test sites are in an urban and suburban environment correspondingly. Klagenfurt: connecting the train and bus station of Klagenfurt West with the university of Klagenfurt, a science park, a work hub and residential area, etc. with an automated shuttle. Conditions of mixed traffic, public roads and high traffic demand. Over 4 km route with 14 stops and travel time of approx. 30 minutes (3 routes) (1 route – 3 metro modes (2, 3, 4 km length)). Pörtschach: connecting the train station of Pörtschach with the town center and the lake with an automated shuttle service on mixed traffic and on public roads. The route is 2.7 km and has 8 bus stops. The interval is 20 minutes.	 
Germany	Karlsruhe	Two areas, urban and peri-urban, mixed lanes, medium traffic density. KIT Campus Ost: Restricted area of the university. People are informed that autonomous driving takes place. Low traffic. Urban environment. Best for testing advanced functionalities. Weiherfeld-Dammerstock: Public urban area. Mixed traffic. Different conditions varying from narrow roads with low traffic to busy roads with many obstacles and varying parking vehicles. Communication infrastructure (V2X) available. Challenging environment for adaptive driving functions.	  

Country	City/Site	Environment/ Infrastructure	Maps
	Monheim	Urban area, mixed lanes. Partly in the old town of Monheim, with narrow roads and a pedestrian area. No traffic lights on the route, but roundabouts and crosswalks. The route marked in red is an alternative route currently used due to road construction. After construction work is finished the route can be switched to the originally planned one marked in blue. The new route is scheduled to be used from October 2022 onwards. It will differ partly from the current route and data will be provided from both routes.	  
Sweden	Linköping	Urban area with a campus and residential area for a mix of people. Mixed traffic and shared spaces with VRUs. The general speed limit vary between 30-40 km/h. The maximum speed is 13 km/h. Mixed traffic has separate lanes for VRUs. Urban Campus area (the red area at the top) and a residential area (bottom right red area).	
	Gothenburg	Urban area. Scientific campus in the north-western district of Gothenburg. The traffic environment is urban with car/bus traffic, cars, pedestrians, cyclists and e-scooters, etc. The traffic density varies also across day, with rush hours in the morning, around lunch and in the afternoon/evening.	

Country	City/Site	Environment/ Infrastructure	Maps
		VRUs don’t always have a dedicated lane / path along the AV route.	
Finland	Tampere	Hervanta suburb. Residential area in southern Tampere. Automated feeder transport service in Hervanta suburb to the new light rail station. The fixed route to be used is normally easy and smooth, but during winter is challenging and includes also driving on the tram line corridor. Traffic lights and roundabouts are present at the routes. Additional routes are planned to be added by autumn 2022. Also a route in the City of Lahti will be added to be controlled by the remote control centre, The route will be planned during the summer 2022.	  
Italy	Turin	The field trials will take place in the streets around the hospital district of the area “City of Health and Science” in Turin municipality, passing through the usual traffic of the city, on mixed lanes.	
Greece	Trikala	1. City centre and University connection including major points of interest such as train station, thematic park/museum and major villages, suburban areas. 2. Peri-Urban area for passenger DRT 3. Urban freight transport LaaS in a circular route of bike lane and pedestrian road. The environment is urban, no dedicated lanes. Mixed traffic with heavy density in specific hours per day.	 

Country	City/Site	Environment/ Infrastructure	Maps
Netherlands	Brainport, Eindhoven	The shuttle will operate on a bike lane between a distant parking and university area closer to the city centre. This route includes traffic lights (with added C-ITS), poor visibility conditions, a tunnel, narrow street, pedestrians crossing, bollards and a bypass.	 
Czech Republic	Brno	The urban environment with mixed traffic, including other vehicles and vulnerable road users. Among location where AV will operate is the historic part of the city of Brno. It is an urban environment in the old part of the city, the route length is around 1 km with the possibility of extension, depending on the actual demand. There will be 4-6 stops. Road markings are sometimes absent; there are also road humps and speed limit of 30 km/h. The road is shared with other vehicles, bicycles and pedestrians. Coordination with the team of the project C-ROADS is undergoing with intention to test their infrastructure (no earlier than Q2/2023).	  

2.3 Digital infrastructures

All types of digital infrastructure and communications are employed at project sites of SHOW shown in Table 3. For more information see *D8.2 Solutions for onsite digital and communication infrastructure*.

Table 3: Overview of digital infrastructure, systems and apps at different sites.

Country	City/Site	Digital Infrastructure/sensors, systems & apps
France	Les Mureaux	Connected infrastructure (lidars) will be deployed at complex intersection and roundabout to detect obstacles and calculate best trajectory for the shuttles. Connected infrastructure will be deployed (lidars) at complex intersection and roundabout to detect obstacles and calculate trajectories. Connected infrastructure (cameras) will be deployed at intersections and roundabout to detect obstacles and calculate best trajectories for the shuttles. Both shuttles will be supervised remotely at the control center (dedicated office within the site). DriveU Cameras system has been added on the shuttle to insure stable connectivity and low latency for the live videos seen by the supervision operator. A specific safety operator application has been developed and deployed to follow-up closely KPIs and complex situations in order to validate safety before starting fully driverless operations. A passenger information application is also available.
Spain	Madrid - Villaverde	• C-ITS (CCAM concept): Hybrid communication (RSU-ETSI ITS G5 – 5G), V2V, V2I. DGPS, Cameras, Radars, Lidars. • Route + POE + Power supply, with access to power outlet-communications antenna – to be placed on a mast / traffic light / lamppost, with connection to an Ethernet cable connected to a) equipment.
	Madrid - Carabanchel	• V2V: 4th generation of Commsignia's vehicular connectivity system • V2I: Cinegears Ghost-Eye Wireless HDMI & SDI Transmitter 300M • PT – EMT local TMC will be used and evaluated.
Austria	Graz	Smart camera platform from Yunex will be used on infrastructure to augment detection capabilities of vehicles sensors, bus stops. Travellers and public buses will be monitored. In addition, ITS-G5, 4G/5G will be used.
	Salzburg	Communication technology: Road side units: ETSI-G5, 3GPP 4G and HD Map of the test route will be used. In addition the following will be at the site: • 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 Integration of the service into a public transportation service app is under evaluation.

Country	City/Site	Digital Infrastructure/sensors, systems & apps
	Carinthia (Klagenfurt and Pörtschach)	4G to 5G, Wifi, C-ITS (connected traffic lights, smart lighting systems or cameras), GNNS-Navigation, Lidar sensors, cameras will be used. In addition a DRT, MaaS/LaaS and PT services will be implemented.
Germany	Karlsruhe	The test area transmits local traffic information with several Roadside units (WLAN 802.11p ITS-G5), e.g. CAM, DENMs, SPaT and MAP messages.TMC for teleoperation supervision. Furthermore, a booking service that allows users to specify a pickup point as well as the destination and the type of booking (person transport or cargo) will be implemented.
	Monheim	4G, Wifi, Lidar sensors, GPS+NRTK, ITCS will be used. Service is integrated into the app BahnenMonheim of the PT.
Sweden	Linköping	SAFE platform will be used as a role-based, situational awareness basis for all types of users, designed to meet the ever-changing demands of day-to-day operations. The focus is seen as a local dashboard supporting the preparation toward remote operation. In SHOW this is used for Connected Traffic Tower with remote monitoring & tele-operation. Radio, GPS (3G & 4G only) and GNSS are used. GNSS communication will be directly to the Navya shuttle with RTCM 3.2 MSM4 data form. A MaaS solution with a possibility to inform the shuttle safety operator is developed – a first on demand solution. The solution use geofencing to avoid bookings out of the area (see Hur många är det som väntar? (ridethefuture.se)). A TMC will be used to monitor the vehicle operation, orders can be sent to the shuttle but the operation itself needs to be performed by the safety operator.
	Gothenburg	5G Connected Traffic Tower with remote monitoring & tele-operation will be established at the campus site.
Finland	Tampere	LTE/5G and ITS G5. 5G & 4G network, intelligent lighting systems, etc. will be complemented whenever required. LoRaWAN. 10 private 5G base stations in Hervanta suburb. SUMP and MaaS will be used.
Italy	Turin	TCC operated by 5T, intelligent Traffic Light Systems (eight connected TLs plus two with TLA), 2 RSUs (with camera+LiDAR) will be integrated. Pedestrian detection and warning will be enabled on one RSU along the route while the other will be used to demonstrate the TLA use case. The eight traffic lights will send, through mobile network, SPATEM information to the edge and this data will be timely retrieved by the autonomous shuttle.
Greece	Trikala	4G, 5G, optic fibers network, Proximity sensors on traffic lights.

Country	City/Site	Digital Infrastructure/sensors, systems & apps
		DRT, LaaS (on demand logistic) with user application for booking and delivering. Remote Control Center for real time continuous monitoring, remote emergency break and immobilization both for passenger and logistic operations. VoIP communication with the Remote Control Center through a network telephone device Smart traffic lights for implementation of “green wave” for the autonomous vehicles. Establishment of 5G network connectivity via cooperation with the telecom operator Vodafone within the whole route and GPS precise localisation via the cooperation with Bosch. Fleet management system that orchestrates that on-demand service and provides operators with comprehensive monitoring of vehicles, reports at all times and communication with SHOW Dashboard. Interaction with VRUs via Direct VRU Communication and sensor’s perceived VRU. Integration of a local Traffic Management Center (by CERTH/HIT). Types of data transmitted include raw data for the telematics devices of the vehicles, video data, traffic data. Information and regulatory signs along the whole route. Terminal and depot equipped with charging facilities.
Netherlands	Brainport, Eindhoven	L5 technology enhanced by hybrid ITS G5/cellular will be used connected with C-ITS services, full 4G coverage, early 5G deployment and IoT service networks. It is used for VRU warning, green light optimal speed, and platooning, and it can be enabled for red light violation warning and emergency vehicle warning,
Czech Republic	Brno	The whole area is covered with 4G network. This network is used for connecting vehicles with the TMC for remote assistance and remote driving if necessary. In 2023, the road operator will install several RSUs for V2I communication, including smart intersection. Discussions are currently ongoing about potential use of these technologies for Brno activities. Vehicles use primarily HD map for their navigation.

2.4 Services

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

Public Transport (PT) SHOW integrates in its sites several PT services, such as automated metro and automated buses. Relevant operations also include parking, cleaning and maintenance services for automated PT fleets; this is demonstrated in Madrid. The goal is to complement existing PT to make it even more attractive to use PT and the new services provided thanks to SHOW.

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

Demand Responsive Transport (DRT) Feeders and people movers currently form the backbone of emerging automated urban services and are present in all SHOW mega and satellite sites, with over 70 such vehicles aimed to 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. In some cases, DRT is integrated as part of the MaaS concept.

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

Table 4: Transport mode services present at SHOW sites.

Country	City/Site	Service					
		PT	**MaaS**	**DRT**	**LaaS**	**TMC**	**Additional information**
France	Rouen	x		~~x~~			
Spain	Madrid - Villaverde	x	x				
	Madrid - Carabanchel					x	Platooning Automated parking
Austria	Graz			x			
	Salzburg	x	x	x		x	
	Carinthia	x	x	x	x		Covid adjusted services
Germany	Karlsruhe	x	x	x			
	Monheim	x	x				
Sweden	Linköping	x	x	x			Trunk lines
	Gothenburg	x					Control tower
Finland	Tampere	x	x	x			Remote Control Centre to be used starting autumn 2022. Sustainable Urban Mobility Planning method to be used
Italy	Turin	X		x		x	
Greece	Trikala		x	x	x		Remote Control center, Prioritisation at traffic light, Vehicle to VRUs interaction
Netherlands	Brainport, Eindhoven	x					GLOSA VRU Warning Platooning
Czech Republic	Brno	X	X			x	Long distance Remote control - teleoperation

3 Use Cases 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 automated vehicles in coordinated PT, DRT, MaaS, and LaaS operational chains in real-life urban operation across Europe".

The research questions (RQs) to be answered in SHOW are derived from the use cases described in Deliverable *D1.2: SHOW Use Cases*. They are further specified for each impact area as described in chapter 5 and Appendix II.

Table 5: UCs and the connection to research questions.

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

Use cases	Research questions
UC2.2: Automated mixed temporal mobility	How will traffic efficiency, energy consumption, and user acceptance be affected by using the same AV for passenger/cargo delivery, but at different times?
UC3.1: Self-learning Demand Response Passengers/Cargo mobility	How will transportation services (mobility) be affected by using services based upon self-learning DRT?
UC3.2: Big data/AI based added value services for Passengers/ Cargo mobility	How will transportation services (mobility) be affected by using services based upon big data and AI algorithms?
UC3.3: Automated parking applications	How will efficiency be affected by the use of AVs self-parking functions?
UC3.4: Automated services at bus stops	How will traffic efficiency and road safety be affected by automated services at bus stops?
UC3.5: Depot management of automated buses	How will traffic efficiency and safety be affected by automated services at AV depot areas?
UC3.6: COVID-SAFE Transport	How will automated services affect a Covid-free mobility era?

Table 6: Overview of use cases in focus at each site.

	UC 1.1	UC 1.2	UC 1.3	UC 1.4	UC 1.5	UC 1.6	UC 1.7	UC 1.8	UC 1.9	UC 1.10	UC 2.1	UC 2.2	UC 3.1	UC 3.2	UC 3.3	UC 3.4	UC 3.5	UC 3.6
	Mega Pilot Sites																	
Rouen site	×	×		×		×	×											
Linköping	×		×			×	×						×	×				
Gothenburg	×	×	×			×	×									×		
Madrid	×	×	×			×	×	×		×					×		×	
Graz		×	×													×		
Salzburg		×	×		×	×							×					
Carinthia	×	x				×					×							×
Karlsruhe	×	×				×	×		×		×	×						
Monheim		×	×	×	×	×	×		×							×		×
	Satellite Pilot Sites																	
Turin	x	×	×		×	x	×			×								
Trikala	×	×	×		x	×	×	×		×								
Tampere	×	×		×			×						×					
Thessaloniki	x	x		x	x								×	×				
Brainport	×		×					×										
Brno	×	×	×			×	×											

4 Methodological approach for large scale pilot evaluation

4.1 Time plan

The most recently updated timeline for the large-scale public pilot phase in SHOW, across all its test sites is presented in the following table. The new-coming test sites (Crest Val de Drome, France replacing former Rennes and Frankfurt replacing Aachen) that are not presented herein pending the formal acceptance of the Amendment 2, will be added in the updated table of the next updated issue of D9.3. In addition, the Brainport and the TRANSDEV operational plans are also under revision, will be stabilised in the next period, and will be presented in the next update of this Del.

Table 7: SHOW updated time plan for final public large-scale pilot phase.

Site	Timeline of Large Scale Public Pilots
France - Rouen – Les Mureaux	September 2022 - November 2023
Germany - Karslruhe	October 2022 - August 2023
Germany - Monheim	January 2022 - August 2023
Spain - Villaverde	March 2023 - June 2023
Spain - Carabanchel	September 2022 - May 2023
Austria - Portshach	May 2022 - September 2022
Austria - Klagenfurt	October 2022 - November 2022 & April 2023 - August 2023
Austria - Graz	September 2022 - September 2023
Austria - Salzburg	October 2022 - June 2023
Sweden – Lindholmen (Gothenburg)	September 2022 - September 2023
Sweden - Linkoping	February 2022 - December 2022
Italy - Turin	September 2022 - February 2023
Greece - Trikala (mob)	January 2023 - June 2023 (passenger) & October 2022 - December 2022 (logistics)
Brno	June 2022 – May 2023 (at least)
Tampere	January 2022 - Spring 2023

4.2 Evaluation framework

The starting point used here is the FESTA framework. The evaluation framework defines the assessment of the automated services that will run at the project test sites, considering the support of the upcoming impact assessment on several layers and, along with them, the simulation based studies that will be performed. A pilot-specific performance indicator framework is used, see the 'V-diagram' in the following figure. Data collections will be done under real-life conditions during the pilots in relation to pre-defined use cases and research questions. The evaluation at the pilot sites in SHOW implements a modified FESTA[2] and Trilateral Impact Assessment Framework

2 https://www.connectedautomateddriving.eu/methodology/festa/ (date: 2022-03-03)

[3]. The following figure shows the adapted version of the FESTA methodology, i.e., the steps that will be carried out during the evaluations in SHOW presented as a V-diagram. The SHOW evaluation framework will focus on the preparation described on the left-hand side of the diagram.

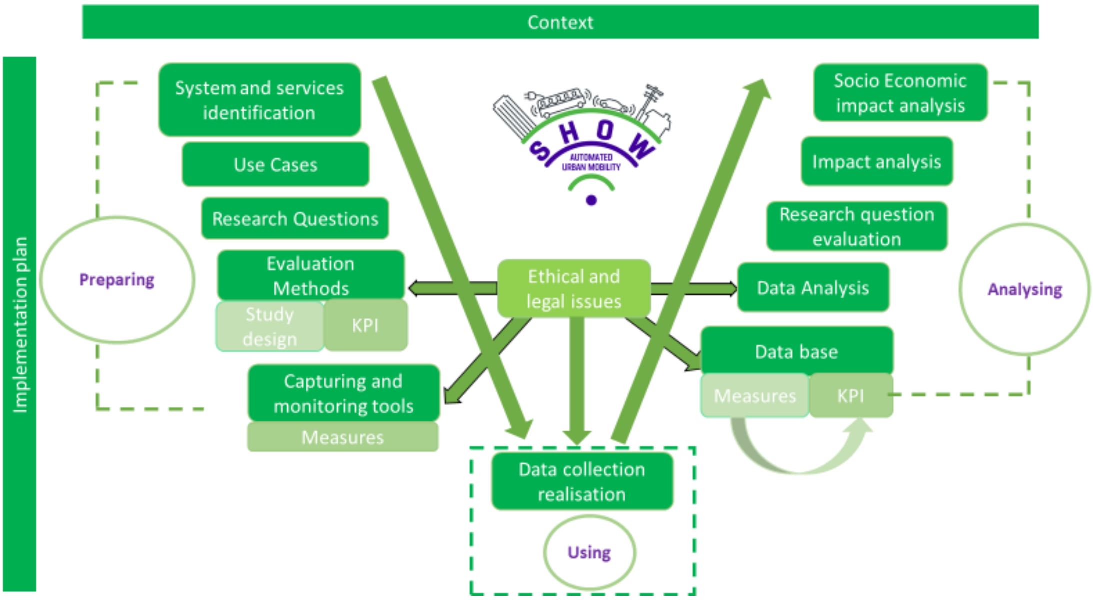


Figure 2: V-diagram modified from the FESTA handbook.

As mentioned above, the SHOW evaluation approach also includes simulations. They are conducted in *WP10 – Operations simulation models' platform and tools.* They cover various kinds of simulations associated with urban mobility (see D10.1: Simulation scenarios and Tools). This includes traffic simulations on different levels, pedestrian simulation, public transport simulation and many other related simulations. Since it is not easy to combine so many different simulation methods under one roof, a classification of simulations was elaborated in WP10, which reflects the focus in SHOW. For more information about the most up to date performed status on simulation studies of SHOW, see *D10.2: Pilot guiding simulation results.*

4.3 Evaluation methods

Before the SHOW pilots (first and second public round) can start, there is a need for technical verification and validation of the systems and functions. The framework for this was defined and developed in *D11.1: Technical Validation Protocol*. The aim was to ensure a satisfying level of robustness, reliability, and safety of all types of vehicles and other key technical ends of the system (communication, cybersecurity, etc.) which are part of the SHOW fleet across the pilot sites, considering the use cases included in the different pilot sites and the related KPIs and their need for measures. The reporting of the technical verification and validation of the SHOW pilot sites systems and functions is done in *D11.2: Demos safety, reliability and robustness validation and commissioning*, for which a first part covering the Linköping, Gothenburg, Tampere

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

and Brainport sites has already been published, while subsequent versions are following for the rest of the test sites (within 2022).

The experimental plans for the final pilot phase have been evaluated in detail across all technical and user experience aspects defined and have been based on the experience gained from the held pre-demo phase (1st pilot phase), the plans of which are provided in D9.2 and the results of which can be found in D11.3 Pre-Demo evaluation activities.

The final open to public pilots will be performed as a part of WP12 activities. All data to cover the KPIs and the needs for simulation will be collected in the WP5 Data Management Platform to support WP10 simulations and WP13 impact assessment. Data may be stored (also) locally at the test sites in addition to the DMP. All project KPIs, either they are processed in the DMP itself, or processed elsewhere, will be finally hosted as values for all test sites and for the project overall in the DMP, as this is the only channel through which data can be visualised in the project Dashboard.

All data collected will be shared across partners and needs to comply with the Ethics and Data Protection Policy defined in *D3.5: SHOW updated Ethics manual & Data Protection Policy and Data Privacy Impact Assessment*. The key data flows have been reported in the Data management plan updates (D14.3) – see more in section 4.9.

For each pilot site, the aim is to provide a clear description of **Why, What** and **How** data collection for evaluation will take place. This is documented in the Experimental Plan for each pilot site, see Appendix 1.

The pilots will run for a specific timeframe at each test site, as shown in section 4.1, and during this timeframe, data collection will take place both continuously and at pre-defined occasions. The study design has its starting point in the use cases, the related common to all research questions (see Chapter 3) and the final list of project KPIs (see Chapter 5).

From an end user perspective, SHOW aims to consider the needs and wants of all citizens, with specific consideration and pilots/use cases planned for specific user clusters, such as tourists, commuters, the elderly, persons with restricted mobility, students and children. For each site, the applicable key stakeholders have been identified.

4.4 Stakeholders

Relevant stakeholders for the SHOW project are in more detail described in D9.2 within the M3ICA methodology. In summary, the identified stakeholder groups are the following:

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

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

- Senders
- Receivers
- Delivery service providers

In Table 8, an overview of stakeholder groups at each test site is presented. Interviews at the sites will take place with representatives from those stakeholder groups identified in the table, excluding the vehicle users, the view of which will be collected using digital survey questionnaires. During the pre-pilot phase, the first interview sessions took place, but also the first data collection using surveys addressed to users. Based on the results an optimisation of survey questions and interview questions took place. In addition, three extra surveys were added, one for VRUs (interacting as road users outside the AV), one for Safety Operators and one addressing evaluation for the logistic services (all annexed in Appendix III of the current Deliverable). Both the updates and the new surveys were translated by partners and integrated in web based survey tool – Netigate – and are already in use by the test sites running their final public large-scale phase.

Table 8: Overview of stakeholders at different pilot sites.

Cities	Passenger mobility stakeholders						Logistics stakeholders		
	Vehicle users	Public interest groups and associations	Decision-making authorities or regulators	Operators	Mobility service providers	Industry	Senders	Receivers	Delivery service providers
Rouen	x	-		x	-	x	-	-	-
Madrid - Villaverde	x	-	x	x	x	x	-	-	-
Madrid- Carabanchel	x	-	-	x	x	x	-	-	-
Graz	x	-	x	x	-	x	-	-	-
Salzburg	x	-	x	x	-	-	-	-	-
Carinthia	x	x	x	x	-	x	-	-	-
Karlsruhe	x		-	x	x	-			-
Monheim	x	x	x	x	x		-	-	-
Linköping	x	-	x	x	x	-	-	-	-
Gothenburg	x		x	X	x	x	-	-	-
Tampere	x	x	x	x	x	x	-	-	-
Turin	x	-	x	x	x	x	-	-	-
Trikala	x	-	x	x	-	-	x	x	x
Brainport, Eindhoven	x	-	x	x	x	x	-	-	-
Brno	x	-	x	x	x	-	-	-	-

4.5 End users

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

The key target end users at each pilot site, without this meaning that other target groups are excluded, are presented in Table 9.

Table 9: Overview of targeted end user at different pilot sites.

Mega site/ Satellites	City	Passengers								
		Commuters	**Residents**	**Students**	**Children/ young adults**	**Elderly**	**Tourist/ Visitor**	**Hospital visitors**	**VRU**	**PRM**
France	Rouen	x		x		x	x			X
Spain	Madrid - Villaverde	x							x	
	Madrid - Carabanchel								x	
Austria	Graz	x	x	x	x	x	x		x	
	Salzburg	x	x				x			
	Carinthia			x			x			x
Germany	Karlsruhe	x	x	x						
	Monheim		x			x	x			x
Sweden	Linköping	x	x	x	x	x				x
	Gothenburg	x		x			x		x	
Finland	Tampere	x*	x	x	x	x	x		x	x
Italy	Turin		x	x		x		x	x	x
Greece	Trikala	x	x	x		x	x		x	
Netherland	Brainport, Eindhoven	x		x			x		x	
Czech Republic	Brno	x		x	x	x	x			***

*Comment: VRU=vulnerable road users such as pedestrians, cyclists, kickboard users etc., PRM=persons with special mobility requirements; * immigrants; *** blind*

4.6 Capturing and Monitoring Tools

In SHOW, various data are captured for different purposes. For various services implemented at the different pilot sites such as traffic management, fleet management or predictive routing as well as for the SHOW dashboard, data need to be captured and transmitted in real-time during operation. These activities are covered in WP4 and WP5, respectively, whereas WP9 and in particular A9.2 are concerned with delivering the necessary data for the impact assessment performed in WP13 and the simulation studies performed in WP10.

In this sense, the capturing and monitoring tools fulfil the purpose to record the data needed to calculate the KPIs (and potential further data that will be progressively recognised) which help answering the different research questions associated with the SHOW use cases, as sketched in the following figure. Be aware of that the UC and the Research Questions are most often clear connected. The test cases in SHOW is the site specific interpretation of the use case.

Figure 3: Connection between research questions, KPIs and capturing/monitoring tools.

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

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

All these mentioned interactions with other activities and work packages within SHOW are depicted in the following figure.

Since the different pilot sites implement different use cases which are related to different research questions and thus KPIs, not all monitoring tools are relevant for all the sites, and not all observations are applicable for all the test sites. The identification of those are closely connected to the outcome of WP11 and WP13, that takes into account the practical implementation of the measurements and their feasibility across the different sites.

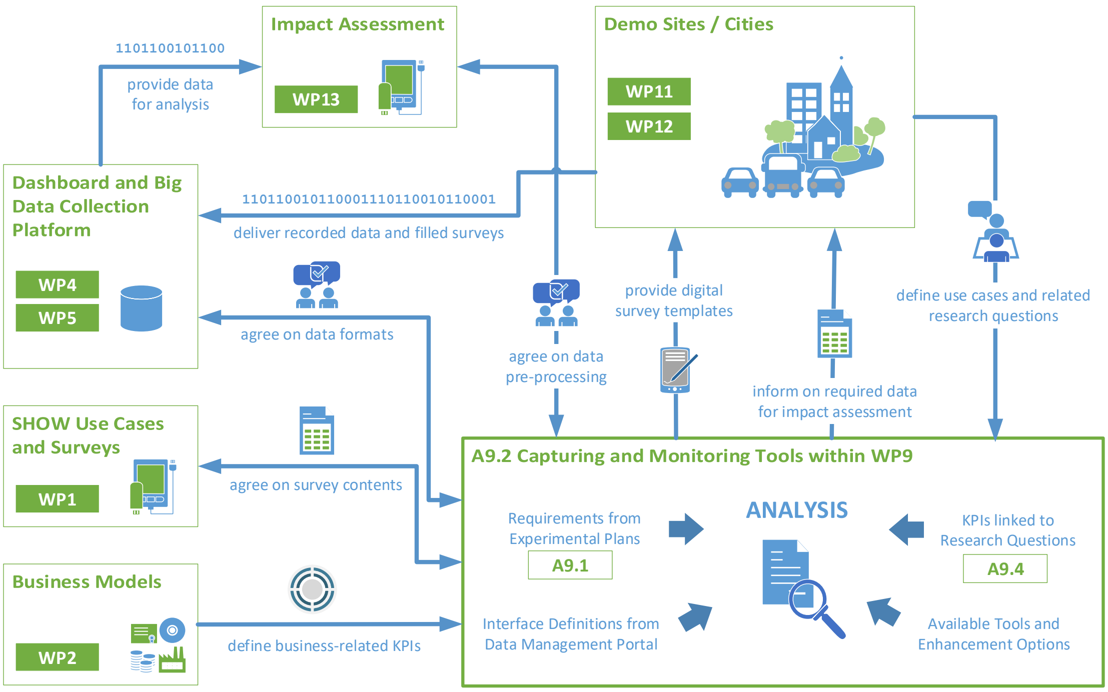


Figure 4: Interactions of A9.2 with other SHOW WPs.

The subjective and objective data analysis tools to be used at the sites are defined and developed in A9.2. The basis for the selection and further development of those tools are the Key Performance Indicators (KPIs) which themselves depend on the different Research Questions (RQs) connected to the use cases which will be implemented at each pilot site. Chapter 5 provides an overview of the impact analysis and the related KPIs. For a more detailed description we refer to D9.2.

The following chapters present the different data collection tools.

4.7 Subjective data

4.7.1 User questionnaires

User questionnaires and stakeholder interviews will be used to collect most of the subjective data. They will focus on experience, usability, user acceptance, trust and socio-economic questions and will be performed by using different questionnaires integrated in a web tool, called Netigate. This tool provides a correct data protection solution and no data is available for others than those with access to the Netigate data through a specific licence with a password restriction. Each site has their own link to be used, with questions translated and adapted to their site. The links to be used by the sites are included in a document on the internal SharePoint in the folder of WP/A9.1 that all sites have access to.

The user questionnaires will be performed with different reasons and at different times depending on its aim. The deliverable *D1.1: Ecosystem actors' needs, wants & priorities & user experience exploration tools* developed the surveys that was later integrated in Netigate. The following table summarises the instruments / tools suggested per user/stakeholder type.

Table 10: Synthesis of survey and interviews targets for the final open to public pilots.

User/ Stakeholder	Method	When	Target	Administration	Tool
Passengers	Acceptance survey	Midterm End	>60 per Site per measure period.	Asked by SHOW pilot personnel entering stops or the AV.	Netigate using QR codes
VRUs	VRU Survey	Midterm End	>40 VRUs per applicable Site/ per measure period.	Asked by SHOW pilot personnel – specifically recruited – tests performed at designated planned topologies.	Netigate using QR codes
Passengers	Satisfaction survey	On-site continuously	As many as possible, but more than 100.	Travellers respond directly in the vehicle (optimally)	Feedback strips or tablets.
Safety drivers	Driver survey	Midterm	All drivers	Given by the operator to the drivers	Netigate using QR codes
Logistic User	Survey	Midterm	Site specific	Given by service provider	Netigate using QR codes
Stakeholders	Interviews	End	Identified key stakeholders	Face to face or using Team, Webex, etc.	Results reported in Netigate

The survey contents are developed in WP1 and WP2, respectively, in cooperation with A9.4 to ensure compliance with all relevant KPIs. The questionnaires have been developed in English and translated by SHOW test sites representatives. The digital questionnaire has been provided to the sites, which are in turn responsible for their administration (and tested and revised during the pre-demo phase as described before).

The user and stakeholders surveys will be performed with different reasons and at different times depending on its aim. The deliverable *D1.1: Ecosystem actors' needs, wants & priorities & user experience exploration tools* developed the surveys that was later integrated in Netigate.

The satisfaction question (one question) will be collected continuously during the final evaluations. Also for this a Netigate link is provided per site, but it can preferably also be collected using a tablet with a GUI with Smileys ranging from Happy to Sad with at least 5 steps. The data should be possible to export into an Excel-format or similar.

The acceptance survey is for whoever gets the experience as a passenger.

The VRU survey will be used in Trikala (Greece), Turin (Italy) and Gothenburg (Sweden) as it concerns dedicated solutions that assume the bilateral interaction with VRUs being outside the vehicle and that need to be specifically recruited for testing specific scenarios (see more in Appendix I). This survey is only for the VRUs that will be specifically recruited to test specific solutions developed that assume interaction with them when they are outside the vehicle, as road users – and, hence, is only applicable for those sites having such solutions

The logistic survey will be used at the site Karlsruhe (Germany), Carinthia (Austria), Trikala (Greece), and the new French site.

4.7.2 Interviews with other Stakeholders

In SHOW 2 occasions with interviews take place. The first one was done in the end of the pre-demo phase and the second one will be done in the end of the final pilots. A template for reporting the results has been prepared in Netigate. Here the sites need to do a first analysis of the result, translate it into English and upload it. The interview grid can be found in Appendix III.

4.7.3 User engagement

The overall objective of A9.3, as a horizontal task within SHOW, is to support the SHOW pilot sites in reaching out to end-users and other stakeholders and to guide and monitor their engagement plans and efforts.

As part of A9.3, Ideathons and Hackathons will be organized, to recognize gaps and collect solution-oriented ideas to improve the services proposed by SHOW. A first (not pilot-specific) Ideathon has been organised on 15 January 2021 (see D9.2) and a first Hackathon took place in Thessaloniki on 21-23 March 2022 (a full report will be included in D9.4).

In addition to these dedicated activities, the *Framework and guidelines for a successful stakeholder engagement process* developed within A9.3 support the sites in developing their own customized engagement strategy and plan, adapted to the local context and taking into account the specificities of each pilot site, covering the following topics:

- Identifying the stakeholders and end-users
- Communication channels and tools
- Engagement with stakeholders and end-users
- Incentivisation and nudging strategies
- How to recruit participants for the acceptance surveys.

In D9.2, the *Framework and Guidelines* are described in more detail. The pilots' engagement strategies are conceived as 'living documents', to be updated regularly as the project progresses. D9.4 (due in M42 (June 2023) of the SHOW project) will provide a complete overview of all sites' efforts in terms of user and stakeholder engagement.

4.8 Observed data

Observations will target user behaviour and system performance taking into account the accurate circumstances in which the transportation takes place. The operators of the sites capture data from the vehicles'/infrastructure sensors and from external sources. The format of the data could be a JSON message, a CSV file or video recordings from the respective sensor, e.g. Lidar, Radar etc. Where direct measurements are not possible, estimations will be performed instead.

- The pilot sites are provided with SHOW Data Registry that includes the data attributes that must be collected for the needs of project. The data attributes are utilized for the calculation of the respective KPIs, the implementation of state-of-the-art services during the project and the impact assessment. The sites' KPIs are given in Table 13. The measures needed to calculate them are presented in Table 12.

- The data is collected in the SHOW Data Management Platform. The SHOW DMP consists of two main mechanisms; the MQTT-broker and the CKAN platform. The MQTT-broker is the dedicated mechanism for the real-time connection. The only required actions are the utilization of the certificates for every site and the alignment with the JSON format message. The CKAN platform is used for the collection of the historical data. The only required actions are the registration in the platform and the alignment with the CSV format.
- How these quantities are assessed is left open to the pilot site owners, thus allowing for maximum operational flexibility while still maintaining a high degree of data quality and minimizing technical efforts at the sites. As an example, the number of passengers during a ride could be assessed through AI methods analysing the video stream from an in-cabin camera or be estimated based on the current vehicle weight or counted manually by an operator with a tally list.
- Among the main contributions from A9.2 is the definition of calculation methods which yield the KPIs required for the Impact Assessment in WP13 based on these recorded data. These methods are harmonized with the requirements and expectations from the respective work packages which will analyse the data later.

4.8.1 Situational Variables

In addition to these continuously measured variables, several situational variables will help in interpreting the measurement data, see Table 11.

Table 11: Preliminary list of situational variables.

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

4.9 Realisation of data acquisition - Final Evaluations

In D9.2 (Chapter 8), a detailed description was given about the steps to take toward realisation of data acquisition. In the following text, a shorter version is given as a reminder.

4.9.1 The procedure

The information and test results from final evaluation will be assessed and reviewed within WP12. The Pre-pilot evaluations were considered as a rehearsal for the final evaluations and thanks to this, the work expected during the final evaluations should be well known by the sites. For more information of the pre-pilot, we refer to D9.2. In general, the approach for pre-demo evaluation at all sites was common and consisted of the following steps:

1. Obtaining permissions for AV operation and data collection.
2. Preparation of the site's physical and digital infrastructure, including SHOW dashboard.
3. Implementation of the specific test cases at each site based on the use cases as defined in D1.2.
4. Technical verification, including iterative revisions and optimisation as defined in WP11.
5. Preparation of the capturing and monitoring tools for measurements related to performance KPIs as defined in chapter 8.
6. Pre-demo data collection activities according to the site-specific experimental plans (of D9.2).
7. Storage and transfer of raw and observation data according to the procedures described in D5.1 and in order to accommodate the KPIs defined (see more in Chapter 5).
8. Adjustment of procedures for the full demonstration/pilots based on the results of the pre-demo evaluations.

For the final evaluations at the sites, the following additional steps will be taken:

1. Before start of final evaluation, the ethical checklist will be signed and upload internally to the project.
2. Distribution of Netigate links for Satisfaction, Acceptance and Safety drivers surveys. In addition the Netigate links to relevant sites dealing with VRU services and/or logistic service
3. Mid and in the end of the Pilot collect relevant number of answer on all surveys (see Table 10).
4. Perform interviews in native language with the stakeholders identified in Chapter 2. Summarise the main results, translate into English and upload using the dedicated Netigate links.
5. Write the site-specific deliverable (D12.2 – D12.8 that are the site specific Demonstrators with internal deliverables).

Observational data from the final evaluations will be collected and managed by the Big Data Collection Platform and Data Management Portal (DMP) developed in A5.1. In the DMP the identified KPIs will be calculated and further sent to the Dashboard for visualisation (WP4).

4.9.2 Roles and responsibilities

To make the pilots 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 pilot site has a denoted leader and a city or operator representative.

Each pilot 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.

There is no mandatory definition of roles and responsibilities in setting up the SHOW pilot site, but it is important to define at least who oversees the different aspects. See D9.2 chapter 8, for a detailed description of all steps to take before the pre-pilot could start.

4.9.3 Ethics

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

SHOW Updated Ethics Manual, *D3.5: Final SHOW Ethics Manual, Data Protection Policy and Data Privacy Impact Assessment* constitutes the Ethics Code of Conduct of Research and it aims to be a reference and living document throughout the whole duration of the project with respect to ethical issues and protection of any type of data collected during the lifetime of the project. An Ethics Controlling process, as defined in D3.5 Final SHOW Ethics manual, Data Protection Policy and Data Privacy Impact Assessment, will be applied prior and after each evaluation phase, with each test site to ensure compliance with the SHOW ethics of conduct. The a priori part has been already reported in D3.5. The final controlling report will be reported in D14.3 DMP – final version.

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.

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 General Data Protection Regulation (GDPR) 2016/679 are 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, More details are find in D3.5 Final SHOW Ethics manual, Data Protection Policy and Data Privay Impact.

Data collection during pilots in SHOW will be conducted in 17 cities across Europe across during both phases of pilots (pre-demo and final demo phase). The Informed Consent mechanisms are discussed in D3.5, 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 involved in the evaluation will be informed they are going to be part of the evaluation 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 (one person) from the test sites. The name of the persons and their contact information has been already identified and will be continuously updated.

In D3.5, the structure of the ethical procedures to guarantee a sound and correct ethical treatment of human participants are described together with the DPIA. The document is aligned with the two pre-defined ethic requirements asked by the European Commission to be written for SHOW, Requirement No. 1 and Requirement No. 3, that also need to be regarded.

4.9.4 Data and information exchange

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

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

For the transfer of data collected at the pilot sites to the SHOW Big Data Collection Platform and Data Management Portal, two alternative dataflows co-exist and both alternatives can be present in one demo site. A description of the key clusters of data and how this will be handled and communicated is included *in D4.3: Open modular system architecture and tools - second version*. The two main alternatives for the data flow will be: 1) directly from the fleet to SHOW platform (fewer pilot sites) 2) fleet to private cloud and then to SHOW cloud (majority of pilot sites). In the following Figure, the two alternative data flows and the location of logger components are visualized. The sites can have a complementary approach where some of the data are stored in a private cloud for example at the OEM and then shared towards SHOW platform and some other data, not available from OEMs, are directly sent from the fleet to the SHOW cloud data platform via dedicated in-vehicle APIs developed for SHOW purposes.

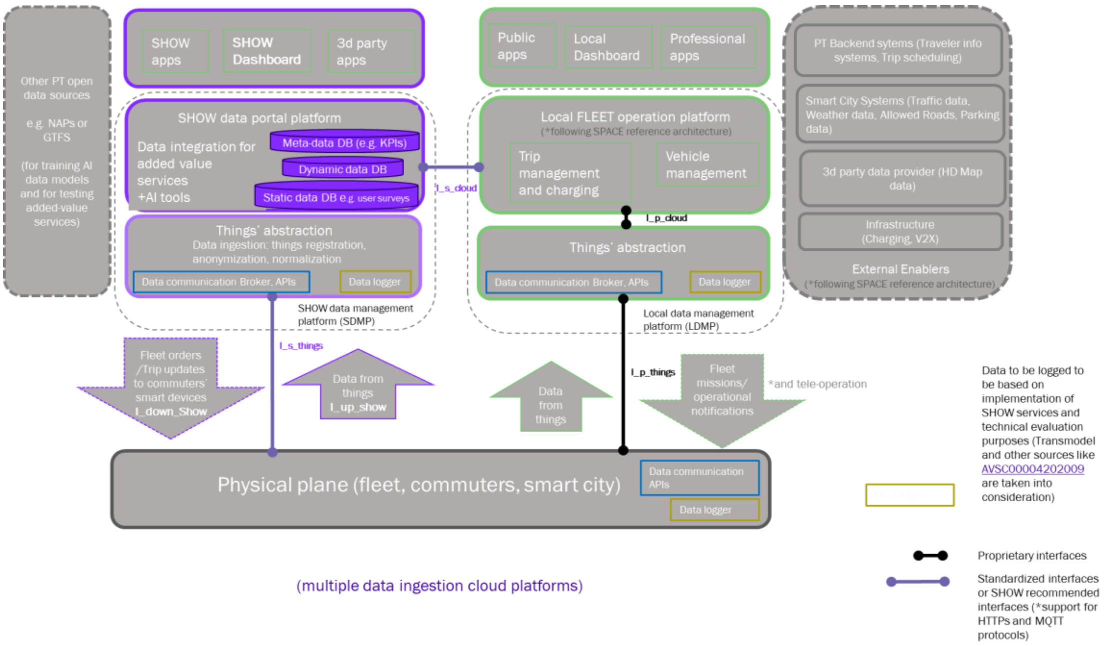


Figure 5: Current version of the SHOW system architecture diagram, as described in D4.1/D4.3.

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

Descriptions of all data generated in the project and details about how it will be exploited or made accessible for verification and re-use, and how it will be curated and preserved are defined in the Data management plan of the project and the latest Ethics Manual update (D14.2, D14.3 & D3.5).

4.9.5 Data analysis

The pre-pilot was aimed to be a 'rehearsal' to make sure that the data collection and the process for data upload worked, but also to check that the data collected are good enough to calculate the defined KPIs. Based on that, the final updated data analysis for final pilots is described below.

4.9.5.1 Type of data and how to avoid bias

As aforementioned, in SHOW, data in relation to **observations** (quantitative measure collected from the vehicles and services while running) are collected continuously and not as a sample. They are uploaded in real-time to the DMP or at least off-line upon a standard frequency. For the observations, the risk of bias is hence not in general high since data collections are done continuously on technical systems.

Again, for the **subjective data** there will be surveys to end-users and interviews with stakeholders. Those have been tested and revised during the pre-pilot period and the final optimised ones are provided in Appendix III of the current Deliverable.

4.9.5.2 Analysis

The consolidation of the results from each site will be done in A12.8 and reported in *D12.9: Real life demonstrations pilot data collection and results consolidation.* In addition, each site will provide an interpretation of the results and integrate those in a site-specific evaluation report. An analysis guideline and tool (spreadsheet) have been developed to make sure it is clear how the analysis should be done and what type of results the sites can expect to achieve. The centralised analysis – for the results collected from the pre-demo phase - will be done by BAX & VEDECOM (Pre-Acceptance survey), VUB, EUROMOBILITA (Acceptance survey), AVL the (Satisfaction survey), CTL (Stakeholder interviews and Logistics related results) and finally IDIADA will do the cross-analysis of subjective and performance data. CERTH/HIT, DLR and VTI will be reviewing the full analysis work to be conducted in the project for the pre-demo phase, whilst VTT will be reviewing the results analysis corresponding to the final demo phase.

First, we check the completion rates of the surveys to ensure that they match the expected rates per site, then a check of the logic and consistency of the responses is done. The guidelines include descriptive statistics of the survey responses. In the acceptance survey, descriptive statistics are calculated for each aspect of acceptance (satisfaction, usefulness, ease of use…), as well as for the overall acceptance score. We can thus analyse the acceptance by looking at the specific factors, also looking at associations with different socio-demographic factors (education, geographical area…).

Concerning the pilot sites measurements and the simulation outputs, the partners in WP13 conducting the impact assessments using these data points will conduct analysis of the data tailored to their assessment methodology. While data preparation will differ across the different impact assessment areas (signals vary in data type, frequency, format etc.), for all, descriptive analysis will be conducted, preceded by data cleaning. As the data may not be complete and consistent across all the pilot sites, a deep exploration of the data to identify missing, incorrect, or inaccurate values in the dataset is needed. An important step here is also evaluating the consistency in terms of format and aggregation level of the data across the pilot sites to ensure comparability. In addition, there could be outlier values which could skew the analysis that must be dealt with. Outliers may be easily identifiable as measurement errors, while others may be unexpected correct measurements.

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

To launch the preliminary assessment of automated logistics service acceptance, a pre-acceptance survey has been created for target groups of "citizens (ordinary users)" and "clients (subscribed/frequent users)" to highlight their prior automated logistics acceptance level, concerns, and possible development approaches of automated logistic service. To do that, a preliminary statistical analysis will be applied considering regression and correlation analysis, means-medians-standard deviations for response analysis considering also variances, and before-after comparison assessment (when an after-implementation survey will be performed). Before accomplishing the preliminary statistical analysis, the data set will be checked and cleared to avoid any unnecessary or useless responses (for example, the response cannot be considered if the respondent doesn't answer all significant/mandatory questions). Furthermore, in the frames of a pre-acceptance survey, the logistics pre-acceptance questionnaire will be executed in various European countries followed by a country-based acceptance analysis. Consequently, factors that are affecting acceptance, and variables/parameters that are more crucial or valuable regarding users' perspectives will be assessed. All the analysis for the preliminary assessment of automated logistics acceptance will be performed using a quantitative data set (responses will be quantified using the Likert Scale (1-5 scale) to unify them in a common form to be utilized for the acceptance evaluation) which is to be also checked and cleared. Moreover, the preliminary assessment will comprise socio-demographic characteristics of examined countries to study levels of automated logistics acceptance.

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

5 Final Impact Assessment Framework

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

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

The correspondence between the above impact areas and the holistic impact assessment performed in A13.6 but also to the WP10 simulations is illustrated in the following figure.

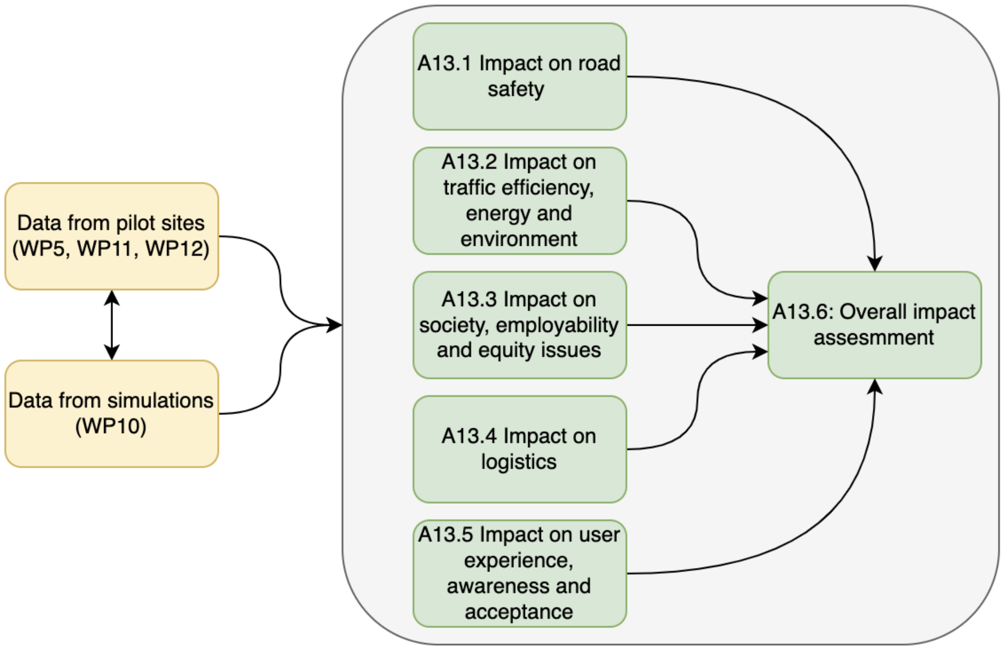


Figure 6: WP13 activities that perform specific and an overall impact assessment.

We focus here on the overall impact assessment as it will be tested with pre demonstration data. The detailed descriptions of the specific impact assessment methodologies can be found in D9.2 and in much more depth, they will follow in the WP13 corresponding Deliverables.

5.1 Overall impact assessment framework

The goal of the holistic impact assessment framework is to assess the impacts of automation in different scenarios (as described later) by stakeholder analysis, as well as data-driven measurements based on pilots and simulations. For this purpose, we introduce the M3ICA framework which brings together these different components.

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

1. Stakeholders (or actors) are identified (1a), and AV service impact criteria are defined (1b) which are in turn weighed by the relevant stakeholders (1c).
2. Autonomous mobility service scenarios are defined based on pilots.
3. Based on literature of AV deployment impacts, key criteria and their respective KPIs can be ordered in terms of their deployment effects.
4. Relevant project pilots and simulations are identified and mapped to the scenarios. This enables the definition of KPIs that can be collected in the next step.
5. KPIs are defined within the different impact criteria in accordance with pilot sites and simulations.
6. The overall analysis is conducted that allows a comparison of the scenarios in relation to impact criteria and KPIs from demo-sites and simulations. Results can be enhanced by conducting a sensitivity analysis if sufficient data is available.

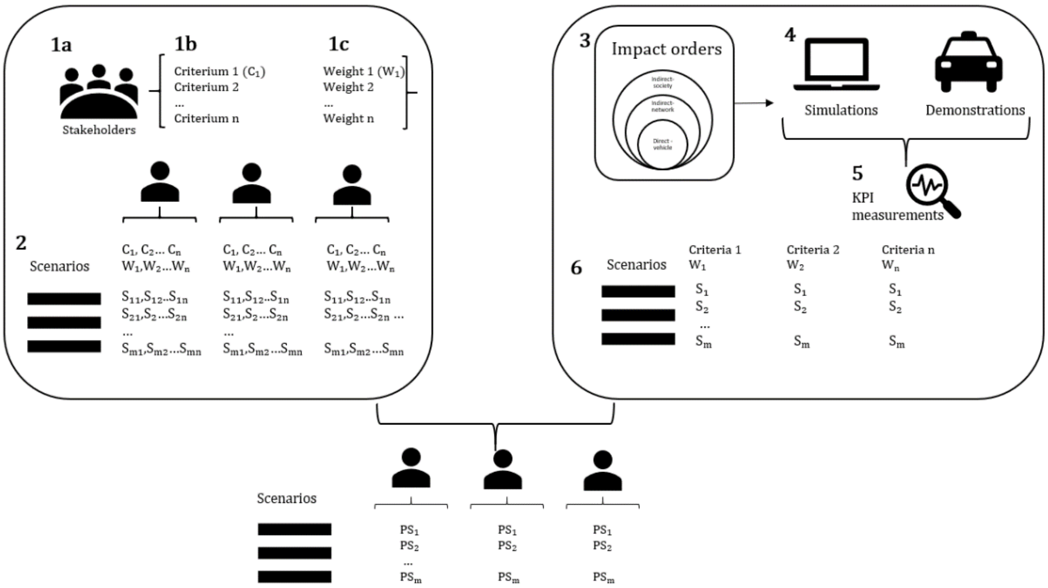


Figure 7: The M3ICA methodology incorporating the pre- and real-life pilot evaluation framework.

The first two steps of the M3ICA methodology are founded on the Multi-Actor Multi-Criteria Analysis (MAMCA), which forms the basis of the stakeholder evaluation. The MAMCA is an approach in which stakeholders are involved from the beginning of the entire exercise, there is no need to achieve a consensus among stakeholders, and results are more transparent, allowing for meaningful discussion (Lebeau et al., 2018; Macharis et al., 2009, 2012; Milan et al., 2015; Sun et al., 2015).

The scenarios identified to cover the pilot sites are presented in the following table.

Table 12: Proposed M3ICA scenarios in relation to pilot sites (as of 31/03/2022).

M3ICA scenario	SHOW Demo-sites
Driverless shuttle as feeder to PT	**Linköping:** Feeder service to PT trunk line, AV pods for first/last mile for children between a school and PT **Gothenburg:** Connection between the PT network from the bus station and a remote parking lost **Graz:** Suburban train station to shopping centre; **Salzburg:** Connection of peri-urban area to city centre **Carinthia:** DRT connection from PT to city (both Klagenfurt and Pörtschach) **Monheim:** PT shuttle connection between the old town and the new health campus to the PT system **Trikala:** DRT shuttle service on a fixed route between suburbs and city centre feeder to train station and PT **Tampere:** Fixed route feeder services from suburban residential area to the tramline **Turin:** DRT connection from PT to the hospital district
Point-to-point services	**Rouen-Les Mureaux:** Shuttle service transporting employees and guests inside large campus
Mass transit with driverless buses	**Madrid:** Minibuses connecting new automated PT (bus) to metro station. Bus operations and platooning in depot **Brno**: Shuttle service on a fixed route in the historic part of the city and in other areas
Shared on-demand Robotaxis	**Madrid:** 2 MaaS cars to supplement automated PT/DRT; **Graz:** 2 passenger cars for connection to PT and shopping centre **Trikala:** 2 MaaS car fleet on a fixed route to supplement automated DRT **Brainport:** 3 robotaxis (in a closed test environment) – to be revisited **Brno**: 1 robo-taxi for long distance commuting and interface to DRT **Karlsruhe**: automated vehicle with remote supervision and remote control in case of critical situations

5.2 KPI List and Measurement Channels

The list of key performance indicators to be measured in the project has been finalized and can be found in Appendix IV. It is an update of the list initially presented in *D9.2 Pilot Experimental plans, KPIs definition & impact assessment framework for pre-demo evaluations* based on feedback received on the deliverable, as well as further work in-between to refine the KPI definitions in collaboration with other SHOW partners. Any emerging updates will be reported in the subsequent version of this Deliverable.

5.3 Validation of impact assessment

As presented in section 5.1, the overall impact assessment is conducted over two stages. The first being the stakeholder assessment through a MAMCA workshop. The second is quantitative assessment of the measured KPIs and further aggregation using the results of said MAMCA workshop. To validate this method, we applied it in the Linköping site, in which pre-pilots have been completed. Due to the unavailability of all the measured KPIs, the second part of the overall impact assessment could not be conducted.

5.3.1 MAMCA Workshop Organization

5.3.1.1 Stakeholder Group Identification

Each pilot site leader must identify representatives of each stakeholder group. Within the definition of the M3ICA framework, the most relevant stakeholder groups were identified and presented already in section 4.4.

Depending on the applications within the site, a passenger mobility or logistic workshop will be organized, and the corresponding stakeholders will be invited by the site leaders. The stakeholder groups are identified for each site, and ideally, for each stakeholder group, 2 to 5 representatives should be invited to in order to have rich and meaningful group discussions.

The local pilot sites will take over the responsibility of contacting and inviting the stakeholder groups, preferably in the local language. The pilot sites are free to use any means they would prefer to do so, but they are provided with email templates, should they like to use them, which they can translate in the local language.

As for the workshop itself, it will be held in English, therefore it would be ideal if the stakeholder representatives understand and speak sufficient English to follow along in the workshop. Nonetheless, the individual stakeholder groups discussions in the break-out sessions can be conducted in the native language of the participants.

5.3.1.2 Practical Organization of the 1st phase

The workshop was organized by the team in charge of conducting the overall impact assessment (the VUB team). While such workshops have generally been conducted physically, the current Covid-19 situation does not guarantee this would be possible in all sites. For that, the organization of the workshop has been adjusted to be feasible virtually as well.

In case face-to-face workshops are possible, the organizers, who are part of the team conducting the impact assessment, will go to the site and meet with the stakeholders. The same procedure applies, only with physical break-out sessions. MAMCA software tool will still be used to capture the criteria weights and performance scores.

Moderators are not a much of a necessity in a face-to-face setting, as the organizing team can take up some of the responsibility of entering the scores to the MAMCA software tool. However, the preference to have the breakout sessions in the local language might require the involvement of one moderator provided by the pilot site for assistance. This matter remains to be discussed and decided on a pilot site basis, depending on preferences and availability of resources.

In the context of SHOW and its sites, the following outline is expected for the workshop:

1. Short introduction and overview of the scenarios
    - Introduction to the SHOW project and local pilots objectives
    - Brief explanation of the MAMCA approach for stakeholder involvement
    - Overview and description of the scenarios for mobility and logistics
2. Scoring the importance of the criteria
    - Brief group discussion on criteria importance for the stakeholder group

- Confirmation of importance scores for each criterion on a 100-scale in MAMCA tool
- Brief group discussion of criteria weights (calculated by the MAMCA tool)

3. Evaluating the scenarios
   - Brief group discussion on the performance of a scenario in term of the stakeholder criteria.
   - Assignment of a performance score (from 1 to 10) for every scenario for each criterium (SMART evaluation method in MAMCA tool).
4. Wrap-up
   - Collective discussion of the results per stakeholder group and the overall ranking of the scenarios across stakeholder groups.
5. Review
   - Review meeting with the pilot site, moderators, and organizing team to discuss the process
   - A post-workshop survey will be distributed to stakeholder group representatives to give their opinions on how the process went and how to improve it.

5.3.2 Pilot MAMCA Workshop in Linköping

A pilot workshop was planned and conducted in the Linkoping pilot site in order to test the methodology with stakeholders and improve the content and process.

5.3.2.1 Preparation

The stakeholders at the Linköping site were invited to the workshop by the organisational leader of the test site. In the specific context of Linköping, land owners and researchers were considered as additional stakeholders, as they are both part of the core working group in the site and are thus significantly involved in the pilot site organization and activities. The following stakeholder groups are invited to participate:

- Decision-making authorities or regulators
- Public transport operators
- Mobility service providers
- Land owners
- Researchers
- Vehicle users

One representative per stakeholder group was invited to create an account on the MAMCA online tool in which the weights and scores will be computed. The stakeholders are confronted with the scenarios and criteria.

Then, each stakeholder group is asked to assign an importance weight to each criteria using a scale rating (see the following figure).

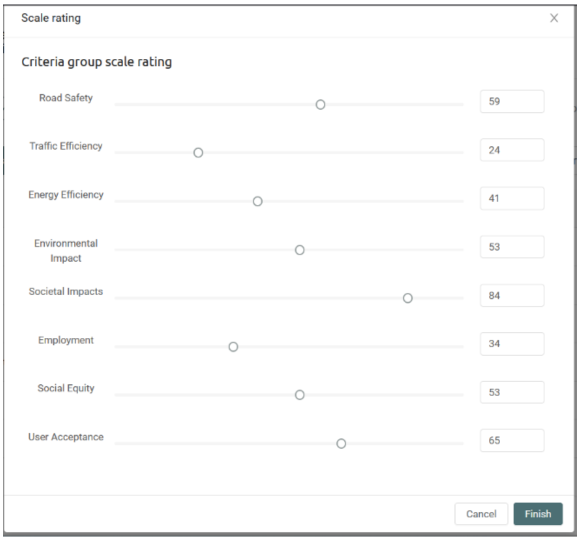


Figure 8: Criteria Weight Scale Rating (MAMCA Online Tool).

After assigning an importance weight to each criterion, the stakeholders evaluate the performance of each scenario under each criteria by assigning a score on a 10-scale (see the following figure. The workshop was conducted prior to a modification in the scenarios, the final list of scenarios with the corresponding pilot sites can be seen above in Table 12.

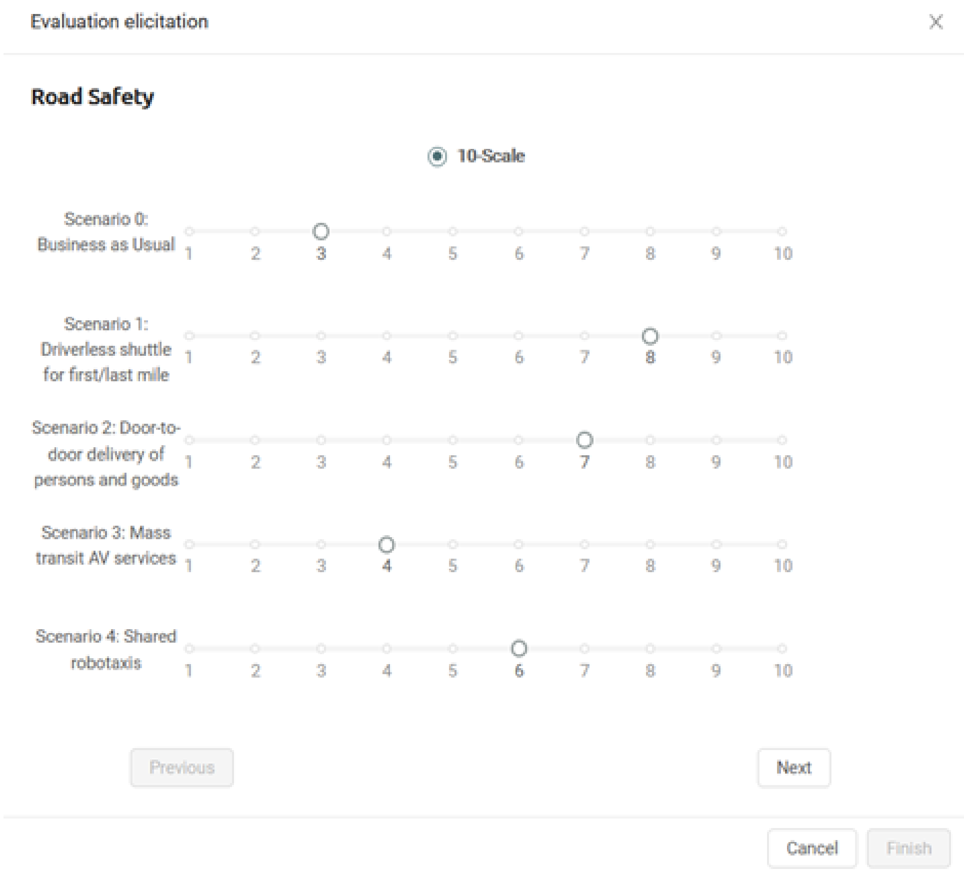
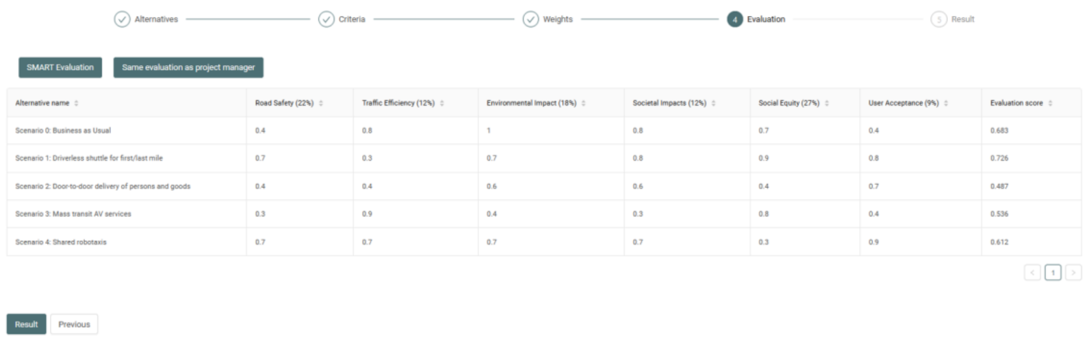


Figure 9: Scenario Criteria Performance Scale Rating (MAMCA Online Tool).

After the stakeholder completes scoring all scenarios in all criteria, the aggregated score for each scenario is calculated, and the results can be visualized in a table, or in a graph in the result tab.



Alternative name	Road Safety (22%)	Traffic Efficiency (12%)	Environmental Impact (18%)	Societal Impacts (12%)	Social Equity (27%)	User Acceptance (9%)	Evaluation score
Scenario 0: Business as Usual	0.4	0.8	1	0.8	0.7	0.4	0.683
Scenario 1: Driverless shuttle for first/last mile	0.7	0.3	0.7	0.8	0.9	0.8	0.726
Scenario 2: Door-to-door delivery of persons and goods	0.4	0.4	0.6	0.6	0.4	0.7	0.487
Scenario 3: Mass transit AV services	0.3	0.9	0.4	0.3	0.8	0.4	0.536
Scenario 4: Shared robotaxis	0.7	0.7	0.7	0.7	0.3	0.9	0.612

Figure 10: Result Table of a Stakeholder in the MAMCA Online Tool.

Once this process is completed by all stakeholders, they return to the main room and the resulting graph with all the resulting performance scores are presented and discussed.

5.3.2.2 Results

The workshop was conducted in a hybrid format with 7 participants in person and 4 participants virtually. In the specific context of Linköping, land owners and researchers were considered as additional stakeholders, as they were both significantly involved in the pilot site organization. It must be noted that some researchers were used as proxy for vehicle users. As users could not be included in the workshop, researchers have been asked to represent their perspective. As they were involved in acceptance studies and user engagement work with users, researchers are informed representatives. Representatives of the industry (OEMs) could not be involved in the workshop.

- **Vehicle users**: 2 representatives from VTI
- **Local authorities/regulators**: 2 representatives from Region Östergötland and the city of Linköping
- **Public Transport Operators**: 2 representatives from Transdev
- **Mobility service provider**: 1 representative from RISE
- **Land owners**: 2 representative from the Linköping University campus
- **Researchers**: 2 representatives from VTI

Not all criteria applied for all stakeholders, so a filtering was conducted before the workshop based on the objectives of each stakeholder interests and knowledge. The table below shows the selected criteria-stakeholder matching.

Table 13: Stakeholders and Criteria Matching

Impact areas	Users	PTOs	Local Authorities	OEMs	MSPs	Land owners	Researchers
Road safety	X	X	X	X		X	X
Traffic efficiency	X	X	X	X	X	X	X
Energy efficiency		X	X	X	X	X	X
Environmental impact	X	X	X	X		X	X

Impact areas	Users	PTOs	Local Authorities	OEMs	MSPs	Land owners	Researchers
Societal impacts	X	X	X	X	X	X	X
Employment		X	X	X	X	X	X
Social equity	X		X			X	X
User acceptance	X	X	X	X	X	X	X

5.3.3 Insights from Workshop

The overall result of the workshop shows a generally positive view of the autonomous scenarios. The evaluation largely reflects the priorities and objectives of each stakeholder, as mass AV transit is evaluated most highly by public authorities, researchers and PTOs, while the shared robotaxis scenario is rated most highly by mobility service providers and vehicle users. While public transport operators have given the highest rating to a single scenario, most scenarios scores are around an average 0.4-0.6 range. No single preferred scenario across the stakeholder groups emerges, but we see comparable evaluations. Vehicle users and mobility service providers have a comparable assessment of automation scenarios, with shared robotaxis as the preferred alternative for both, though vehicle users are also partial to door-to-door delivery of goods and persons. For the researchers, however, the scenarios were close in scores, with only mass AV transit emerging as a preferred scenario, and BAU as the lowest scored. The BAU scenario reflects the current traffic system with non-automated passenger cars and non-automated public transport services.

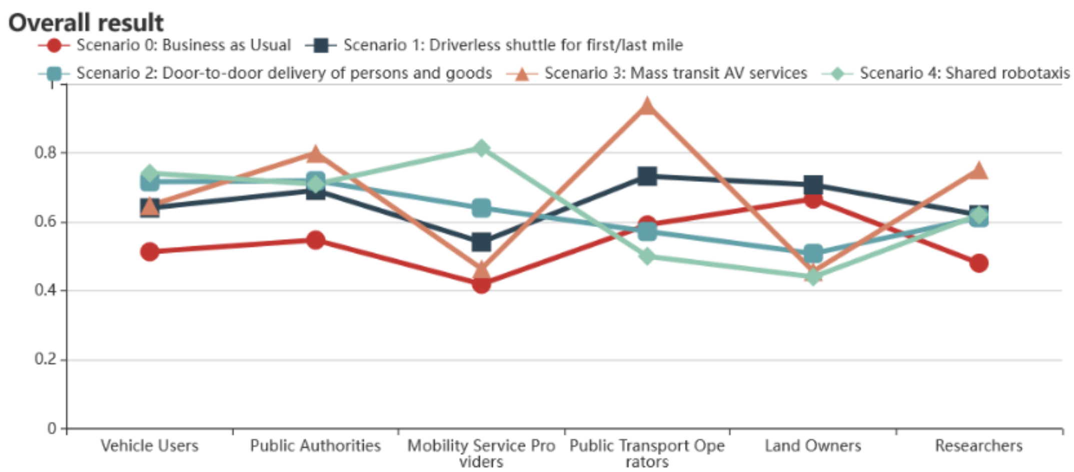


Figure 11: Overall MAMCA Result.

Taking a deeper look into the specific stakeholder, we see that the vehicle users consider road safety and user acceptance as the most important criteria, with interestingly less interest for societal and environmental concerns.

Overall, all automation scenarios are rated higher than the BAU (Business As Usual) scenario, with the exception of driverless shuttles in the road safety and traffic efficiency criteria. Robotaxis and door-to-door delivery are the highest rated scenarios. When discussing the user acceptance evaluation, representatives of vehicle users mentioned that flexibility in mobility was considered the most important factor in determining how they perceive automation solutions. Thus, their evaluation favoured robotaxis and door-to-door delivery, which offer more freedom and flexibility for users in comparison to mass AV transit and the BAU scenario.

Overall, the general perception from users is that automation in all its forms will have positive impacts on all criteria, with a general preference for robotaxis and door-to-door delivery.

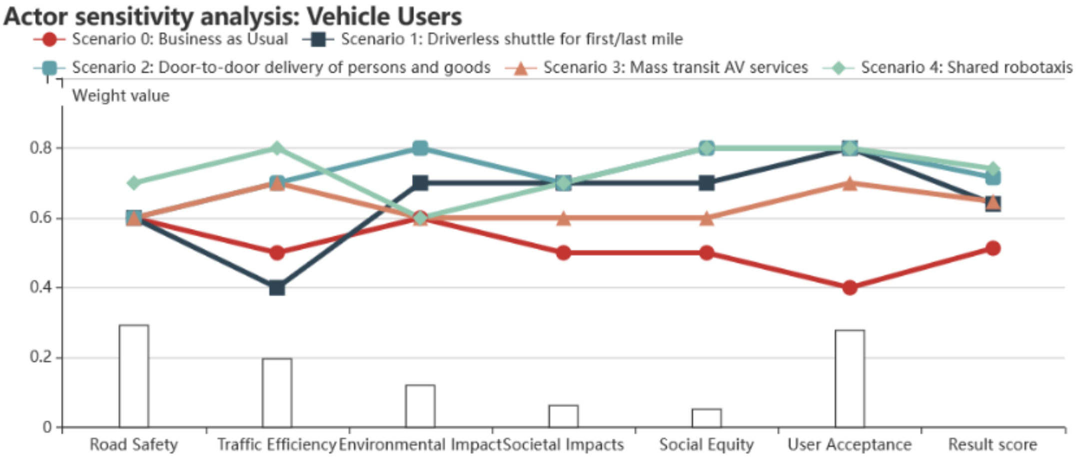


Figure 12: Vehicle Users Evaluation.

Public authorities consider road safety most important, followed by traffic efficiency and user acceptance. The remaining criteria, aside from employment, are weighted nearly equally.

All alternatives are perceived positively in comparison with the BAU scenario, which is rated the lowest across most criteria. Mass AV transit emerges as the most highly rated alternative, as it scores consistently across most criteria, but especially the ones with the highest assigned importance weights (road safety, traffic efficiency). From their perspective, mass AV transit is the closest to existing modes of transport, thus, is easier to regulate than other modes, which could bring a more significant disruption to urban transport.

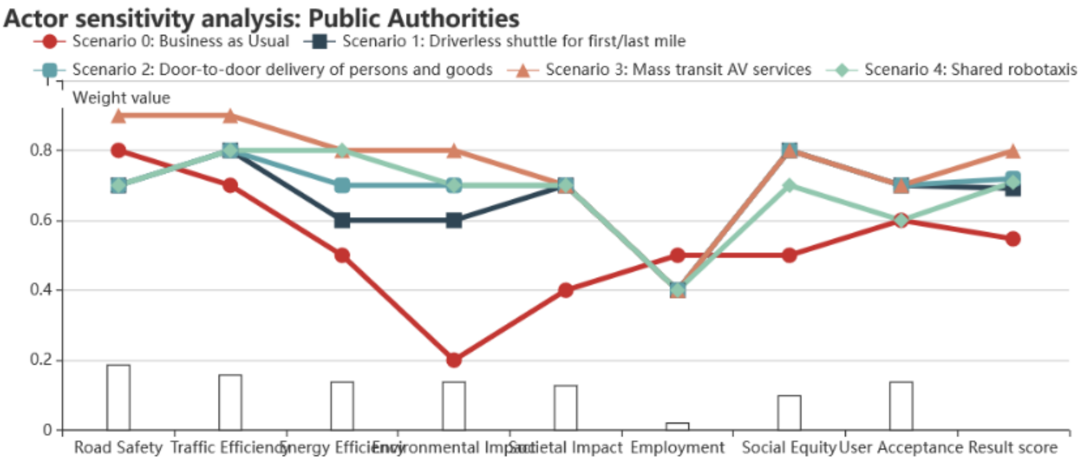


Figure 13: Public Authorities Evaluation.

Mobility service providers weigh user acceptance the highest, followed by traffic efficiency and energy efficiency.

The shared robotaxis scenario was rated the best performing scenario, with a perfect score in societal impact and user acceptance. During the discussion, the representative of mobility service providers reported that flexibility for users, as was mentioned by the users' group, is an important factor. The important thing for is to have the best product for users, and the most convenient in terms of flexibility, location, options for private transport or limited sharing. Thus, they considered that robotaxis and door-to-door delivery would provide more freedom and comfort in travel, and thus perform best in criteria like user acceptance and societal impact.

While BAU was considered the worst performing option, mass AV transit was not rated significantly higher.

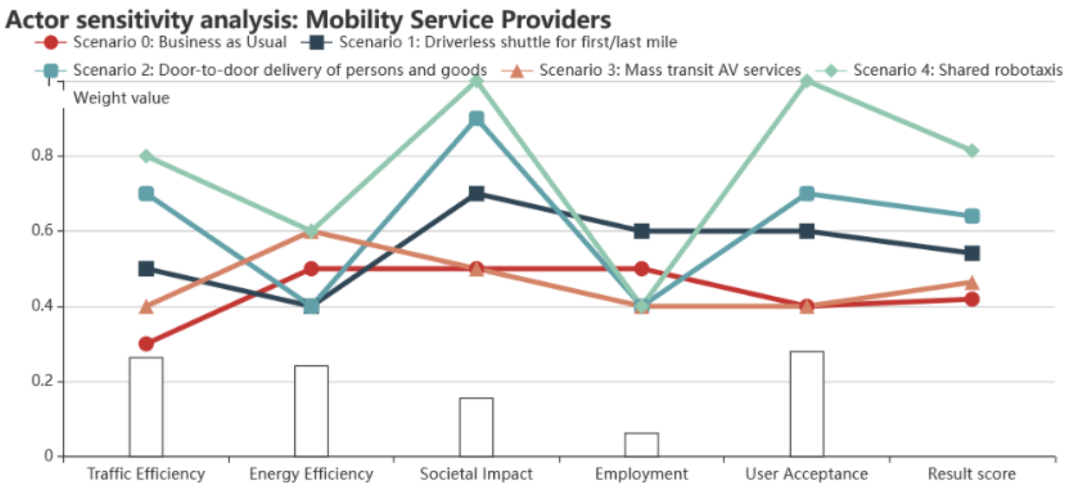


Figure 14: Mobility Service Providers Evaluation.

The transport operators consider road safety the most important criteria, followed by traffic efficiency and societal impacts.

Public transport operators had a clear preference for automating traditionally shared modes, especially mass transit. They consider they have a wider range of concerns beyond the commercial ones of mobility service providers, and find that shared automated modes are the ones that achieve their objectives best. Of these, mass AV transit is considered to perform best across all criteria, followed with driverless shuttles for first/last mile. Robotaxis and door-to-door delivery do not offer a traditionally shared service, thus they are not rated very highly by the PTOs, even rating lower than BAU. During the discussion, the PTO representatives emphasized that while they do think mobility is about having a mix in available modes, automating shared public transport services is, in their opinion, the preferred path.

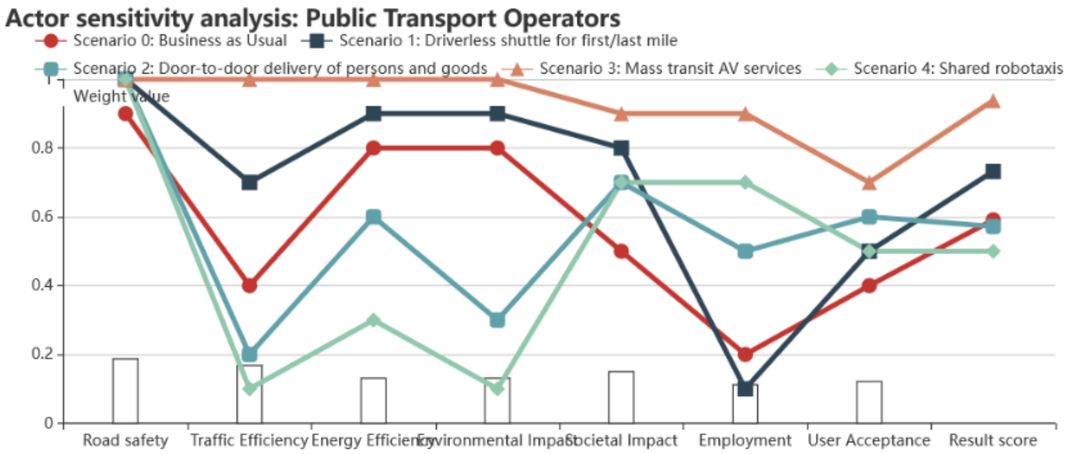


Figure 15: Public Transport Operators Evaluation.

Land owners considered road safety and environmental impacts most important for their objectives, followed by social equity. Societal impact and employment were not considered significantly important for them. As for the scenarios, driverless shuttles for first/last mile emerged as the most preferred option, but the land owners had largely positive views of the current BAU scenario. In the discussion, they mentioned that their area of responsibility (the campus area) mostly has bicycle traffic, and that is their reference scenario. As a result, they have not rated robotaxis and mass AV transit highly, but considered driverless shuttles (which is the applicable scenario in Linköping) as the highest performing scenario.

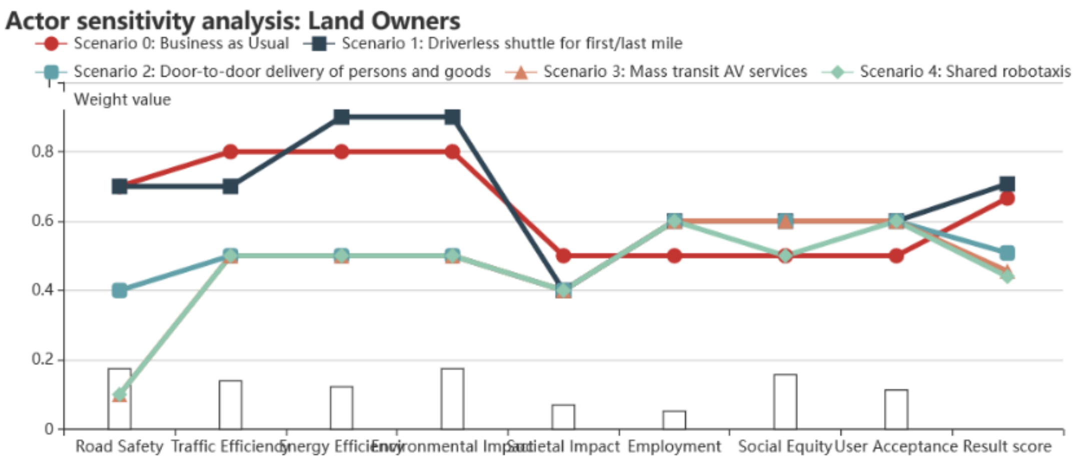


Figure 16: Land Owners' Evaluation.

Researchers considered road safety, environmental impact, societal impact and social equity most important. User acceptance is moderately rated, while employment and energy efficiency are considered least important. In the discussion, the representatives have explained that their reasoning behind assigning a low weight to employment reflects how they interpreted employment and from which perspective. From the perspective of a university, the impact of automation scenarios on job creation or losses may not be as large as the environmental, road safety, traffic efficiency and societal impacts. Thus, they chose to assign it a lower weight. Similarly, their interpretation of what the evaluation scale represents with regards to the employment effect influenced their scoring of scenarios. User acceptance was interpreted more as what would motivate people to use or not use the autonomous service rather than how they perceive the technology or experience itself. Thus, they discussed factors like time saved by using alternative modes (namely a private car) compared with the cost of parking. With these factors in mind, door-to-door delivery, shared robotaxis and mass AV transit were scored the highest in user acceptance. Overall, mass AV transit scored highly on the most important criteria, such as road safety, environmental impact, societal impact, traffic efficiency and social equity. Other scenarios' final scores were equal, in part because they performed differently across the most important criteria. Business as usual was consistently evaluated as the least performing scenario, except for the user acceptance criteria.

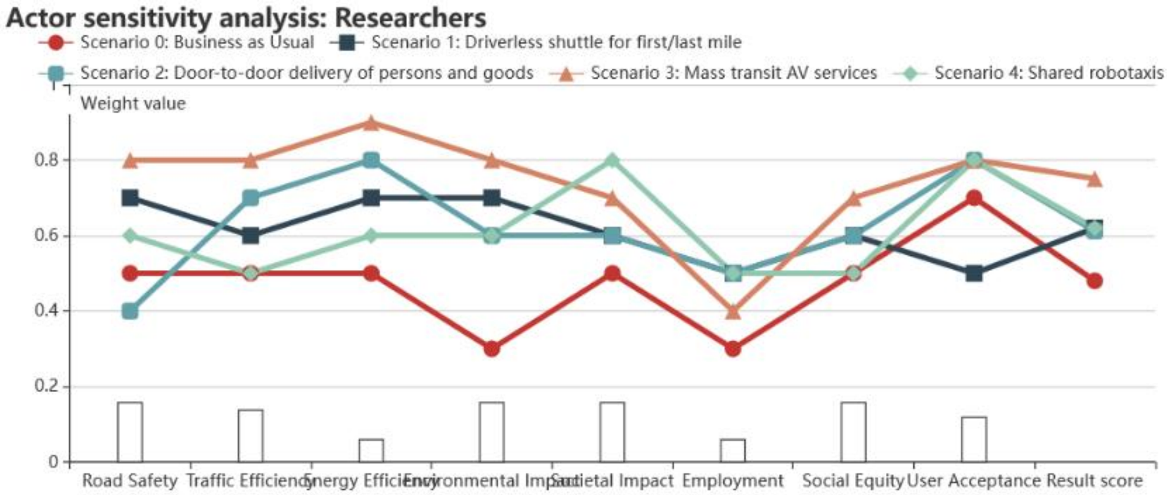


Figure 17: Researchers' Evaluation.

5.3.4 Conclusions and Lessons Learned

The MAMCA workshop performed in this deliverable was meant as a pilot workshop, with the intention to validate the approach, the criteria and scenarios defined, and the selected stakeholders. Through the MAMCA workshop, the participants weighed criteria that reflected the different impact areas concerned by the SHOW autonomous mobility scenarios and evaluated the performance of each scenario in these criteria. This workshop in Linkoping served as a first test to validate and optimize the process. It must be noted that due to Covid-19 related constraints and problems, the running of the shuttles in Linkoping was limited, thus insight from the actual operations and engaging with users was not as extensive as expected so far. Not only has this hampered the stakeholder's ability to assess the current scenario at their site, but it also made imagining futures with autonomous mobility scenarios difficult. As a result, the outcomes of the assessment are to be interpreted keeping in mind these constraints. Overall, the MAMCA workshop highlighted the positive perception that stakeholders have of autonomous solutions for passenger mobility compared to the business-as-usual scenario, with varying preferences depending on the stakeholders' objectives. Traditionally shared solutions were more positively evaluated by authorities, transport operators and researchers. Stakeholders who considered the perspectives of the end users more, i.e., vehicle users and mobility service providers, found more advantageous scenarios that offer flexibility to users.

As for the MAMCA process, we identified the stakeholders had difficulties imagining the effects on a criterion, with varying interpretations of what the scales reflected. Due to the unavailability of calculated KPIs we could not include them to serve as references for the evaluation process, which we believe could have helped to deal with this issue. Nonetheless, in future SHOW workshops, clearer descriptions of the criteria, with links to the KPIs, and interpretations of the criteria evaluation scale will be provided with concrete examples of the ranges of effects. We identify that the criteria do not explicitly cover economic/business impacts, though they are somewhat addressed in the employment criteria. Nonetheless, we will update the criteria list to consider economic impacts, and will discuss with WP16 to evaluate which stakeholder perspective is most valuable in the assessment of these impacts. Furthermore, we see that the participation of OEMs could be valuable to the discussion and the assessment, so we aim to incentivize them to take part in the upcoming workshops.

6 Conclusion

The evaluation framework in SHOW defines the assessment of the automated services that will run at the project pilot sites, considering the support of the upcoming impact assessment on several layers together with the simulation-based studies in WP10.

A methodology for impact analysis has been created, denoted M3ICA (multi-impact, multi-criteria, and multi-actor). It allows for consistent analysis and evaluation of pilots and simulations within the ecosystem of electric connected automated vehicles. The SHOW's M3ICA framework describes how data collected will be used for the impact analysis, including baseline data along with dimension of measurement of the Key Performance Indicators (KPIs) per vehicle, per service etc. and the aggregation rule (sum or average). Specifically, for the evaluation and data collection at pilot sites, the FESTA Handbook for field operational tests is used in an adjusted manner as the starting point for setting up the framework.

The experimental design to be used at the final pilot evaluations has its starting point in the identified use cases described in deliverable *D1.2: SHOW Use Cases*. The experimental plan encompasses clear definitions of research questions (for each pilot site), liaison to KPIs defined in A9.4 "Impact assessment framework, tools & KPIs definition", objective measurement tools and more subjective measuring tools (surveys and interviews/focus groups) to be used (fed by A9.2 "Capturing and monitoring tools"), timetables, but also allocation of responsibilities and definition of all operational conditions for the realisation of the pilots.

Data at all sites will cover collection of both subjective data and observed/raw data considering different stakeholders' perspective, including the end users as one of the most important groups of interest. The end users could be passengers with different profiles (age, gender, persons with special needs, etc.), users of systems in general and safety operators. Specific surveys have been developed and integrated in a capturing and monitoring tool (Netigate) to harmonise data collections at all sites. Interviews will be performed with a selection of stakeholders at pilot sites using a common interview guide. All interviews will together bring a deeper understanding of the effect of such a system of system as SHOW is and point at future directions for a successful step toward future effective and sustainable urban transport system. The observed data is based on the UCs its Research Questions, that is used to identify the measures needed to be collected to be able to calculate the KPIs identified as important for both evaluation of the pilot site operations and for the impact analysis.

The deliverable presents both a horizontal perspective of the pilot sites and what will be included at the sites, but also the details for each site to be able to perform the data collections needed to perform the generic evaluation and impact assessment.

Updates on the experimental plans of the presented in this issue test sites as well as the plans of the ones that are still to get accepted by the EC in the context of Amendment will be all reflected in a subsequent issue planned for this Deliverable.

References

Chen, F., Wang, J., & Deng, Y. (2015). Road safety risk evaluation by means of improved entropy TOPSIS–RSR. *Safety Science*, 79, 39–54. https://doi.org/10.1016/j.ssci.2015.05.006

Kumar, R., Singh, S., Bilga, P. S., Jatin, Singh, J., Singh, S., Scutaru, M.-L., & Pruncu, C. I. (2021). Revealing the benefits of entropy weights method for multi-objective optimization in machining operations: A critical review. Journal of Materials Research and Technology, 10, 1471–1492. https://doi.org/10.1016/j.jmrt.2020.12.114

Lebeau, P., Macharis, C., Van Mierlo, J., & Janjevic, M. (2018). Improving policy support in city logistics: The contributions of a multi-actor multi-criteria analysis. *Case Studies on Transport Policy*, 6(4), 554–563. https://doi.org/10.1016/j.cstp.2018.07.003

Macharis, C., & Baudry, G. (2018). The Multi Actor Multi Criteria Analysis framework. *Decision-Making for Sustainable Transport and Mobility*. https://www.elgaronline.com/view/edcoll/9781788111799/9781788111799.00008.xml

Macharis, C., Turcksin, L., & Lebeau, K. (2012). Multi actor multi criteria analysis (MAMCA) as a tool to support sustainable decisions: State of use. *Decision Support Systems*, 54(1), 610–620. https://doi.org/10.1016/j.dss.2012.08.008

Macharis, C., Witte, A. de, & Ampe, J. (2009). The multi-actor, multi-criteria analysis methodology (MAMCA) for the evaluation of transport projects: Theory and practice. *Journal of Advanced Transportation*, 43(2), 183–202. https://doi.org/10.1002/atr.5670430206

Milakis, D., Van Arem, B., & Van Wee, B. (2017). Policy and society related implications of automated driving: A review of literature and directions for future research. *Journal of Intelligent Transportation Systems: Technology, Planning, and Operations*, 21(4), 324–348. https://doi.org/10.1080/15472450.2017.1291351

Milan, L., Kin, B., Verlinde, S., & Macharis, C. (2015). Multi-actor multi-criteria analysis for sustainable city distribution: A new assessment framework. International *Journal of Multicriteria Decision Making*, 5(4), 334–354. https://doi.org/10.1504/IJMCDM.2015.074088

Nogués, S., González-González, E., & Cordera, R. (2020). New urban planning challenges under emerging autonomous mobility: Evaluating backcasting scenarios and policies through an expert survey. *Land Use Policy*, 95, 104652. https://doi.org/10.1016/j.landusepol.2020.104652

Smith, S., Koopmann, J., Rakoff, H., Peirce, S., Noel, G., Eilbert, A., & Yanagisawa, M. (2018). *Benefits Estimation Framework for Automated Vehicle Operations: Phase 2 Final Report*. John A. Volpe National Transportation Systems Center U.S.

Sun, H., Zhang, Y., Wang, Y., Li, L., & Sheng, Y. (2015). A social stakeholder support assessment of low-carbon transport policy based on multi-actor multi-criteria analysis: The case of Tianjin. *Transport Policy*, 41, 103–116. https://doi.org/10.1016/j.tranpol.2015.01.006

Zhu, Y., Tian, D., & Yan, F. (2020). Effectiveness of Entropy Weight Method in Decision-Making. Mathematical Problems in Engineering, 2020, 1–5. https://doi.org/10.1155/2020/3564835

SHOW deliverables/ internal reports referred to:

SHOW (2020). D1.1: Ecosystem actor's needs, wants & priorities & user experience. Deliverable of the Horizon-2020 SHOW project, Grant Agreement No. 875530.

SHOW (2020). D1.2: SHOW Use Cases. Deliverable of the Horizon-2020 SHOW project, Grant Agreement No. 875530.

SHOW (2022). D4.3 Open modular system architecture – second version. Deliverable of the Horizon-2020 SHOW project, Grant Agreement No. 875530.

SHOW (2021). D8.2 Solutions for onsite digital and communication infrastructure. Deliverable of the Horizon-2020 SHOW project, Grant Agreement No. 875530.

SHOW (2022). D3.5: Final SHOW Ethics manual, Data Protection Policy and Data Privacy Impact Assessment. Deliverable of the Horizon-2020 SHOW project, Grant Agreement No. 875530.

SHOW (2021). D10.2 Pilot guiding simulation results. Deliverable of the Horizon-2020 SHOW project, Grant Agreement No. 875530.

SHOW (2022). D11.1: Technical Validation Protocol. Deliverable of the Horizon-2020 SHOW project, Grant Agreement No. 875530.

SHOW (2022). D11.2: Demos safety, reliability and robustness validation and commissioning. Deliverable of the Horizon-2020 SHOW project, Grant Agreement No. 875530.

SHOW (2022). D14.3 DMP – final version, Grant Agreement No. 875530.

Appendix I: Experimental Plan for Final Pilots

This Appendix aims to give an overview of each pilot site including key objectives, site specific test cases with short storyboards (coming from and connected to the use cases defined in D1.2), stakeholders and end users in focus, and the experimental plans for the pilots together.

[4]France: Rouen - Les Mureaux

Key objectives

In SHOW the key objectives for the new Rouen – Les Mureaux are the following:

- Demonstrate the safety case to operate remotely without on-board safety operator within a complex environment. Fully driverless operation are the first step to expect demonstrating the AV economic case.
- Implement supervision procedures for the fleet of vehicle and for the intervention procedure of the human operator (remote supervision, monitoring...).

Test cases

The Rouen – Les Mureaux sites specific use cases (here called test cases) cover the following SHOW use cases and are specified as follows:

- Automated passengers' mobility in Cities under normal traffic & environmental conditions (UC1.1)
- Automated passengers' mobility in Cities under complex traffic & environmental conditions (UC1.2);
- Energy sustainable automated passengers' mobility in Cities (UC1.4);
- Mixed traffic flows (UC1.6);
- Connection to Operation Centre for remote supervision (UC1.7)

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

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

From a service point of view, in this project we have 3 different routes of shuttles services for employees, VIPs and visitors including persons with reduced mobility (PRM)

All of them are aim for better transport options within the large site

[4] Plans will be revisited in the next update.

Evaluation methods

Stakeholders and end users

In Rouen – les Mureaux end users are generally employees or visitors willing to go from one part to the other part of the site either for meetings or for lunch time.

All categories of ages will be represented, but also vulnerable road users and persons with special needs. Stakeholders targeted in the pilots in Rouen – Les Mureaux are presented in Table 14.

Table 14: End users and Stakeholders in Rouen.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator)	Transdev employees Ariannegroup employees Visitors
Public interest groups and associations	No
Decision-making authorities or regulators	
Operators (e.g. public transport operators, private fleet operators)	PTO: Transdev
Mobility service providers	No
Industry (e.g. AV manufacturers)	Vehicle provider: EM, Vedecom
Other	CD78

Study design and capturing and monitoring tools

Vehicle data will be collected continuously in all vehicles and stored locally. Data will be uploaded to WP5 Data Management Platform at least mid and end of the final pilot. Subjective data surveys will be conducted also mid and end of final Pilot, see Table 10 for more information. Stakeholder interviews will be completed by the stakeholders defined above, in the end of the large-scale pilots.

Spain: Madrid - Villaverde

Key objectives

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

- A fluid transport service with fleet of two AVs (passenger vehicles) to all the road users that demand an efficient way to connect both stops in the round trip.
- Following complex trajectories with difficult manoeuvres (intersections, mixed lanes) in open dense traffic.
- In various traffic conditions (urban, and sub urban) covering speed on 15-30 km/h.
- Supervised by one single interoperable system with a high TRL (8), which is Madrid MaaS Platform, hold by EMT.

Test cases

The site-specific test cases in Villaverde are as follows:

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

  Here the vehicles will attend the urban route that connects La nave with the Subway station and vice-versa.

- Automated passengers' mobility in Villaverde around Bajo Cruce (subway station) (complex traffic & environmental conditions) (UC1.2)

  The objective is to supply a fluid transport service to all the road users that demand an efficient way to connect both sites. One of the stops will be in La Nave and the other one in the Subway station. Both stops will have an available vehicle to provide the service.

- Reliable and safe VRU interfacing at Villaverde Bajo Cruce (subway station) (UC1.3)

  Here the vehicles will be capable to execute an automated re-planning process in case of unexpected situations or pedestrians, present on the road.

- Villaverde open traffic conditions (UC1.6)

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

- SAE L3-4 Villaverde passenger mobility (UC1.10)

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

Figure 18: Visualisation of the test cases in Madrid Villaverde (Left: the route with red spots for manual driving; Right: the connected traffic light).

Evaluation methods

Stakeholders and end users

Passengers in focus are commuters and VRUs. In addition, safety drivers at shuttles and PT operator, will be involved during the evaluations. Stakeholders to be target of evaluation in Madrid, Villaverde, are presented in Table 15.

Table 15: End users and Stakeholders in Madrid, Villaverde.

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

Study design and capturing and monitoring tools

Vehicle data will be collected continuously in all vehicles and stored locally. Data will be uploaded to WP5 Data Management Platform at least mid and end of the Final pilot. For subjective data, surveys will be done also mid and end of final Pilot, see Table 10 for more information. Stakeholder interviews are those defined in the stakeholder table above and will be conducted at the end of the final Pilot.

Spain: Madrid - Carabanchel

Key objectives

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

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

Test cases

The site-specific test cases are as follows:

- Minibus teleoperation at Carabanchel depot (UC1.7).

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

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

  The Twizy vehicle will guide the automated IRIZAR's bus using a platoon formation. This procedure will permit the movement of multiple vehicles with one driver or guiding vehicle in the EMT's depot that improves the performance of daily operative. The zone to execute the manoeuvre is in the dense parking zone of Carabanchel which demands efficiency while executing the exit and parking processes of the buses.

- Minibus and electric bus automated docking at Carabanchel depot (UC3.3).

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

- SAE L3-4 automated depot management, at Carabanchel (UC3.5).

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

Table 16: Visualisation of the test cases in Madrid Carabanchel.

Evaluation methods

End users and stakeholders

The evaluations at the EMT depot focus on the bus drivers, maintenance personnel and the operator’s perspective on remote control of parking and platooning, see Table 17.

Table 17: End users and Stakeholders at Madrid, Carabanchel.

Stakeholders	**Org. Name**
Vehicle users (end users, drivers, remote operator)	Gulliver EMT drivers I2ebus IRIZAR drivers Twizzy TECNALIA drivers EMT maintenance personnel VRUs at Carabanchel
Operators (public transport operators, private fleet operators)	EMT
Mobility service providers	EMT
Industry (AV manufacturers etc.)	Irizar (OEM)

Study design and capturing and monitoring tools.

Vehicle data will be collected continuously in all vehicles and stored locally. Data will be uploaded to WP5 Data Management Platform at least mid and end of the Final pilot. For subjective data, surveys will be done also mid and end of final Pilot, see Table 10 for more information. Stakeholder interviews are those defined in the stakeholder table above and will be conducted at the end of the final Pilot.

Austria: Graz

Key objectives

The key objectives in Graz are as follows:

- To integrate automated and connected passenger vehicles into existing mobility services (but not as a permanent service).
- To enable automated vehicles to enter highly frequented public transport bus stops.
- To perform safe detection of pedestrians and shuttle passengers at bus stops.
- To construct an automated shuttle line demonstrator linked to a bus stop.

Test cases

The specific test cases are as follows:

The passenger gets off a public bus and wants to proceed to a shopping centre. He or she decides spontaneously to take the AV vehicle, which starts from a defined stop very close and visible from the public busses.

- Serves a bus stop (UC3.4).

The passenger recognizes that the AV vehicle is available and gets on board. After a confirmation of the departure and a safety check, the shuttle starts and autonomously searches for a passage through the terminal. The AV vehicle follows a predefined route and crosses a traffic light-controlled intersection. When the AV vehicle reaches the destination, the passenger gets off and the vehicle drives back on its own.

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

Figure 19: Visualisation of test cases in Graz (busy and occupied bus terminal).

Evaluation methods

Stakeholders and users

End users in focus are generally visitors at the shopping centre. Stakeholders targeted in the pre-pilot are presented in Table 18.

Table 18: End users and Stakeholders in Graz.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator	Visitors at shopping centre Safety drivers
Public interest groups and associations	No

Stakeholders	Org. Name
Decision-making authorities or regulators	AustriaTech
Operators (e.g. public transport operators, private fleet operators)	Holding Graz
Mobility service providers	No
Industry (e.g. AV manufacturers)	Yunex (smart camera)
Other	No

Study design, capturing and monitoring tools

Vehicle data will be collected continuously in all vehicles and stored locally. There are three different ways of data communication and processing.

- Live measurement in vehicle and processing in the cloud: Live data of vehicles like current speed, acceleration, position etc. is continuously uploaded to the SHOW Data Management Platform, which then calculates the SHOW KPIs from this. Most SHOW pilot sites follow this concept.
- Live measurement in vehicle and local processing: The SHOW KPIs are directly calculated in the vehicle and are transmitted to the SHOW Data Management Platform. Only a few SHOW pilot sites follow this concept.
- Data collection in vehicle and upload to the cloud at later time (historic data): The collected data can be uploaded via a special API or a web-based interface to the SHOW Data Management Platform. This concept can be very useful for analysing data of vehicles without the need of a permanent data connection.

For subjective data, surveys will be done also mid and end of final Pilot, see Table 10 for more information. Stakeholder interviews are those defined in the stakeholder table above and will be conducted at the end of the final Pilot.

Austria: Salzburg

Key objectives

In Salzburg the key objectives in SHOW are as follows:

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

Test cases

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

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

The whole route is fully equipped with ETSI ITS-G5-enabled Roadside Stations (#5). HD map of the whole test route has been created. The use of the autonomous passenger mini-van is free of charge. ITS enabled buses equipped with OBU's connect the station "Koppl Sperrbrücke" with the city centre. The route is equipped with ETSI ITS-G5-enabled Roadside Stations, which are connected to the TMC of Salzburg, enabling e.g. ITS-G5-based traffic light prioritization for public buses.

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

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

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

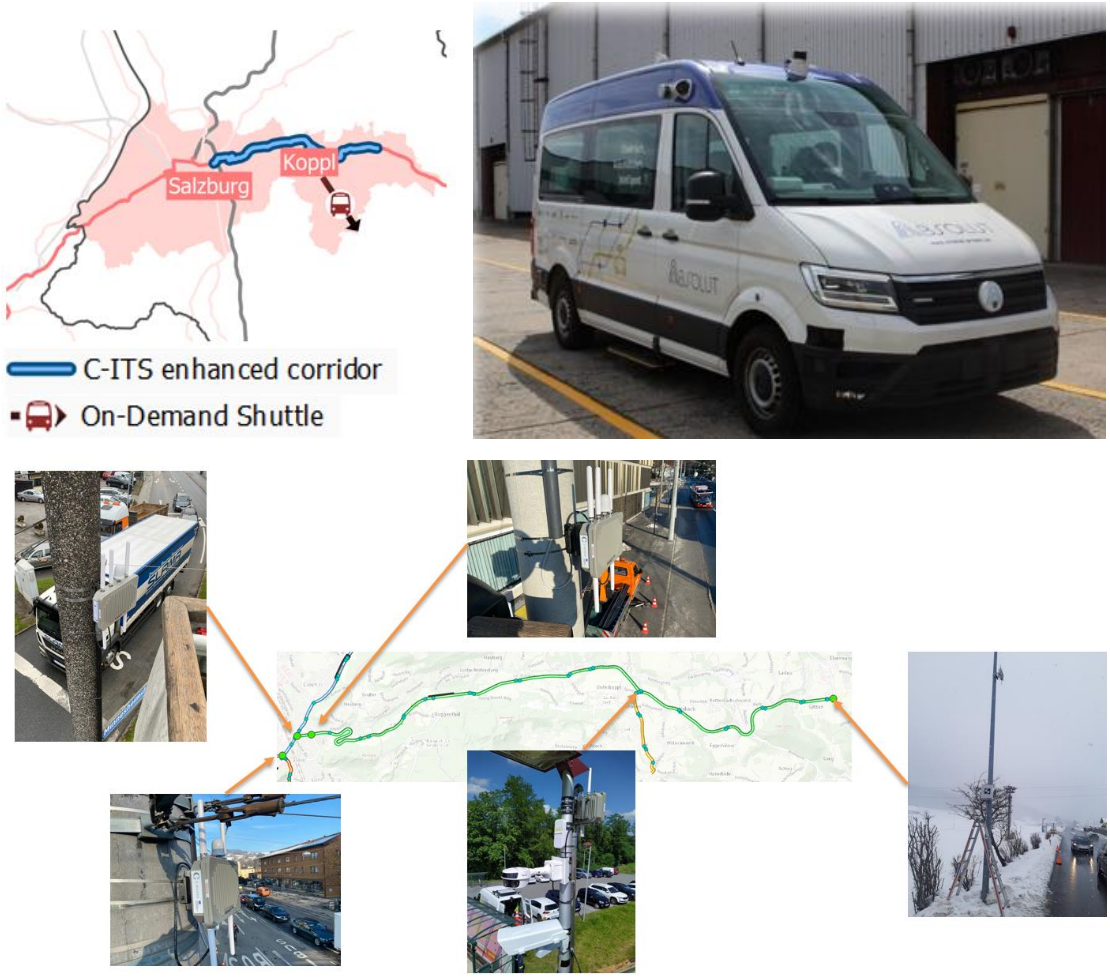


Figure 20: Visualisation of the test cases in Salzburg.

Evaluation methods

Stakeholders and end users

End user groups in focus in Salzburg are pedestrian in the role of commuters from peri-urban residents, tourists, safety drivers and TMC personal, see Table 19.

Table 19: End users and Stakeholders in Salzburg.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator	Commuters (Salzburg Researchers) Safety drivers
Public interest groups and associations	No

Stakeholders	Org. Name
Decision-making authorities or regulators	Federal State of Salzburg
Operators (e.g., public transport operators, private fleet operators)	Salzburg Transport Authority
Mobility service providers	No
Industry (e.g., AV manufacturers)	No

Study design, capturing and monitoring tools

Vehicle data will be collected continuously in all vehicles and stored locally. Data will be uploaded to WP5 Data Management Platform at least mid and end of the Final pilot. For subjective data, surveys will be done also mid and end of final Pilot, see Table 10 for more information. Stakeholder interviews are those defined in the stakeholder table above and will be conducted at the end of the final Pilot.

Austria: Carinthia

Key objectives

Carinthia includes 2 areas: Klagenfurt and Pörtschach. The key objectives will be as follows:

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

Test cases

The specific test cases are built around three of the original use cases, in addition one test case with focus on safe Covid-19 transportation will be assessed. The test cases are as follows: UC1.1, UC1.2, UC1.6, UC2.1, UC3.6.

Carinthia is offering a scheduled daily automated public transport service in an urban and peri-urban environment within all UCs. The traffic situation is different on the two demo sites. In Pörtschach the main users are tourists and in Klagenfurt it is commuters and students.

The cargo use case will be realised in Klagenfurt, which is the larger demo site in Carinthia with complex traffic and environmental situation. The idea is to transport small and medium sized parcels with a custom build transportbox, fixed in the autonomous shuttle. The route will include mixed traffic, traffic lights, a roundabout, and different traffic barriers. There are three different route options, which will be implemented as levels 1 - 3, the final route length will be 4.4 km. The route will connect the train station with a living area, restaurants, shops, the university, and a business and science park. On this route, a high variety of stakeholders like tourists, residents, students, senior citizens, and commuters. A Navya Arma DL4 shuttle is used on the pilot site. Additional Q-Straints are implemented on the floor to fix a container secure to the floor. Additionally, equipment will be used as a box specially made for the shuttle. The box should fit in the space now reserved for a wheelchair or a stroller.

The goal of the Covid-19 UC is to find feasible solutions to decrease the possibility of becoming infected, when using public transportation. The focus is on pre-detection of potentially infected persons, to keep the viral load within the vehicle, during operating hours, as low as possible through using different methods of disinfection.

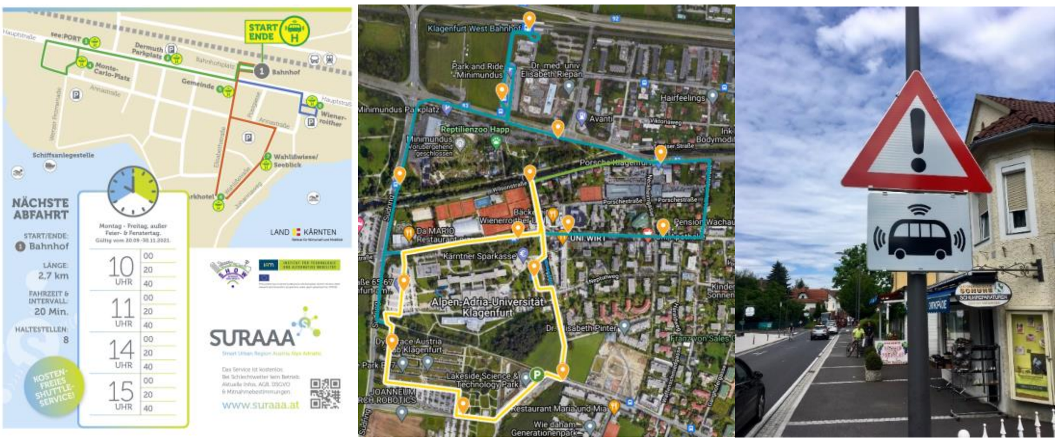


Figure 21: Left: Time-table and route of Pörtschach test site; Centre: Route of Klagenfurt test site; Right: sign automated bus at test site Pörtschach

Figure 22: Demo event with students at test site Pörtschach.

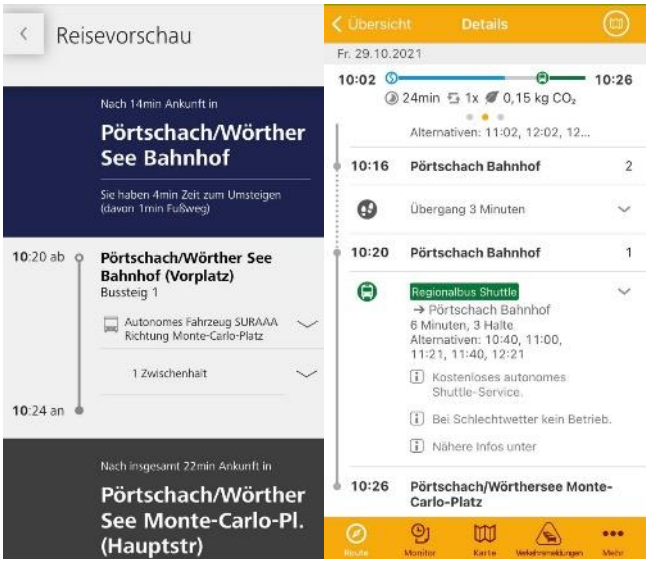


Figure 23: Integration of Pörtschach service time-table into public transport platforms.

Evaluation methods

Stakeholders and end users

Target end user groups are citizens and visitors of selected urban quarters, commuters, staff of science park, students, and persons with reduced mobility like elderly, see Table 20.

Table 20: End users and Stakeholders in Carinthia.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator	End users (tourists, commuters, students, vulnerable road users), Safety driver Remote or supervised operator
Public interest groups and associations	Tourist organisation like Tourismusverband Pörtschach, Klagenfurt and Wörthersee
Decision-making authorities or regulators	Several authorities like BMK – Bundesministerium für Klimaschutz, Mobilität und Innovation, AustriaTech and local authorities like Land Kärnten, Stadt Klagenfurt and Gemeinde Pörtschach
Operators (e.g., public transport operators, private fleet operators)	Klagenfurt Mobil, Kärntner Linien
Mobility service providers	No
Industry (e.g., AV manufacturers)	Navya for Shuttles and one additional, Yunex for traffic lights

Study design, capturing and monitoring tools

Vehicle data will be collected continuously in all vehicles and stored locally. Data will be uploaded to WP5 Data Management Platform at least mid and end of the Final pilot. For subjective data, surveys will be done also mid and end of final Pilot, see Table 10 for more information. Stakeholder interviews are those defined in the stakeholder table above and will be conducted at the end of the final Pilot.

Germany: Karlsruhe

Key objectives

The key objectives for the Karlsruhe site will be on:

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

Test cases

In total 7 Use Cases will be in focus in Karlsruhe. The site-specific test cases will take place in either the restricted area at KIT Campus Ost or the public urban residential area in Weiherfeld-Dammerstock (see section 2.1.2). The test cases are described as follows:

- Driving in (peri-) urban areas under normal traffic & environmental conditions (UC1.1), Driving in (peri-) urban areas under complex traffic & environmental conditions (UC1.2) and Driving in (peri-) urban areas with mixed traffic flow (UC1.6)

  By offering autonomous on demand rides to local Points of Interests like bus stops or tram stations, interest and trust in autonomous vehicles shall be created. Especially the concept of the last mile shall be deployed. The area offers a wide range of scenarios with different challenges like narrow roads with parking cars and heavy traffic including a great amount of VRUs like cyclists. Since this environment requires a lot of evasive manoeuvres all autonomous vehicles compute their respective trajectories on the fly. The vehicles can cope with this challenging environment, because they are not fixed to a virtual rail. The demonstrations will take place in the residential area (Weiherfeld-Dammerstock).

- Evaluation of Connection to Operation Centre for remote supervision and decision aid in restricted or in (peri-) urban areas (UC1.7)

  For the evaluation of Connection to Operation Centre for tele-operation and remote supervision the autonomous vehicles will provide the possibility for a tele operator to supervise it. The operator has the possibility to investigate the current state of the vehicle and can support the vehicle in its decision process. There is no direct control of the driving shaft. The control is only possible through the planning process which is running on the vehicle. This will take place in the residential area (Weiherfeld-Dammerstock).

- Evaluation of Cargo platooning in restricted or in (peri) urban areas (UC1.9).

  Regardless of business models or the transported freight, platooning with autonomous vehicles is still a challenging technical task. To highlight current possibilities and challenges the FZI will demonstrate platooning with different autonomous vehicles at varying speed. Since this is an experimental feature of the autonomous driving functions, platooning will take place in the restricted area (KIT Campus Ost).

- Evaluation of automated mixed spatial mobility in restricted or in (peri-) urban areas (UC2.1).

To demonstrate the automated mixed spatial mobility, it will be studied how the transport of cargo influences passenger transport and vice versa. Therefore, a custom designed removable cargo hold will be installed in the shuttles in order to combine cargo transport with person transport. The time-dependent effects on person and cargo throughput will be estimated with a set of KPIs, including e.g. the average numbers of person/cargo transports per hour, that will be compared to the same set of KPIs calculated during the respective transport time slots in UC2.2 in order to derive a globally optimal operation plan. This study will take place in the residential area (Weiherfeld-Dammerstock).

- Evaluation of automated mixed temporal mobility in restricted or in (peri-) urban areas (UC2.2).

  To evaluate the automated mixed temporal mobility it will be studied how the transport of cargo influences passenger transport and vice versa. Therefore, we will vary the time slots for person and cargo transport in order to derive an efficient timetable that optimizes person and cargo throughput with respect to constraints like operating times. The person and cargo throughput will be measured with KPIs and compared to UC2.1. This study will take place in the residential area (Weiherfeld-Dammerstock).

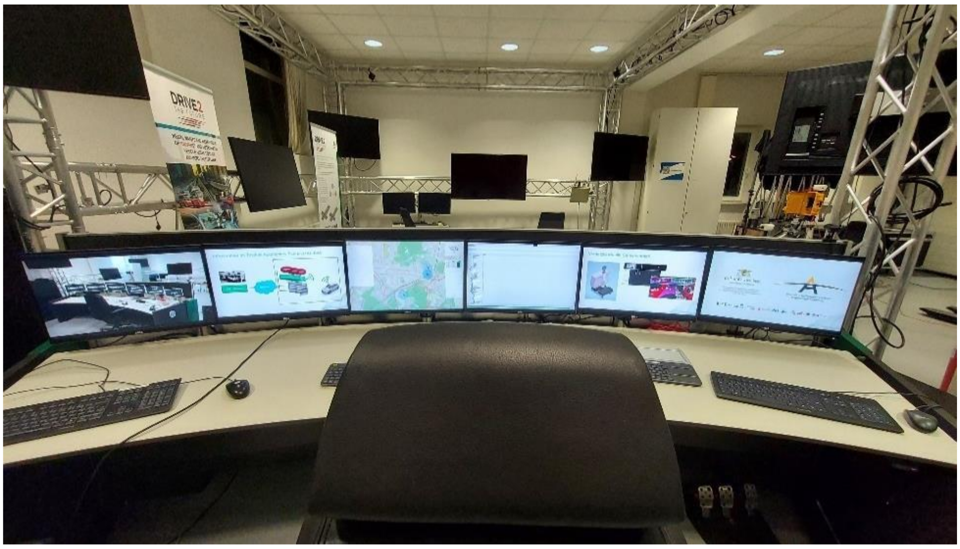


Figure 24: Top: the remote supervision center of the test area autonomous driving. Below: Visualisation of the information displayed to the remote supervision centre in Karlsruhe. The left-hand side shows the current position of the autonomous vehicles.

Evaluation methods

Stakeholders and end users

In Karlsruhe, the target end users are all citizens, but with focus on commuters and residents. Also, tele operator supervisors is an end user target group of interest, see Table 21.

Table 21: End users and Stakeholders in Karlsruhe.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator	Residents Commuters
Public interest groups and associations	No
Decision-making authorities or regulators	x
Operators (e.g., public transport operators, private fleet operators)	representive of VBK (PT)
Mobility service providers	x
Industry (e.g., AV manufacturers)	No

Study design, capturing and monitoring tool

Vehicle data will be collected continuously in all vehicles and stored locally. Data will be uploaded to WP5 Data Management Platform at least mid and end of the Final pilot. For subjective data, surveys will be done also mid and end of final Pilot, see Table 10 for more information. Stakeholder interviews are those defined in the stakeholder table above and will be conducted at the end of the final Pilot.

Germany: Monheim

Key objectives

Key objectives for the operation of the AV fleet in Monheim are:

- Connecting the old town (narrow streets not accessible by conventional buses) to public transport.
- Driver shortage - according to a study by the Association of German Transport Companies, 74,000 positions will be unfilled due to age by 2030 in Germany, while 100,000 additional drivers will be needed.
- Our goal is to expand all PT services in order to reduce individual mobility to a minimum level. Therefore, driverless transportation is essential.
- Enhance Safety for all road users.

Test cases

Monheim already has an existing line concession for public transport with buses. Monheim is working on 8 use cases in total which are explained below:

- Automated passenger mobility in cities under normal/complex traffic & environmental conditions (UC 1.2)

  The route is partly on a main road with high traffic density and many parking procedures, but also partly in the old town, which is characterised by narrow streets and a pedestrian zone.

- Interfacing non-automated vehicles and travellers (UC1.3)

  The route is on public ground, hence the fleet is interfacing all kind of road users including VRUs (cyclists, pedestrians, etc.). In specific, in Monheim, Easymile vehicles will integrate LEDs that will visualise line number and terminus information (see D7.3 for more). The target audience for this is mostly pedestrians (any type) and cyclists that inevitably interact with the vehicles in real traffic. No specific events need to be triggered in this respect, as this will be a continuous active element present in the full series of the pilots operation in real traffic. As such, neither the logging of specific data is applicable nor the completion of the VRU acceptance survey of Appendix III.

- Energy sustainable automated passengers mobility in cities (UC1.4)

  The vehicles are locally emission-free due to the battery electric drive. The goal is to expand the conventional public transport with AVs and substitute private cars.

- Actual integration to city traffic management control (UC1.5)

  Operation of the AVs is fully integrated into the PT control center.

- Mixed traffic flows (UC1.6)

  The route is on public ground and therefore there is a mix of the traffic flows of the AVs with other non-automated vehicles (e.g. private cars)

- Teleoperation (UC1.7)

  The goal is to reach a fully driverless operation by building a remote supervision that is integrated into the PT control center.

- Automated services at bus stops (UC3.4)

  The PT aims to develop solutions for ticketing, stop requests, lost property control and other procedures that are currently dependent on the safety operator on board.

- Covid-safe transport (UC3.6)

  BSM wishes to add a device for the monitoring of air quality inside the AVs and provide information about occupancy rates of the vehicles to passengers. Also a button for stop requests will be integrated into the existing MaaS-App BahnenMonheim, which will be used for ticketing, information etc. (see U 3.4). With the integrated button, touching actual surfaces in the vehicle can be reduced to a minimum.

Figure 25: Visualisation of the test cases in Monheim.

Evaluation methods

Stakeholders and end users

In Monheim the key stakeholders and end user are described in Table 22.

Table 22: End users and Stakeholders in Monheim.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator	Residents, tourists, Elderly, PRM
Public interest groups and associations	VDV
Decision-making authorities or regulators	Stadt Monheim am Rhein
Operators (e.g., public transport operators, private fleet operators)	BSM

Stakeholders	Org. Name
Mobility service providers	BSM
Industry (e.g., AV manufacturers)	EasyMile

Study design, capturing and monitoring tool

Vehicle data will be collected continuously in all vehicles and stored locally. Data will be uploaded to WP5 Data Management Platform at least mid and end of the Final pilot. For subjective data, surveys will be done also mid and end of final Pilot, see Table 10 for more information. Stakeholder interviews are those defined in the stakeholder table above and will be conducted at the end of the final Pilot.

Sweden: Linköping

Key objectives

The key objectives for Linköping are as follows:

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

Test cases

In Linköping 7 use cases will be covered, with the following site-specific test case descriptions, see also Figure 26

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

  Along the route there is a school for children with special needs and in the same building there is a residential for elderly people. The distance from this building to the PT trunk line is >300 meters and hence too long to walk. The Shuttle operation is used as first – last mile solution to get access to the PT trunk line for this specific end users. .

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

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

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

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

- Elin operational Dashboard (UC1.7).

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

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

  The shuttles intend to stop only when there is an actual demand. Using the shuttles control APIs, the shuttles will stop only when travellers want to get on or off. A simple but integrated and connected “stop button” is placed along the route. The stop button (and potentially other sources like an app or Linköping MaaS) will signal the operation centre and create a stop order at the correct bus stop. The system runs both on a web application (see Figure 26) and through buttons installed at the bus stops. The information is sent to the local dashboard and possible to see by the driver. At this point the drivers use this as an input for the decision on where to go. It is not connected to a customer promises as it is right now.

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

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

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

  Combining real time data city wide public transport information, historical travel data and passenger information suggest the most optimal way of transport for all individual users of this service in terms of where and when to embark and disembark (see Figure 26 and real time data at ([Hur många är det som väntar? (ridethefuture.se)](ridethefuture.se))). The system considers the users’ personal preferences and/or limitations e.g, special needs.
  - Strategic (when to leave home/work/school to get to the shuttle that connects to PT etc.).
  - Tactical (to know when and where to go and to get off the bus stop taking the passengers specific needs into consideration).

Figure 26 visualises the test cases. The top left describes the route including UC1.1 and UC 1.3 and UC1.7. The photos described UC 1.3 (middle) and UC 1.6 (right). The map and then screen shots on the mobile application is relevant for UC3.1 and UC3.2 and UC3.4. The photo of traveller shows the main end user in focus, elderly and children.

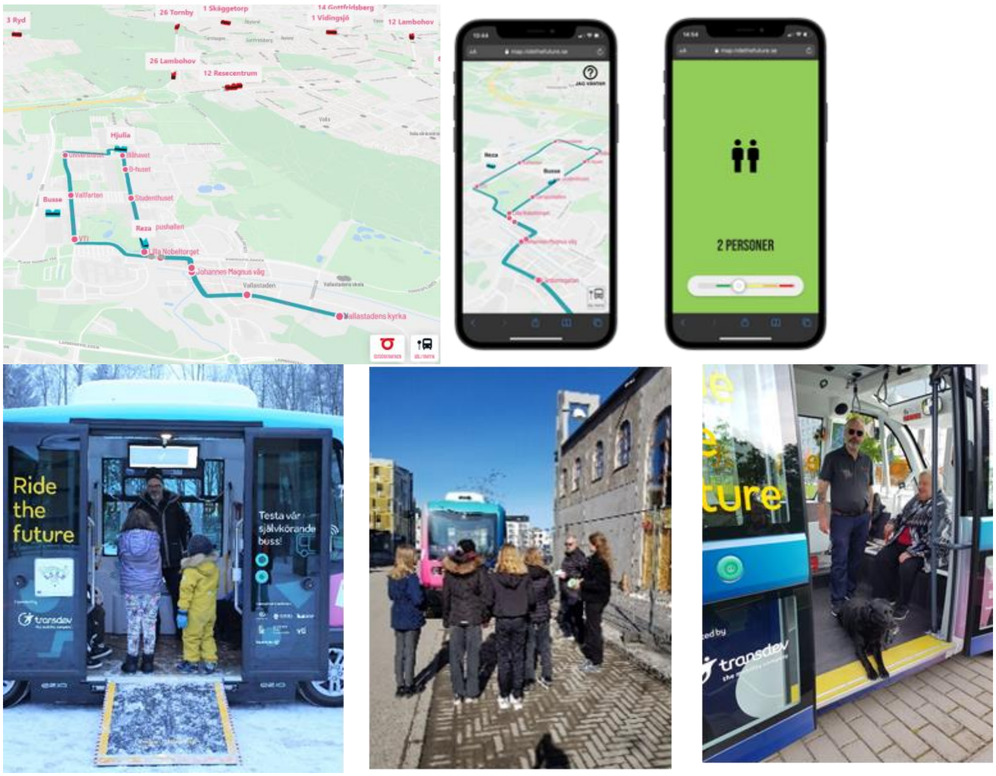


Figure 26: Visualisation of the test cases in Linköping.

Evaluation methods

Stakeholders and End users

Stakeholders and end users that will be target in Linköping is presented in Table 23.

Table 23: End users and Stakeholders in Linköping

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

Study design and capturing and monitoring tools

Vehicle data will be collected continuously in all vehicles and stored locally. Data will be uploaded to WP5 Data Management Platform at least mid and end of the Final pilot. For subjective data, surveys will be done also mid and end of final Pilot, see Table 10 for more information. Stakeholder interviews are those defined in the stakeholder table above and will be conducted at the end of the final Pilot.

Sweden: Gothenburg

Key objectives

The key objectives in Gothenburg are the following:

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

Test cases

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

- First/last mile public transport in Gothenburg under normal environmental conditions (UC1.1) and under complex environmental conditions (UC1.2)

  For the final pilots, the autonomous shuttles are driving along the route in Johanneberg Science Park in Gothenburg. The route is in total 3.04km long with six stops, connected to the public transport network of Västtrafik from the bus and tram station Chalmers. The shuttles stop at institutes, the library and different parking lots during the loop.

- Complex environmental conditions anticipated are as follow:

  Extreme weather conditions in winter: snow and extremely low temperatures, reduced luminosity (up until 40% of operations run in the dark in winter), fog, heavy rain and puddles.

  Dense car traffic is present in an open road environment (peak hours, special events, etc.) as well as 1 roundabout on the route.

- First/last mile PT in Gothenburg operated in mixed traffic (UC1.6)

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

- Control Tower connecting to other travellers in Gothenburg (UC1.3)

  In short, the Control Tower in the Gothenburg case can connect to VRUs and other passengers in the surroundings of the shuttle to warn them of the shuttle's impending arrival. In more detail and as described in D7.3, a C-ITS based solution is implemented for interaction between AVs and particular VRUs – pedestrians in specific here. The SHOW Dashboard is able to visualize location of the vehicle, and network information at the particular location. It will contain real-time processing logic to trigger actions based on location / heading of reporting objects, such as the AVs and a Vulnerable Road User (VRU) sensor.

  In the specific use case, static and dynamic geofences (enabled by the Dashboard) will be tested. Static geofences represent areas with a set of realtime rules, around e.g. construction works areas or accident areas. Notifications will be sent to both vehicle and VRU sensor device when events are trigged, such as by entering and leaving specific static geofence areas through 5G network. These notifications will be presented as alert messages in both the shuttles and the SHOW Dashboard, while they are represented as visual notifications for the vulnerable road users (LED lights on their safety vests). Dynamic geofences will be created around dynamic objects, such as the AV and a VRU, and follow the object's movements. Once a vehicle- and a VRU dynamic geofences overlap, notifications are sent to respective connected sensor subsystems as well as in the SHOW Dashboard.

Visual notifications for VRUs will be tested with selected pedestrians at Chalmers in the use case. To limit the risk of collision, geofences and notifications for AVs and pedestrians will be used in specific areas, such as construction sites or other premises.

The developer of the solution in this case is Ericsson and the solution will be tested with NAVYA vehicles deployed in the site. Due to the fact that specific events have to be triggered, specifically recruited pedestrians will participate in the specific trials that will answer the dedicated VRU survey (Appendix III).

Logging: Apart from the user feedback that will be collected through the VRU acceptance survey, there will be performance data logged that will concern a) the detection of VRU [Successful/ Not successful], and, b) the timing of VRU detection on behalf of the vehicle [time of actual VRU presence in field vs time of VRU detection by the system]

- Assistance of driverless vehicle by the 5G Control Tower (UC1.7)

  The Control Tower is permanently connected to the vehicles through a 5G connection. The 5G infrastructure enables communications between the control tower and the vehicle as well as supervision, for example to confirm an action, to send a request for assistance or to exit the planned route.

- Autonomous driving functions at bus stop (UC3.4)

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

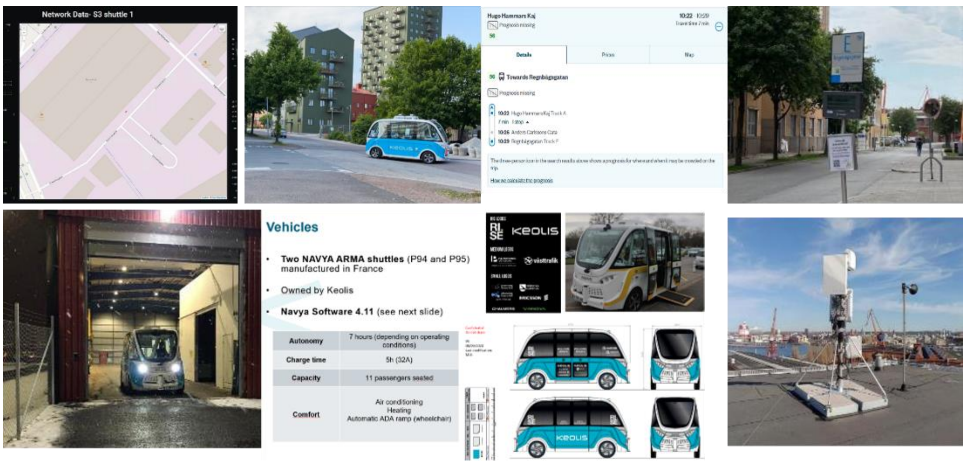


Figure 27: Impressions of the pre-demo set-up to be demonstrated in Johannesberg, Gothenburg.

Evaluation methods

End users and stakeholders

Stakeholders and end users targeted in Gothenburg are commuters, residents and tourists/visitors, but also safety operators and remote operators, see Table 24.

Table 24: End users and Stakeholders in Gothenburg.

Stakeholders	Target/ Org. Name
Vehicle users (end users, drivers, and remote operator)	Commuters/visitors Safety operator: Keolis Remote operator: Keolis / Ericsson
Decision-making authorities or regulators	Municipality: Gothenburg Traffic office
Operators (e.g., public transport operators, private fleet operators)	Västtraffic Götaland
Mobility service providers	Service provider (Keolis) Service provider (Ericsson)
Industry (e.g., AV manufacturers)	OEM: Navya

Study design and capturing and monitoring tools

Vehicle data will be collected continuously in all vehicles and stored locally. Data will be uploaded to WP5 Data Management Platform at least mid and end of the Final pilot. For subjective data, surveys will be done also mid and end of final Pilot, see Table 10 for more information. Stakeholder interviews are those defined in the stakeholder table above and will be conducted at the end of the final Pilot.

Finland: Tampere

Key objectives

For Tampere, the key objectives are as follows:

- Tampere Regional Transport offers a complete regional bus services and route network with connections to main national services. Starting 2021 autonomous buses, city bikes and e-scooters are gradually being added as feeder means to the new tramway and other services. The feeder services will first use fixed routes and there are plans to also introduce DRT services either during or after the SHOW project. The objective is to improve and integrate the mobility system with autonomous feeder buses and shared services as MaaS.
- Existing technologies will be complemented whenever needed. The number of vehicles is expected to increase from the 2 vehicles used during the test site pilot phase 1 (first phase of the pre-demo phase), to about 10 already during the after the project.
- The City of Tampere aims to establish a permanent autonomous transport test and pilot area to the Hervanta suburb, where the SHOW piloting will take place.

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

The fixed route to be used is normally easy and smooth, but during winter is challenging and includes also driving on the tram line corridor. The Finnish pilot offers a mobility solution for local inhabitants with cooperative connected and automated vehicles. During the very first pilot phase of the site (January to March 2022), the service was running on a circular route of some 3.5 km on public streets with 9 stops with 2 autonomous Toyota Proaces. The feeder services to tram operated at some 10 minute intervals between 8:30 – 15:30 on weekdays and had some 1.700 passengers.

In the next phase, one autonomous Auvetech electric shuttle bus by VTT was added in piloting in May – June 2022.

In turn, three more electric shuttle buses will be used under supervision of remote control centre for half a year period, starting in autumn 2022 and to targeted to last until 2023. *If the Amendment 2 will be accepted by the European Commission there will be a pilot phase 4 from spring 2023 to the end of 2030. During this phase new operational areas will be added and several new vehicles will be piloted in Tampere. There will also be a route in the City of Lahti will be added to be controlled by the remote control centre, The route in Lahti will be planned during the summer 2022.*

Test cases

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

- Automated passengers/cargo mobility in Cities under normal traffic & environmental conditions (UC1.1)

  The Finnish pilot (feeder service to the tram) has transported and will transport passenger (no cargo) in mixed traffic and under normal traffic and environmental conditions in Hervanta suburb.

- Automated passengers/cargo mobility in Cities under complex traffic & environmental conditions (UC1.2)

  The Finnish pilot (feeder service to the tram) has transported and will transport passenger (no cargo) also in mixed traffic and under complex normal traffic and environmental conditions in Hervanta suburb. The challenges and complexity has been and will be because of wither-time with very cold weather and icy & snowy streets, with no visible road and lane markings, etc.

- Interfacing non automated vehicles/ travellers (VRU) (UC1.3)

  The Auvetech vehicles operated by VTT in Tampere do not engage any direct interaction with VRUs but the vehicle & the safety driver receive information of VRUs in monitored area. The RSU information (images and classified objects in area) are sent to the AV (as described in D7.3). All types of VRUs are targeted/detected (pedestrians, cyclists, motocyclists, etc.) but, further to that, other cars and buses are also detected. The RSUs are also specifically installed to detect people crossing pedestrian zones and send the data to the vehicle.

The information is shown to the safety driver and passengers on board. The reaction of the vehicle upon the receipt of this information (i.e. slowing down) will be tested.

Due to the inherent cross-cutting way the VRUs are detected in the same context as other obstacles recognition, no specific VRUs will be recruited to trigger specific events. The key feedback regarding the robustness of this part will come from the safety driver acceptance survey as well as through the horizontal data logging for detection that will take place.

On the other hand, **Sensible 4**, deploying also in Tampere, does not have solutions for interacting with VRUs with the AV outside of the vehicle. Their technology is based on LiDAR detecting obstacles. They do not utilise cameras at this stage to identify those obstacles or classify them as VRU or other. The vehicle adjusts its behaviour according to what it detects in its surroundings and if there are potential obstacles approaching its trajectory. Sensible 4 vehicles have been introduced to the Tampere test groups including also VRUs and feedback has been received on how to make the vehicle and the journey more accessible (those aspects are explored in the context of the typical user acceptance survey). Still, it is worth noting that in Tampere pilots, the Sensible 4 vehicles had been taped to identify clearly that the vehicles are self-driving as a passive means to inform other road users of the nature of the vehicle.

- Energy sustainable automated passengers/cargo mobility in Cities (UC1.4).

  At the beginning, the Toyota Proaces vehicles were not yet electrified, but from phase 2 onwards all the automated vehicles to be used in passenger transport will be electrified and thus sustainable.

- Connection to Operation Centre for tele-operation and remote supervision (UC1.7)

  The Finnish pilot vehicles have been and will be monitored remotely. A dedicated remote control centre will be built and used.

- Self-learning Demand Response Passengers/Cargo mobility (UC3.1) is still under discussion and depends on funding.

Figure 28: Visualisation of the test cases in Tampere.

Evaluation methods

Stakeholders and End users

In general, the pilot is for all citizens (business travellers, tourists and residentials), but with target groups local residents commuters, and students at the university. There are also specific groups of interest, such as elderly and persons with reduced mobility, see Table 25.

Table 25: End users and Stakeholders in Tampere.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator	Commuter/students Elderly with reduced mobility Safety Drivers (Sensible 4)
Public interest groups and associations	Nysse Lab members (test users recruited by the Tampere City Transport), Accessibility Working Group representatvites
Decision-making authorities or regulators	City of Tampere
Operators (e.g. public transport operators, private fleet operators)	Tampere City Transport VR (Tram operator)
Mobility service providers	Tampere City Transport Sensible 4 VTT
Industry (e.g. AV manufacturers)	Sensible4/ Toyota ProAceVTT/Auvetech shuttle

Study design, capturing and monitoring tools.

Vehicle data will be collected continuously in all vehicles and stored locally. Data will be uploaded to WP5 Data Management Platform at least mid and end of the Final pilot. For subjective data, surveys will be done also mid and end of final Pilot, see Table 10 for more information. Stakeholder interviews are those defined in the stakeholder table above and will be conducted at the end of the final Pilot.

Italy: Turin

Key objectives

The key objectives for Turin are as follows:

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

Test cases

In total 7 use cases will be assessed. The site-specific test cases are as follows:

- Demand Responsive Transport of passengers towards the hospital district in normal and complex traffic conditions (UC1.1 and UC 1.2)

  A person (e.g. a patient of the hospital of the "City of Health and Science of Turin") books the automated shuttle service on a dedicated user app provided by ioki. The whole service will be free of charge. At the agreed time, the autonomous vehicle will pick up the user at the pick-up point and take him to the desired stop. Along the way, the shuttle can also collect other people who have booked the service.

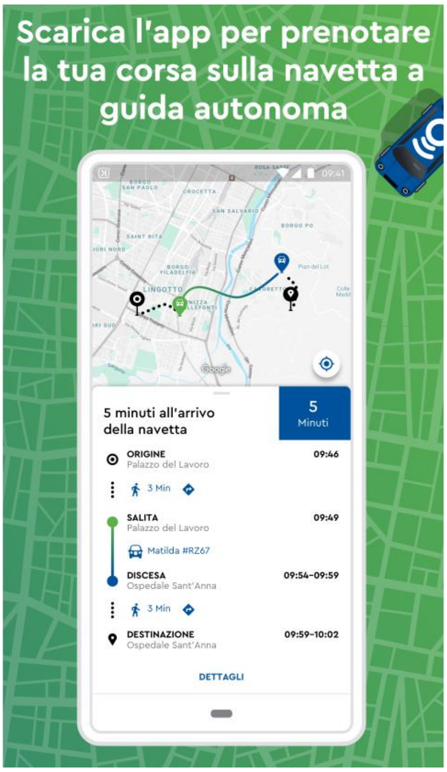


Figure 29: Screenshot of the user app.

- Presence of vulnerable road user on smart crossing equipped with C-ITS capabilities (UC1.3).

  In Turin, there are two solutions that will be tried in this respect, as follows:

1. **On-board solution by Navya.** As described in D7.3, this includes acoustic signalling (buzzer activation) from the vehicles' side for VRUs warning. It is coupled with an emergency button and a video monitoring system and audio system for communication on-board. The NAVYA vehicles that will be deployed in Turin will have this feature present.
2. **C-ITS solution by Links**. As described in D7.3, this solution assumes notifications to the vehicle's tablet about VRUs crossing the street. The VRUs are being detected via the two RSUs installed in the infrastructure that are equipped with a camera and possibly with a LIDAR. The RSUs detect VRUs thanks to an SoA YOLO-based object detection and tracking framework. All the needed processing, including detection and tracking, will be done on the RSU thanks to a mixed ARM + GPU hardware architecture (see D7.3). Finally, the information of the VRU crossing the street will be received by the tablet used by the safety driver to increase his/her awareness of the surrounding traffic. The notification will be sent using a DENM message over the cellular network (4G/5G) using AMQP 1.0 as application layer protocol for the message brokering as done in the C-ROADS Platform.

Overall and most probably, no special events are needed to be triggered for the testing of both solutions. As such, the VRU dedicated survey of Appendix III is not applicable per se (although this will be reconfirmed in the next semester). The information on successful detection of VRUs will be basically evaluated through the safety driver for both solutions.

In addition to the above, there is another solution that has been developed by VEDECOM (and described in D7.3) that would be deployed in the TRANSDEV test site. As this is not feasible any more due to the change of plans of TRANSDEV, it will be explored if this solution can be deployed in the context of the Turin site in collaboration with NAVYA. This will be made clear in the next couple of months and will be respectively reflected in the next issue of this Deliverable. In case this solutions is finally deployed in the Turin site, the VRU dedicated survey will be made applicable and specific events will have to be triggered with specifically recruited participants.

- Traffic light priority to autonomous shuttle (UC1.5)

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

- Transport of passengers towards the hospital district in mixed traffic on public roads (UC1.6)

  The shuttles are authorised to circulate in a path in the southern part of Turin, close to the area of the hospital district. All the roads in the path are public, and no dedicated lanes are present for the automated vehicles.

- Connection to Operation Centre for tele-operation and remote supervision (UC 1.7)

  The shuttles will be constantly remotely supervised from the Navya operation centre in Lyon for maintenance and quick detection of any potential technical issues. Similarly, the dashboard for the fleet management (provided by Ioki) will be constantly monitored by the local public transport operator. The dashboard will allow to monitor the position of vehicles in real time, track the bookings and collect and analyze data regarding shuttle operation.

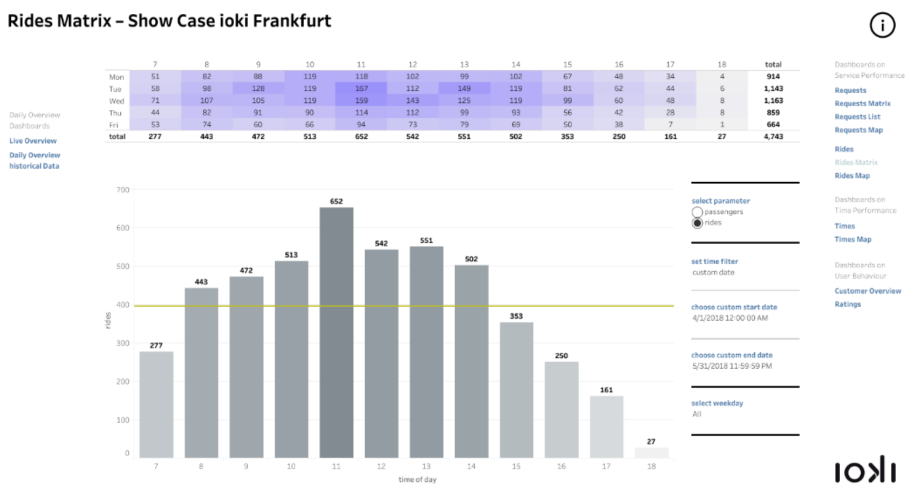


Figure 30: Ioki fleet management dashboard.

- Link between the PT stops and the hospital district (UC1.10)

  A public transport user gets off at a (bus or metro) stop near/along the authorised route and gets on the autonomous vehicle, having booked the service via a dedicated app.

Figure 31: Visualisation of the test cases in Turin.

Evaluation methods

Stakeholders and end users

The involved stakeholders and the potential users of Turin pilot site include patients at the hospital, ca 40% will be elderly, people with chronic diseases, other PRM (physical and rehabilitation medicine), employees at the hospital, TMC operator and the Tier 1 supplier for the C ITC solution, see Table 26.

Table 26: End users and Stakeholders in Turin.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator)	Patients/employees at the hospital. Students (university/high schools). Any interested user > 18 yy. Safety drivers
Public interest groups and associations	No
Decision-making authorities or regulators	City of Turin “City of Health and Science”
Operators (public transport operators, private fleet operators etc.)	GTT
Mobility service providers	Ioki
Industry (AV manufacturers etc)	Navya, Swarco, 5T, Links, Yape

Study design, capturing and monitoring tools

Vehicle data will be collected continuously in all vehicles and stored locally. Data will be uploaded to WP5 Data Management Platform at least mid and end of the Final pilot. For subjective data, surveys will be done also mid and end of final Pilot, see Table 10 for more information. Stakeholder interviews are those defined in the stakeholder table above and will be conducted at the end of the final Pilot.

Greece: Trikala

Key objectives

Trikala will develop an integrated transport and mobility service of passenger and freight in cooperation with public transport operator, the Trikala Municipality, Traffic Police and other local stakeholders.

The key objectives for the Trikala site are as follows:

- Operation of automated shuttles fleet DRT service to serve suburban areas at the outskirts of the city with the focus on active users working in the city centre, and on vulnerable user groups (elderly, low-income, immigrants), connecting them with the train station , the university, a big thematic park/museum and the city center The service will be complemented by a fleet of 2 automated passenger cars.
- Future exploitation of the DRT CAVs' services as permanent and integration to the MaaS platform under construction (in the framework of the SMATRA2 project) focusing on the inclusiveness for people living in suburban areas, students and tourists.
- Integration of the abovementioned integrated system in the city's traffic management system which will be implemented within next year in order to optimise and prioritise the PT system service levels.
- Implementing mechanisms related to interaction of the CAVs and digital infrastructure with VRUs and other vehicle drivers.
- Integration of a fleet of delivery robots in the city center for delivery of parcels and small freight in order to optimize load capacity and distribution as well as eliminated the usage of ICE delivery cars inside the pedestrian area and city center.
- Measuring the sustainability indicators (emissions, reliability) of the integration and assessing the potential towards carbon-neutrality.
- Assessing and measuring the impacts on citizens' mobility patterns, modal shift, level of satisfaction and distributional effects on citizens' perceived well-being with the focus on vulnerable user groups.
- Demonstrating sustainable people-public-private partnerships and highlighting critical societal success factors (user acceptance, political consensus, ecosystem stability).

Test cases

In total 7 use cases are planned in Trikala. The site-specific test cases are as follows:

- Autonomous shuttles operation in real urban mixed-traffic environment connecting City Centre with University at the outskirts of the city (UC1.1a)

  The route of the automated shuttles runs between the city centre and the University covering also specific points of interest of the citizens such as a big thematic park/museum, the train station, major suburbs and villages. The bus starts its route from the terminal at the city centre under normal traffic and environmental conditions with a maximum speed of 25km/h. The remote PT operator monitors continuously the bus via the fleet management software installed in the control centre. The bus follows the heavy traffic in front, adjusts accordingly its speed and brakes smoothly following the traffic in front. Passengers wait at the predefined bus stations and are informed for the bus arrival time via their mobile application. The bus stations are also equipped with the bus schedule. The bus follows the route and stops at each station where passengers are detected. The passenger enters the vehicle. The bus arrives at a signalised intersection and communicates with the traffic lights in order the green wave to be implemented. The bus stops at the next bus station upon the request of the passenger via the stop button installed inside the vehicle. The passenger exits the bus. The bus continues the route, with priority and reaches its final destination at the depot area.

- Autonomous delivery robots (YAPES) operation in real urban bike-lane and pedestrian city-centre environment (UC1.1b)

  Trikala site will have a delivery service that will be provided between the Municipality building, pick-up point and delivery points which are ELTA Courier and 3 kiosks located in the pedestrian area of the city. A fleet of 5 droids (YAPES) will deliver parcels/envelops between the Municipality building and the ELTA Courier ,with the cooperation of local stakeholders and courier services. It will also serve the delivery of freight to local stakeholders at a pedestrian road at the city center between the Municipality parking area and the three kiosks.

  The services will be performed once or twice a day, depending on demand. Droids will move on a bike lane, which is almost flat. The width of the bike lane, in general, is 1,50m, and a few more narrow parts where it is 1,20m. The cycle lane is on the roadway and runs parallel to the footway. The cycle lane is partly physically separated by posts from the vehicular lane and partly separated only by painted line markings on the roadway. Along the circular route, the YAPES will have to cross 5 road intersections, 2 of which are controlled by traffic lights.

  This demonstrator will show why and how this kind of a novel transport services will be useful and beneficial for the local people to improve their mobility and goods delivery offering.

  The delivery robot' load is packaged in with the help of the vehicle operator. The safety driver that follows the robot monitors continuously the vehicle's route. The robot follows its predefined route and stops at the fixed location either to the Municipality building or to local stakeholders to the pedestrian road to unload part of its cargo. The vehicle parks safely in an autonomous way. The local business stakeholder picks up the load via the help of the YAPE app. The vehicle continues its route, stops at every delivery location until all the goods are delivered. The vehicle parks at the depot area. The delivery robots will be continuously monitored from the remote control room and, if necessary, the operator will take control and manage critical operations.

- Autonomous shuttles operation in real urban mixed and complex traffic environments involving intersections and roundabout connecting City Centre with the University (UC1.2)

  Two autonomous shuttles will operate on a fixed line. The route of the automated shuttles runs between the city centre and the University covering also specific points of interest of the citizens such as Trikala's thematic park/museum, train station and major suburbs and Villages.

  The shuttle starts its route from the terminal under normal traffic and environmental conditions with a maximum speed of 25km/h. The remote PT operator monitors continuously the shuttle via the fleet management software installed in the control centre. The shuttle follows the heavy traffic in front, adjusts accordingly its speed and brakes smoothly whenever the vehicles in front are braking. Passengers wait at the predefined bus stations and are informed for the shuttle arrival time via their mobile application. The shuttle stations are also equipped with the bus schedule. The bus follows the route and stops at each station where passengers are detected. The passenger enters the vehicle. The shuttle arrives at a signalised intersection and communicates with the traffic lights in order the green wave to be implemented. The shuttle stops at the next bus station upon the request of the passenger via the stop button installed inside the vehicle. The passenger exits the bus. The shuttle continues the route, but another vehicle is blocking the road as the bus in not running in a dedicated lane. The shuttle detects this obstacle and is safely immobilised. The remote operator monitors the situation for the remote-control centre. After the vehicle moves and unblocks the road the shuttle continues its route. The routing schedule is updated, and the passengers are informed for the new arrival times at each station. The shuttle continues the route, delivers the rest of the passengers at the next stations and after all the passengers are exit, follows the roundabout on the route with priority and reaches its final destination at the depot area.

- Autonomous passenger vehicles operation in real urban mixed and complex traffic environments involving pedestrian crossings and VRUs connecting City Centre with University (UC1.3a)

  Two autonomous passenger vehicles will operate on a fixed line. The route of the automated passenger vehicles runs between the city centre and the University complementing the shuttles operation in high demand.

  The vehicle starts its route from the terminal under normal traffic and environmental conditions with a maximum speed of 25km/h. The remote PT operator monitors continuously the vehicle via the fleet management software installed in the control centre. The vehicle follows the traffic in front and reaches a pedestrian crossing where people are waiting to cross the road.

  In the context of this test case, there are two basic solutions that have been already described in D7.3 in detail and will be tested and concern a) a C-ITS solution for direct and bilateral communication between VRU and the AV, that upon detection of VRUs, results in warnings to them (through visual and audio messages in a custom wearable carried by the VRUs) and, b) a C-ITS solution specifically for VRUs moving on zebra crossings, regardless if there is or there is not traffic light (and the VRUs ignore it or not). The second solution and upon detection of the VRU, results in a visible actuation of the headlights and/or the horn of the AV and, also, in the actuation of a buzzer/horn installed at the zebra crossing.

  Those solutions, including the custom wearable in the second solution will be developed by CERTH/HIT and the testing will take place upon specific scenarios and recruited participants using the CERTH/HIT retrofitted passenger vehicles. The scenarios topology will lie in zebra crossings (for the second solution) and in other relatively protected from surrounding traffic spots (for the first solution). Especially in the first solution, the scenarios will be designed to involve obstructed and not-obstructed VRUs.

  In both cases, the VRUs addressed are pedestrians and cyclists.

  Logging: Apart from the user feedback that will be collected through the VRU acceptance survey, there will be performance data logged that will concern the following:

  - Detection of VRU [Successful/ Not successful]

- Timing of VRU detection on behalf of the vehicle [time of actual VRU presence in field vs time of VRU detection by the system]
- Timing of the warning receipt on behalf of the VRU [time of warning/notification issued by the system vs time of warning/notification received by the VRU]
- Time to Collision between the AV and the VRU
- Actuation of the AV (deceleration/ braking) [type of actuation & timing of the actuation as of the time VRU has been detected in critical TTC]

Logging will happen in all cooperative system ends (vehicle, infrastructure) and with the complementary use of event diaries.

▪ Autonomous delivery robots operation, smooth braking and immobilisation in real urban bike lane and pedestrian city-centre environment (UC1.3b)

The Yape robot follows its predefined route and stops at the fixed location in order to unload part of its cargo. The vehicle parks safely in an autonomous way. The local business stakeholder picks up the load via the robotised freight boxes. The vehicle continues its route, but a pedestrian is crossing the road. The vehicle detects the pedestrian, adjusts its speed and stops smoothly. The safety person on the control room can also activate the emergency brake in critical situation. After the pedestrian moves and the road is unblocked the vehicle continues its route towards every delivery location until all the goods are delivered. The vehicle parks at the depot area.

▪ Autonomous shuttles and delivery robots remote monitoring and emergency braking for immobilization mechanism via the connection with the remote-control centre (UC1.7)

The operations are described in 1.1-1.3, i.e. monitoring and focus on emergency brake and immobilisation.

▪ Autonomous shuttles and passenger cars DRT operation via a MaaS service within a fixed route in real urban mixed traffic environment connecting City Centre with the University (UC1.10)

Two autonomous shuttles will operate on a fixed line on demand. The user requests a ride via its mobile application by setting the pickup bus station, its destination bus station and time of departure. The system collects all the relevant requests that exceeds the capacity of the autonomous shuttles and performs the optimised route scheduling including the capacity of the 2 passenger cars fleet. The passengers are informed about their request (accept or deny), the vehicle that is going to collect them from the predefined bus stop and the pickup time. The shuttle and the passenger cars start their route from the terminal under normal traffic and environmental conditions with a maximum speed of 25 km/h. The remote PT operator monitors continuously the vehicles via the fleet management software installed in the control centre. Passengers wait at the requested bus stations and are informed for the vehicles arrival time via their mobile application. The bus stations are also equipped with the vehicles' schedule. The shuttle and the passenger cars follow the route and stop at each station where the system has provided. The passenger enters the vehicle that is assigned to. The shuttles and the vehicles stop at the requested by the scheduling system bus stations. The passengers exit the vehicles. The vehicles continue the route and reach their destination at the depot area.

Evaluation methods

End users and stakeholders

The pilot site in Trikala is for all citizens going to and from the University at the outskirts of the city. Of specific interest is the vulnerable user groups living in the suburbs such as women/elderly as well as students and tourists, see Table 27.

Table 27: End users and Stakeholders in Trikala.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator	Commuters to the city center from the suburbs Students commuting to/from the University Tourists commuting to the Trikala thematic park/museum Commuters to the train station to
Public interest groups and associations	-
Decision-making authorities or regulators	Municipality of Trikala
Operators (public transport operators, private fleet operators etc.)	Local Public transport operator
Mobility service providers	No
Industry (AV manufacturers etc.)	Vodafone, Bosch, YAPE mobility
Other	Local stores e-commerce users Courier service provider

Study design, capturing and monitoring tools

Vehicle data will be collected continuously in all vehicles and stored locally. Data will be uploaded to WP5 Data Management Platform at least mid and end of the Final pilot. For subjective data, surveys will be done also mid and end of final Pilot, see Table 10 for more information. Stakeholder interviews are those defined in the stakeholder table above and will be conducted at the end of the final Pilot.

The Netherlands: Brainport, Eindhoven[5]

Key objectives

The key objectives for Brainport are the following:

- to demonstrate cooperative automated driving technologies with solutions for smooth and safe intersection crossing with normal roads, aimed for PT buses and shuttles, and platooning with shared passenger cars.
- to utilize day 1 C-ITS services for safe and informed intersection crossing.
- to support L4 and cooperative driving technologies for crossings traffic light intersections with presence of other vehicles and VRU.

Test cases

The specific test cases are as follows:

- Intersection crossing at normal operational speed (UC1.1)

  The automated vehicle will start at point A (e.g. a bus stop and pick up a passenger) that needs to reach a destination in a point B. The automated vehicle will handle preceding traffic, will pass through intersections and for that it will be capable of handling information that comes from traffic lights. The vehicle adjusts the speed in response to C-ITS services for traffic light status, red-light violation warnings, and emergency vehicles.

- Safety for VRU at intersections (UC1.3)

  The vehicles are equipped with C-ITS enabled functions for crossing intersections at normal operational speed. Concerning the interaction with VRU's, the vehicles can receive C-ITS Messages (CPM or DENM) about the presence of VRU's at intersections (all type of VRUs are accommodated). The automated vehicle adjusts the speed, if needed, to avoid too severe braking in case the detected VRU would cross the road when the vehicle is close (see more in D7.3). TNO is responsible for all the development and C-ITS functions on vehicle side for their vehicles that have been currently involved in the trials in the controlled environment. The function has been already tested by TNO with dummies representing pedestrians for safety reasons (results will be presented in D11.3 first issue). The scenarios executed involved a notification of presence of a VRU with the VRU remaining a) next to the road and b) being on the road when the AV is close. In future operational plans of TNO – to be acknowledged in the next issue of this Deliverable – the C-ITS functions might be replicated in the context of an operational service as well.

  Logging: In the VRU related scenarios the message on the presence of the VRU was continuous broadcasted. The vehicle initiated braking at the same distance to the event for each repetition, and in case the VRU appeared not to be on the road the vehicle automatically accelerated to the set speed. The interest was to obtain feedback of the passengers for both scenarios (i.e. VRU on the road or next to the road). The data logging has been initiated at about 150 m distance to the event.

---

[5] Plans will be revisited in the next update.

- Vehicle relocation for automated mobility using platooning (UC1.8)

  At a bus stop or predefined point, empty automated vehicles will form a platoon. The leader of the platoon is a vehicle driven by a human. The platoon of vehicles will drive to a predefined destination, crossing an intersection. The platoon assembly will adjust to situations at intersections that it is crossing.

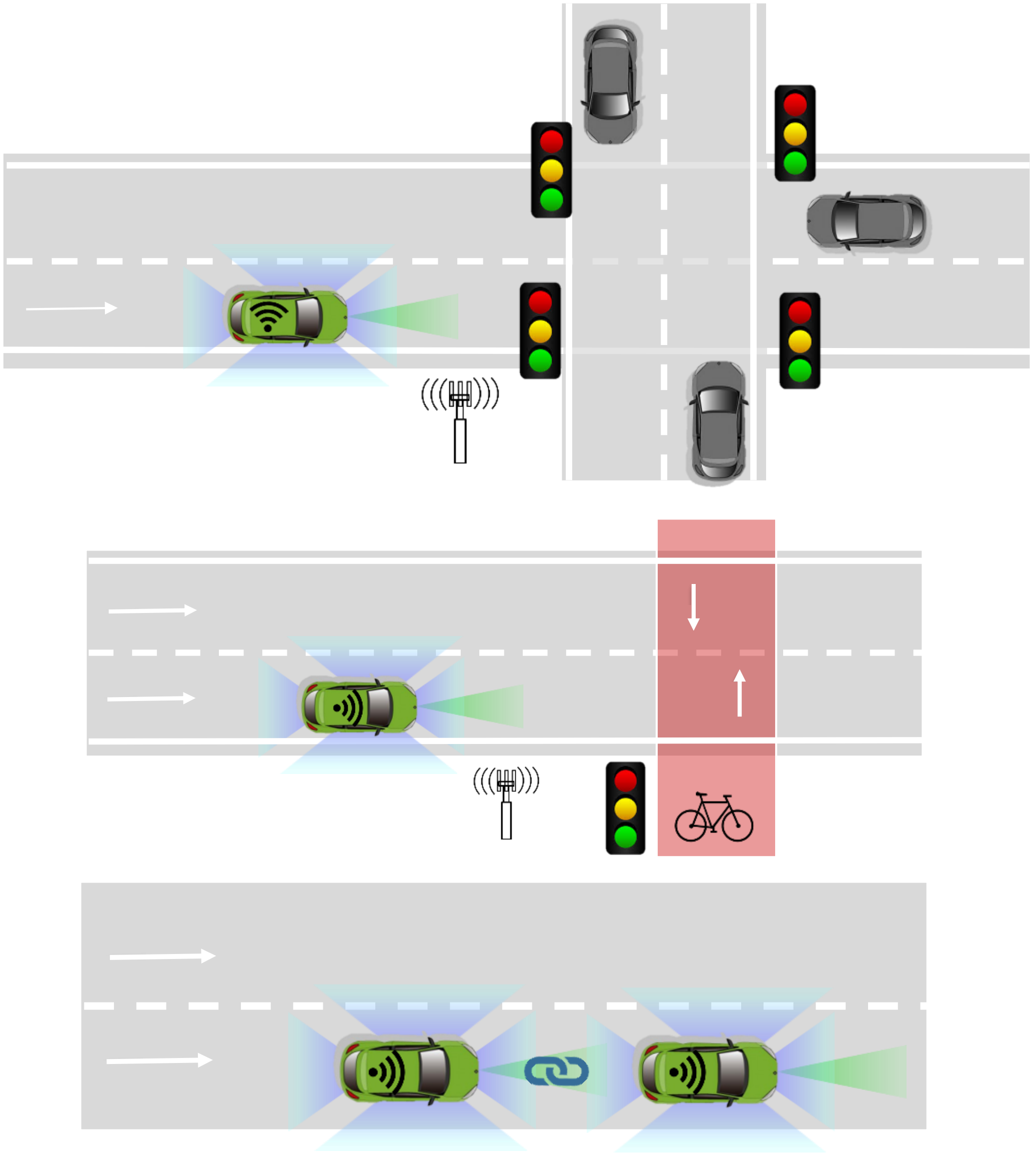


Figure 32: Visualisation of the test cases in Brainport.

Evaluation methods

Stakeholders and end users

Note: The description below is according to updated plans that are pending approval.

Targeted end users are visitors that park their car next to an indoor amusement park outside the city ring, city residents and students visiting the amusement park. For the evaluations also VRU is of specific interest, and the safety drivers experience. Stakeholders and end users are presented in Table 28.

Table 28: End users and Stakeholders in Brainport.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator	City visitors, residents and students Safety drivers
Public interest groups and associations	No
Decision-making authorities or regulators	City of Hasselt
Operators (e.g. public transport operators, private fleet operators)	No
Mobility service providers	No
Industry (e.g. AV manufacturers)	AuveTech (to be reflected in the next issue)

Study design, capture and monitoring tools

Vehicle data will be collected continuously in all vehicles and stored locally. Data will be uploaded to WP5 Data Management Platform at least mid and end of the Final pilot. For subjective data, surveys will be done also mid and end of final Pilot, see Table 10 for more information. Stakeholder interviews are those defined in the stakeholder table above and will be conducted at the end of the final Pilot.

Czech Republic: Brno

Key objectives

The key objective for Brno is the following:

- Autonomous traffic will interface with and complement an existing PT service. The PT service will connect places that are poorly served as well as optimize routes to provide the group of users with increased mobility, especially people with disabilities, elderly, students, and under-aged people.

Test cases

In total Brno demonstrate 5 use cases. Their site-specific test cases are as follows:

- Normal speed robotaxi service (UC1.1)

  The goal is to demonstrate the possibility of semi-autonomous transport in the old part of the city, which is inaccessible to ordinary urban transport. The vehicle could be booked via telephone number to increase accessibility of the service for disabled people. An electric shuttle/or Robotaxi will be used for this task.

- Lower speed shuttle service (UC1.2)

  The goal is to demonstrate the possibility of semi-autonomous transport in the old part of the city, which is inaccessible to ordinary urban transport. An electric shuttle will be used for this task. The operational model and operating hours will reflect the time schedules of regular PT to allow for smooth transitions of passengers between these two modes.

- Lower speed shuttle service serving students, commuters, tourists (UC1.3)

  The goal is to demonstrate the possibility of using automated vehicles for specialized uses.

- Traffic centre controlled remote automated driving over long distance (up to 200 km) (UC1.7).

  This centre allows for a management of operations from one central place and also adds another level of safety and security through the possibility of remote driving in case something unexpected happens and the vehicle cannot properly react.

Evaluation Methods

End users and stakeholders

In Brno the target groups are users with disabilities (blind persons), elderly, students, young people, commuters and tourists, see Table 29.

Table 29: End users and Stakeholders in Brno.

Stakeholders	Org. Name
Vehicle users (end users, drivers, and remote operator	Commuters Tourists
Public interest groups and associations	No
Decision-making authorities or regulators	Ministry of Transport
Operators (e.g. public transport operators, private fleet operators)	TBD
Mobility service providers	TBD
Industry (e.g. AV manufacturers)	Esagono Energia, Roboauto, Technotrade

Study design, capturing and monitoring tools

Vehicle data will be collected continuously in all vehicles and stored locally. Data will be uploaded to WP5 Data Management Platform at least mid and end of the Final pilot. For subjective data surveys will be done also mid and end of final Pilot, see Table 10 for more information. Stakeholder interviews are those defined in the stakeholder table above and will be conducted at the end of the final Pilot.

Appendix II: Overall Impact Assessment Framework – M3ICA Steps

The full description of the steps of the overall impact assessment methodology is presented here.

Step 1: Identifying stakeholders, criteria, and weighting

In this first step, discrete stakeholder groups are identified first, by consulting relevant literature on autonomous mobility and logistics. Based on the stakeholder categories that were reviewed from literature, and from clusters from the SHOW ecosystem, the broad classifications were defined for SHOW and AV mobility. Listed in Table 11, these stakeholders that were defined, with the goal of operationalising the stakeholder analysis of the M3ICA framework are overviewed. They are further matched to ecosystem stakeholders, as defined in SHOW deliverable D1.1, and their relation to passenger mobility and urban logistics.

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

Table 30: M3ICA stakeholder groups in relation to SHOW stakeholder clusters

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

Defined M3ICA stakeholder groups	**SHOW stakeholder ecosystem clusters (as described in D1.1)**	**Passenger mobility**	**Urban logistics**
Delivery service providers	-		✓

Secondly, criteria are defined for the SHOW's pilot ecosystem. As such, broad impact areas from SHOW's evaluative needs (defined in WP13) are further refined in relation to AV impact literature. As introduced, the M3ICA integrates underlying methods from the MAMCA (Macharis et al., 2012), and in this context, criteria represent the goals and objectives of the stakeholders (Macharis & Baudry, 2018). Following MAMCA literature, criteria are developed using relevant literature and the objectives of the analysis, which in this case is impact assessment. For the purpose of the M3ICA, it has been decided to define identical criteria across all stakeholder groups to ensure the output from the analysis can be comparable between stakeholders. Of course, criteria can be excluded for specific stakeholders when they are not relevant to them or their use case. Furthermore, Stakeholders can also be involved in this process for their feedback and agreement of criteria, though the practitioner leads the process (Macharis et al., 2012). Criteria were identified following impacts that are of specific focus in WP13.

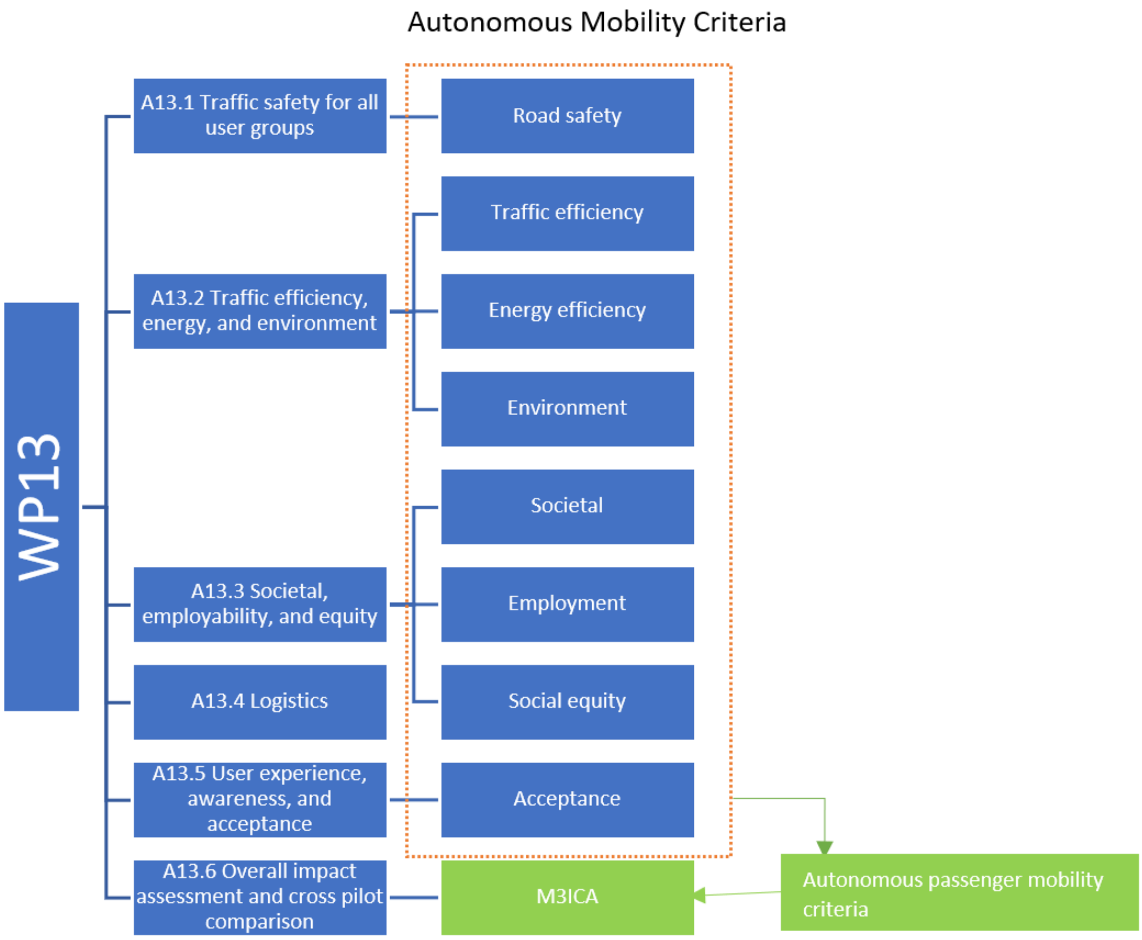


Figure 33: An overview of the relationship between WP13 activities and criteria derived internally and from literature.

In this last sub-step, stakeholders will weigh the predefined criteria as defined in step 1b, using existing weighing methods, and as reviewed by Macharis et al. (2012). The methods that can be applied are, Saaty's analytic hierarchy process (AHP), Edward's simple multi-attribute rating technique (SMART), and the Anderson's functional measurement (FM). The SMART approach is preferred due to the fact that it is considered a more intuitive weighing method.

Step 2: Defining and Scoring Scenarios

The second step of the M3ICA framework is essentially the second step of the MAMCA approach. For MAMCA, this is the final stage of the analysis. In that final stage, weighted criteria are assigned a performance score by stakeholders for each scenario. In this section, scenarios are defined in relation to the delineation of AV service types that are implemented in the SHOW project. Scenarios are chosen over technical forecasts because they are more adaptable and can easily incorporate more flexible conceptualizations of future AV services (Nogués et al., 2020).

The goal of developing M3ICA scenarios is to test various AV operation configurations within a predefined scope. The definition of the scenarios is supported by the SPACE use cases as well as the SHOW use cases. In this stage, it is critical that scenarios are optimally chosen but differentiable in order to ensure comparable analysis and meaningful results. This is further supported with academic literature that has investigated and classified AV scenarios.

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

At each site, the stakeholders will assign scores to the defined criteria under the scenario that is relevant to them.

Step 3: Defining Impact Levels

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

To define the impact levels in step 3, a literature review was conducted from which AV deployment impacts were delineated. Commonly used automation impact frameworks were identified that aid in conceptualising impacts through linkages and hierarchies. Based on the review, a hierarchy that conceptualises impacts as three levels was defined, which is similar to Milakis et al.'s (2017) spheres of influence (see Figure 33 below). The lower the impact level, the lower the spatial resolution, following Smith's et al. (2018) AV Benefits Framework. According to that framework, the spatial resolution begins at the level of the person or vehicle, then the transport network, and finally beyond the transport system. The overall scoring or evaluation of criteria or KPIs by stakeholders were then structured in the form of levels. This allows the understanding and weighing of impact criteria or KPIs grouped in relation to impact levels.

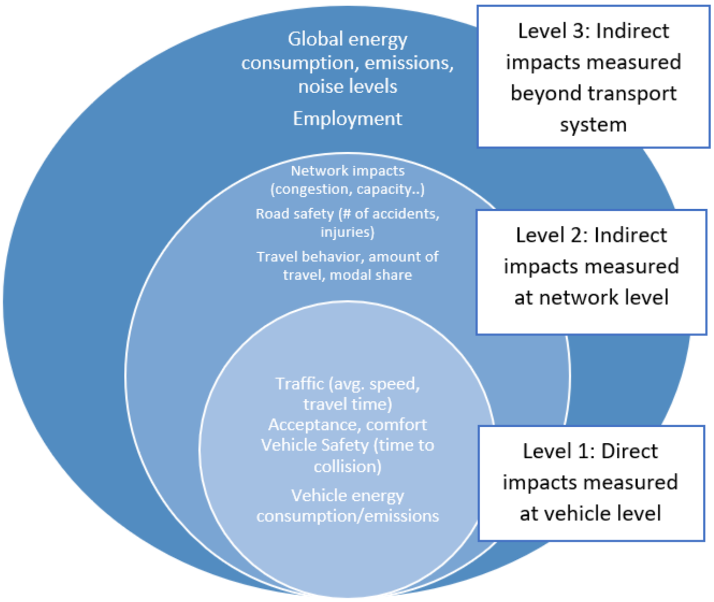


Figure 34: Proposed M3ICA Impact Hierarchy.

Step 4: Setting up the pilot and simulation evaluation

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

Step 5: Applying KPIs in pilot sites and simulation

The full updated KPI list can be found in Appendix IV.

Step 6: Performing the Overall Analysis

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Appendix III: Surveys and interview guides

Pre-Acceptance Survey

The aim of this survey is to get a deeper understanding of citizens' needs, wants and acceptance of transportation solutions today and in the future, when automated solutions will be a part of the system. The study is co-financed by the EU project SHOW and in realised in the context of the pilot evaluation across all its test sites in Europe.

By responding to the question in the web survey you also accept that we can use your answers in this research study.

You can withdraw whenever you want to without any reason. Your answers will be stored separately and are anonymous, that means without any connection to you personally.

For further information, please visit our website:

https://show-project.eu/citizens-engagement/

1. I confirm that I am 18 years or older.

☐Yes

☐ No

2. What is your level of knowledge about automated vehicles?

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

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

☐ Beginner (e.g., I only heard about Google Car or Tesla)

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

3. Do you have a public transport subscription?

☐ Yes

☐ No

a. If yes, is it an annual or a monthly subscription?

☐ Annual

☐ Monthly

☐ Other

4. What other subscription do you have?

____

____

____

____

____

5. What mode of transport do you usually use?

☐ Public transport

☐ Carpooling

☐ Private car

☐ Motorcycle/scooter/moped

☐ Bicycle, roller, etc.

☐ Walking

6. In general, how would you rate your current mobility experience?

very unsatisfying						very unsatisfying
1	2	3	4	5	6	7

7. On a scale from 1 to 7, how important are the following aspects for a good travelling experience for you? (1 = not at all important; 7 = very important)

    a. Safety

not at all important						Very important
1	2	3	4	5	6	7

    b. Punctuality

not at all important						Very important
1	2	3	4	5	6	7

    c. Good connection with other transport mode

not at all important						Very important
1	2	3	4	5	6	7

    d. Minimum interchanges

not at all important						Very important
1	2	3	4	5	6	7

e. Real-time information during the journey

not at all important						Very important
1	2	3	4	5	6	7

f. Comfort/Hygiene (e.g. seating, cleanliness)

not at all important						Very important
1	2	3	4	5	6	7

g. High perception of reliability

not at all important						Very important
1	2	3	4	5	6	7

h. Cost

not at all important						Very important
1	2	3	4	5	6	7

i. High service frequency

not at all important						Very important
1	2	3	4	5	6	7

j. High perception of security inside the vehicle

not at all important						Very important
1	2	3	4	5	6	7

k. Trust in the service provider

not at all important						Very important
1	2	3	4	5	6	7

l. Door-to-door travel time

not at all important						Very important
1	2	3	4	5	6	7

m. Physical accessibility

not at all important						Very important
1	2	3	4	5	6	7

n. No hassle searching for a parking space

not at all important						Very important
1	2	3	4	5	6	7

o. Availability of staff on-board to assist me

not at all important						Very important
1	2	3	4	5	6	7

p. Availability of online customer service to assist me

not at all important						Very important
1	2	3	4	5	6	7

q. Clear and easy use of ticketing and/or integrating ticketing

not at all important						Very important
1	2	3	4	5	6	7

8. An automated vehicle is capable of driving without the driver's intervention – during parts of, or the entire ride. Have you ever seen an automated vehicle?

☐Yes

☐No

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

☐ Yes

☐ No

☐ I don't know

☐ Train/Metro

☐ Bus/Shuttle

☐ Private passenger car

☐ Other passenger car (taxi, sharing, pooling)

10. The experience with an automated Train/Metro was...

not good at all				very good
1	2	3	4	5

11. The experience with an automated bus/shuttle was...

not good at all				very good
1	2	3	4	5

12. The experience with an automated private passenger vehicle was...

not good at all				very good
1	2	3	4	5

13. The experience with an autonomous other passenger car (taxi, sharing, pooling) was...

not good at all				very good
1	2	3	4	5

14. To what extent do you consider the following aspects important when you select an automated vehicle?

a. I would be able to engage in other activities during my trips (like reading, working, relaxing)

not at all important						Very important
1	2	3	4	5	6	7

b. It would be punctual

not at all important						Very important
1	2	3	4	5	6	7

c. It would offer me better connection with other transport modes (e.g., between bus and train)

not at all important						Very important
1	2	3	4	5	6	7

d. It would be cheaper

not at all important						Very important
1	2	3	4	5	6	7

e. I do not like driving

not at all important						Very important
1	2	3	4	5	6	7

f. There would be fewer accidents because human errors will be significantly decreased.

not at all important						Very important
1	2	3	4	5	6	7

g. It would be more environmentally friendly

not at all important						Very important

1	2	3	4	5	6	7

h. It would cover parts of my journey that they are not covered until now (first-last mile)

not at all important						Very important
1	2	3	4	5	6	7

i. The journey would be more comfortable

not at all important						Very important
1	2	3	4	5	6	7

j. There would be more frequent service

not at all important						Very important
1	2	3	4	5	6	7

k. The journey would be faster

not at all important						Very important
1	2	3	4	5	6	7

15. Why would you refrain from using an automated vehicle?

a. The journey would not be safe and/or secure

Totally disagree						Totally agree
1	2	3	4	5	6	7

b. It would be unreliable

Totally disagree						Totally agree
1	2	3	4	5	6	7

c. It would be expensive

Totally disagree						Totally agree
1	2	3	4	5	6	7

d. It would not be fast enough

Totally disagree						Totally agree
1	2	3	4	5	6	7

e. It would not be punctual enough

Totally disagree						Totally agree
1	2	3	4	5	6	7

f. I would trust humans more than the[autonomous solution]

Totally disagree						Totally agree
1	2	3	4	5	6	7

g. It would not be environmentally friendly

Totally disagree						Totally agree
1	2	3	4	5	6	7

h. I would be afraid that my personal data could be hacked

Totally disagree						Totally agree
1	2	3	4	5	6	7

i. It would be too complicated to use it

Totally disagree						Totally agree
1	2	3	4	5	6	7

j. I want to have control of the vehicle

Totally disagree						Totally agree
1	2	3	4	5	6	7

k. There would be no human contact on board

Totally disagree						Totally agree
1	2	3	4	5	6	7

l. It would not be frequent enough

Totally disagree						Totally agree
1	2	3	4	5	6	7

m. It would be difficult to access

Totally disagree						Totally agree
1	2	3	4	5	6	7

n. I enjoy driving

Totally disagree						Totally agree
1	2	3	4	5	6	7

16. For each statement, indicate your degree of agreement, from 1 = totally disagree to 9= totally agree. The intermediate values are used to qualify your judgment. I think the JOURNEY with an automated bus/shuttle would be…

a. Pleasant

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

b. Relaxing

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

c. Comfortable

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

d. Safe

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

e. Easy

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

f. Fast

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

g. Cheap

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

17. For each statement, indicate your degree of agreement, from 1 = totally disagree to 9= totally agree. The intermediate values are used to qualify your judgment. I think the JOURNEY with an automated car with other passengers (taxi, sharing, pooling) would be…

    a. Pleasant

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

b. Relaxing

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

c. Comfortable

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

d. Safe

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

e. Easy

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

f. Fast

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

g. Cheap

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

18. Regarding the following propositions, indicate your degree of agreement
    a. I would use an automated vehicle if it is shared.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

    b. I would use an automated vehicle if it is individual.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

    c. I would not use an automated vehicle.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

19. How useful do you think that an automated vehicle would be in the following areas?
    a. Urban

Not useful						Very useful
1	2	3	4	5	6	7

    b. Peri-urban

Not useful						Very useful
1	2	3	4	5	6	7

    c. Rural

Not useful						Very useful
1	2	3	4	5	6	7

    d. Confined area (e.g., university, hospital, airport, etc.)

Not useful						Very useful

1	2	3	4	5	6	7

20. I would use an autonomous bus/shuttle for ...

☐Commuting

☐Business/ Work travel

☐ Leisure

☐ Shopping and errands

☐ Going to/from School/University

☐ Visiting family and friends

☐ I would not take this means of transport

21. I would use an autonomous car without other passengers for ...

☐Commuting

☐Business/ Work travel

☐ Leisure

☐ Shopping and errands

☐ Going to/from School/University

☐ Visiting family and friends

☐ I would not take this means of transport

22. I would use an autonomous car with other passengers (taxi, sharing, pooling) for ...

☐Commuting

☐Business/ Work travel

☐ Leisure

☐ Shopping and errands

☐ Going to/from School/University

☐ Visiting family and friends

☐ I would not take this means of transport

23. For the automated mobility service, you would prefer to...

...order your transport via an application

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

...order your transport at a dedicated terminal on public roads

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

...order your transport from a sales agent

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

...not make a reservation but to wait at a collection point with fixed passage times

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

...to make a booking via a phone call

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

24. Before using an automated vehicle for the first time, you would prefer…
    a. A tutorial on a dedicated terminal

Totally disagree				Totally agree
1	2	3	4	5

    b. A tutorial on the mobile phone or available on the internet

Totally disagree				Totally agree
1	2	3	4	5

c. Training carried out by the transporter

Totally disagree				Totally agree
1	2	3	4	5

d. Real person that accompanies you on the first trip and provides explanation

Totally disagree				Totally agree
1	2	3	4	5

e. A paper booklet

Totally disagree				Totally agree
1	2	3	4	5

25. You would prefer to...

...pay with your usual public transport card

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

...pay using a mobile application

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

...pay directly in the vehicle

Totally disagree								Totally agree

1	2	3	4	5	6	7	8	9

...receive an invoice and pay at a date chosen by you

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

...pay by credit card

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

26. Concerning the use of the vehicle, I would prefer:

☐On expressways

☐On roads with mixed traffic (i.e. conventional and automated vehicles share the same roads)

☐On dedicated lanes

27. For each of the following statements, please indicate your degree of agreement
    a. I think an automated solution will become an important part of the existing public transport system.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

b. I think using an automated solution in my day-to-day commuting would be better and more convenient than my existing form of travel.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

c. I think an automated solution would be more efficient/faster than existing forms of public transport.

Totally disagree								Totally agree

1	2	3	4	5	6	7	8	9

d. I think an automated solution would be easy to understand how to use.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

e. It would not take me long to learn how to use an automated solution.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

f. The people around me think that I should use an automated solution.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

g. I think I am more likely to use an automated solution if my friends and family used it.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

h. If it were affordable, I would use an automated solution.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

28. What is your age?

____

____

____

29. What is your gender?

☐Male

☐Female

☐Other

☐Prefer not so say

30. The annual income of my household before tax is approximately (please SELECT your nearest estimate)

☐Under €12.000

☐€12.000-24.000

☐€24.001-36.000

☐€36.001-60.000

☐€61.001-90.000

☐Over €90.000

☐Prefer not to say

31. Do you need any type of assistance to support your mobility on any of these aspects? (multiple answers possible)

☐Motor

☐Auditory

☐Visual

☐Mental

☐Not applicable

☐I prefer not to say

32. In which type of household do you live in?

☐Single person household

☐Multi-person household without children

☐Multi-person household with children

33. Please indicate your level of education.

☐Primary/Elementary/High School Degree

☐Trade/Technical training

☐Bachelor Degree

☐Master Degree

☐PhD

34. What is your employment status?

☐Higher managerial, administrative and professional occupations

☐Intermediate occupations

☐Small employers and own account workers

☐Lower supervisory and technical occupations

☐Semi-routine and routine occupations

☐Never worked and/or long-term unemployed

☐Student

☐Pensioner

☐Unemployed

☐Homemaker

☐Other

35. If other, please specify your employment status:

____

36. In which geographical area do you live in?

☐Urban

☐Peri-urban

☐Rural

Thank you for participating!

More information about the European project SHOW can be found on (website link)

Acceptance Survey (passenger mobility)

The aim of this survey is to get a deeper understanding of citizens' needs, wants and acceptance of transportation solutions today and in the future, when automated solutions will be a part of the system. The study is co-financed by the EU project SHOW and in realised in the context of the pilot evaluation across all its test sites in Europe.

By responding to the question in the web survey you also accept that we can use your answers in this research study.

You can withdraw whenever you want to without any reason. Your answers will be stored separately and are anonymous, that means without any connection to you personally.

More information about the European project SHOW can be found on https://show-project.eu/

I confirm that I am 18 years old or older.

☐Yes

☐No

Please create an anonymous code for yourself. This code will be unique to you while it will keep your anonymity. To create this code, please enter the following information (all letters in lower case):

1. Second letter of your first name

2. Last digit of your year of birth

3. Third letter of your month of birth

4. Second letter of your mother's first name

5. Third letter of your mother's first name

____

____

____

1. How often do you usually use the following modes of transport?

☐On a daily basis

☐On a weekly basis

☐On a monthly basis

☐A few times a year

☐Rarely

☐Never

☐Automated mobility solutions

☐Public transport

☐Taxi/ride hailing

☐Car pooling

☐Car sharing

☐Private car

☐Motorcycle / moped

☐E-bike / e-scooter(PLEV)

☐Bicycle / scooter

☐Walking

☐Why did you take an automated vehicle?

☐Curiosity

☐Tourism

☐Commuting

☐Errands

☐Leisure

☐Other

2. Why did you take an automated vehicle?

____

____

____

____

____

If other, please specify:

____

____

____

____

____

3. Indicate the year of your journey with the automated vehicle:

☐2022

☐2023

4. Indicate the month of your journey with the automated vehicle:

☐January

☐February

☐March

☐April

☐May

☐June

☐July

☐August

☐September

☐October

☐November

☐December

5. Please indicate the day of the month your journey with the automated vehicle:

☐1

☐2

☐3

☐4

☐5

☐6

☐7

☐8

☐9

☐10

☐11

☐12

☐13

☐14

☐15

☐16

☐17

☐18

☐19

☐20

☐21

☐22

☐23

☐24

☐25

☐26

☐27

☐28

☐29

☐30

☐31

6. Please indicate the time of your journey with the automated vehicle:

☐12 am - 1 am

☐1 am - 2 am

☐2 am - 3 am

☐3 am - 4 am

☐ 4 am - 5 am

☐ 5 am - 6 am

☐ 6 am - 7 am

☐ 7 am - 8 am

☐ 8 am - 9 am

☐ 9 am - 10 am

☐ 10 am - 11 am

☐ 11 am - 12 pm

☐ 12 pm - 1 pm

☐ 1 pm - 2 pm

☐ 2 pm - 3 pm

☐ 3 pm - 4 pm

☐ 4 pm - 5 pm

☐ 5 pm - 6 pm

☐ 6 pm - 7 pm

☐ 7 pm - 8 pm

☐ 8 pm - 9 pm

☐ 9 pm - 10 pm

☐ 10 pm - 11 pm

☐ 11 pm - 12 am

7. Please indicate the time of your journey:

☐ 12 am

☐ 12:15 am

☐ 12:30 am

☐ 12:45 am

☐ 1:00 am

☐ 1:15 am

☐ 1:30 am

☐ 1:45 am

☐ 2:00 am

☐ 2:15 am

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☐ 10:30 pm

☐ 10:45 pm

☐ 11:00 pm

☐ 11:15 pm

☐ 11:30 pm

☐ 11:45 pm

8. Indicate, in minutes, the time of your journey with the automated vehicle:

____

____

____

____

____

9. Did you encounter any problems during your trip?

☐Yes

☐No

10. If yes, which problem(s) did you encounter?

____

____

____

____

____

11. Please indicate your level of agreement using the Automated Mobility Solution you experienced.

I am satisfied.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

It is useful.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

It is easy to use.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

It is easy to learn.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

It is reliable.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

It feels safe.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

It corresponds to my needs.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

It is comfortable.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

I will make use of the service again.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

I would recommend the service to a friend or a colleague.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

I felt well informed about the service before using it.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

It is easy to book.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

In the case of unexpected events during my ride, I felt well informed about the status of the automated vehicle.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

The ride in the automated vehicle is comfortable.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

During my ride, I felt well informed about the upcoming stops of the automated vehicle.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

The vehicle travels at an adequate speed.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

It is punctual.

Totally disagree								Totally agree
1	2	3	4	5	6	7	8	9

12. In the following section, we ask you to provide some personal data.

☐Do you need assistance to support your mobility due to any of these disabilities?

☐I do not need assistance to support my mobility.

☐Motor

☐Auditory

☐Visual

☐Mental

☐I prefer not to say.

13. The Automated Mobility Solution is accessible to me.

Totally disagree							Totally agree
1	2	3	4	5	6	7	8

not applicable

14. If you were to make alterations to the Automated Mobility Solution, what would you do to improve it?

____

____

____

15. How much would you be willing to pay for a single 10-minute ride of 2 km with the Automated Mobility Solution you experienced? (in Euro)

____

____

____

____

____

16. How much would you be willing to pay for a single 10-minute ride of 2 km with the Automated Mobility Solution you experienced? (in SEK)

____

____

____

____

____

17. How much would you be willing to pay for a single 10-minute ride of 2 km with the Automated Mobility Solution you experienced? (in CZK)

____

____

____

____

____

18. How much would you be willing to pay for a single 10-minute ride of 2 km with the Automated Mobility Solution you experienced? (in CHF)

19. How much would you be willing to pay for a single 10-minute ride of 2 km with the Automated Mobility Solution you experienced? (in DKK)

20. Would you be willing to share your ride in an automated vehicle with other passengers in the future?

☐No

☐Only if it was cheaper than going by myself

☐Only if I knew a personal profile of the other passengers in advance

☐Only under certain circumstances.

☐Yes

21. Under which circumstances would you be willing to share your ride in an automated vehicle with other passengers?

22. How old are you?

____

23. What is your gender?

☐Male

☐Female

☐Other

☐Prefer not to say

24. What is your highest level of education?

☐Primary/Elementary/High School Degree

☐Trade/technical training

☐Bachelor Degree

☐Master Degree

☐PhD

25. In which geographical area do you live?

☐Urban

☐Peri-urban

☐Rural

26. Is there anything else you would like to let us know?

____

____

____

____

____

Thank you for participating!

More information about the European project SHOW can be found on https://show-project.eu/

Satisfaction survey (passenger mobility)

The aim of this survey is to get a deeper understanding of citizens' needs, wants and acceptance of transportation solutions today and in the future, when automated solutions will be a part of the system. The study is co-financed by the EU project SHOW and in realised in the context of the pilot evaluation across all its test sites in Europe.

By responding to the question in the web survey you also accept that we can use your answers in this research study.

You can withdraw whenever you want to without any reason. Your answers will be stored separately and treated anonymously, that means without any connection to you personally.

1. Please move the slider to select a number between 0 and 100 that represents your level of satisfaction. (0 = not satisfied at all; 100 = extremely satisfied)

1-100

Thank you for participating!

More information about the European project SHOW can be found on (website link)

Interviews (passenger & freight mobility)

The aim of this survey is to get a deeper understanding of stakeholders' needs, wants and acceptance of the automated services piloted in the SHOW project. The study is co-financed by the EU project SHOW and in realised in the context of the pilot evaluation across all its test sites in Europe.

By responding to the question in the web survey you also accept that we can use your answers in this research study.

You can withdraw whenever you want to without any reason. Your answers will be stored separately and are anonymous, that means without any connection to you personally.

1. What is your age?

____

____

____

____

____

2. What is your gender?

☐Male

☐Female

☐Other

☐Prefer not to say

3. What is your stakeholder group?

☐Operator

☐Service provider

☐Tier 1 provider

☐Authority

☐Other

If other, please specify:

____

____

____

____

____

4. Please indicate your organization type.

☐Governmental agency

☐Non-governmental organization

☐Industry/ Supplier

☐Insurance company/ association

☐Research/ Academia

☐Other

If other, please specify:

____

____

____

____

____

5. How many employees does your organization have?

☐1 - 100

☐101 - 500

☐501 - 1000

☐1001 - 5000

☐> 5000

6. Please indicate your highest educational level

☐Primary / Elementary / High School Degree

☐Trade/technical training

☐Bachelor Degree

☐Master Degree

☐PhD

7. What is your area of expertise?

____

8. What is your working experience?

☐no experience

☐< 5 years

☐5-10 years

☐> 10 years

9. How many years of experience do you have working with automated vehicles/services?

☐No experience

☐< 5 years

☐5-10 years

☐> 10 years

10. Please indicate your level of agreement with the following statements.

The vehicle/service is useful.

strongly disagree				strongly agree
1	2	3	4	5

The vehicle/service is pleasant.

strongly disagree				strongly agree
1	2	3	4	5

The vehicle/service is bad.

strongly disagree				strongly agree
1	2	3	4	5

The vehicle/service is nice.

strongly disagree				strongly agree
1	2	3	4	5

The vehicle/service is effective.

strongly disagree				strongly agree
1	2	3	4	5

The vehicle/service is irritating.

strongly disagree				strongly agree
1	2	3	4	5

The vehicle/service is assisting.

strongly disagree				strongly agree
1	2	3	4	5

The vehicle/service is undesirable.

strongly disagree				strongly agree
1	2	3	4	5

The vehicle/service is raising alertness.

strongly disagree				strongly agree
1	2	3	4	5

11. In case the stakeholder has actively participated in the project:

What was your BEST experience from the SHOW project demonstrations?

What was your WORST experience from the SHOW project demonstrations?

In case the stakeholder has not actively participated, but was only invited to the demonstrations:

What did you like MOST about SHOW project technologies/services/implementations?

What did you like LEAST about SHOW project technologies/services/implementations?

12. For the next questions, we would like you to focus on the current SHOW project.

Which are your major concerns for the period after the SHOW implementations and why?

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

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

15. Where would you like to be in your professional life in a few years? (e.g., Would you like to be more involved in automation or other new areas and/or other services?)(expectations as professionals, as themselves)

16. What do you believe will be the most important impact of automatic vehicles/services for travellers with disabilities?

Thank you for participating!

More information about the European project SHOW can be found on (website link)

Safety Driver (passenger mobility)

The aim of this survey is to get a deeper understanding of the safety drivers' perspective regarding the automated services they operated in the context of the SHOW project. The study is co-financed by the EU project SHOW and in realised in the context of the pilot evaluation across all its test sites in Europe.

By responding to the question in the web survey you also accept that we can use your answers in this research study.

You can withdraw whenever you want to without any reason. Your answers will be stored separately and treated anonymously, that means without any connection to you personally.

I consent to participating in the survey. I understand that my responses are recorded anonymously and may be used in project deliverables and other types of scientific publications.

☐Yes

☐No

Please create an anonymous code for yourself. This code will be unique to you while it will keep your anonymity. To create this code, please enter the following information (all letters in lower case):

1. Second letter of your first name

2. Last digit of your year of birth

3. Third letter of your month of birth

4. Second letter of your mother's first name

5. Third letter of your mother's first name

____

____

____

____

____

1. Did you participate in SHOW field trials as a safety driver/operator on-board, remotely or both?

☐Safety driver on-board

☐Remote driver/operator

☐Both

2. What type of automated vehicle(s) (AVs) did you operate in SHOW?

☐Automated shuttle (up to 8 passengers)

☐Automated bus (more than 8 passengers

☐Automated passenger car

☐Other

☐

If other, please specify:

____

____

____

____

____

3. What was the SAE level of the vehicle(s)?

☐SAE L3

(conditional automation: the vehicle can handle some specific situations; the rest isup to the driver)

☐SAE L4

(high automation: the vehicle can handle most situations; the driver usually remains passive)

☐Other

4. Which other SAE level was your vehicle?

____
__

____
__

____
__

____
__

____
__

5. Which are the tasks you are responsible for as a remote driver/operator (more than one options)?

☐Supervising

☐Hard/emergency-braking events

☐Steering (for specific parts of the route)

☐Parking

☐Enabling restart of AV after unplanned stops

☐Passenger support

☐Other

☐

6. Which other tasks are you responsible of?

____

____

____

____

____

7. For what period of time have you had experience operating an AV during SHOW?

☐1-3 months

☐4-6 months

☐7-9 months

☐10-12 months

☐more

8. Please indicate how many days a week on average you have operated a SHOW AV in that period?

☐1 day

☐2 days

☐3 days

☐4 days

☐5 days

☐6 days

☐7 days

9. Please indicate the (average) length of the operational route of the AV(s) in km

____

____

____

10. For the operation of how many automated vehicles (AVs) have you been responsible for at the same time?

☐1

☐2

☐3

☐4

11. Have you operated an automated vehicle (of any type) before SHOW?

☐yes

☐no

12. For what period of time have you operated an automated vehicle?

☐1-3 months

☐4-6 months

☐7-9 months

☐10-12 months

☐more

13. Please indicate how many days a week on average you have operated an AV in that period?

☐1 day

☐2 days

☐3 days

☐4 days

☐5 days

☐6 days

☐7 days

14. How would you describe your overall experience as a safety driver/operator during the SHOW field trials?

☐Very positive

☐To some degree positive

☐Neutral

☐To some degree negative

☐Very negative

15. Please move the slider to select the scale that best matches how you experienced the AV service across the several aspects.

According to my experience, the AV service I have been operating was:

unreliable				reliable
1	2	3	4	5

According to my experience, the AV service I have been operating was:

inaccurate				accurate
1	2	3	4	5

According to my experience, the AV service I have been operating was:

not comprehensive				comprehensive
1	2	3	4	5

According to my experience, the AV service I have been operating was:

not robust				robust
1	2	3	4	5

According to my experience, the AV service I have been operating was:

unsafe for me				safe for me

1	2	3	4	5

According to my experience, the AV service I have been operating was:

unsafe for the passengers				safe for the passengers
1	2	3	4	5

According to my experience, the AV service I have been operating was:

unsafe for the other road users				safe for the other road users
1	2	3	4	5

According to my experience, the AV service I have been operating was:

making me feel unconfident				making me feel confident
1	2	3	4	5

According to my experience, the AV service I have been operating was:

difficult to operate				easy to operate
1	2	3	4	5

According to my experience, the AV service I have been operating was:

not reacting adequately to obstacles				reacting adequately to obstacles
1	2	3	4	5

16. Please state if you have experienced any crashes.

☐Yes

☐No

17. How many crashes have you experienced in the whole period?

____

____

____

____

____

18. Please state if you have experienced any Near miss incidents

(An incident that would have ended up in a crash immediately if no evasive manoeuvre (e.g. hard braking) had been taken.)

☐Yes

☐No

19. How many near miss incidents did you experience in the whole period?

____

____

____

____

____

20. Please state if you experienced any conflicts

(An incident that not inherently would lead to an immediate crash but where an interference with other road users occurs.)

☐yes

☐no

21. How many conflicts did you experience in the whole period?

____

____

____

____

____

22. Please describe in short, a couple of the most representative case(s)

____

____

____

____

____

23. On average, how often did you need to take over the control of the vehicle per day and vehicle?

☐Never

☐Rarely (1-2 times)

☐Sometimes (3-5 times)

☐Often (6-10 times)

☐Very often (more than 10 times)

24. In which situation/s did you take over?

☐Safety emergency (e.g., needed to proceed to hard braking/ immobilise the vehicle)

☐Prolonged waiting time at the pick-up/drop-off point

☐On request of the passenger/s

☐On request of the driver on-board/ remote driver-operator

☐For scheduled negotiation of part of the route (i.e. at intersections, U-turns, etc.)

☐For unscheduled negotiation of part of the route (i.e. intersection, U-turns, etc.)

☐Other

☐Not applicable

25. In which other situation/s did you take over?

____

____

____

____

____

26. Please rate the criticality of those situations, when applicable.

☐not at all critical

☐somewhat critical

☐moderately critical

☐very critical

☐extremely critical

☐Safety emergency

☐Prolonged waiting time

☐On request of the passenger/s

☐On request of the driver on-board/remote driver-operator

☐Scheduled negotiation of part of the route

☐Unscheduled negotiation of part of the route

☐Other

27. Which other situation were you referring to?

____

____

____

____

____

28. Did you experience a take-over?

☐yes

☐no

29. Please tick the box that you think best matches the take-over situation/s you experienced:

☐never

☐rarely

☐sometimes

☐often

☐always

☐it was necessary

☐it was reliable

☐it worked accurately

☐it was understandable

☐it worked robustly

☐I was confident during the take-over

30. Which are the most negative aspects you experienced while operating the vehicle during the last month?

____

____

____

____

____

31. Which are the most positive aspects you experienced while operating the vehicle during the last month?

____

____

____

____

____

32. What would you recommend to get improved in near future?

____

____

____

____

____

33. On average, how often did you lose communication with the vehicle per day?

☐Never

☐Rarely (1-2 times)

☐Sometimes (3-5 times)

☐Often (6-10 times)

☐Very often (more than 10 times)

34. If you ever lost communication with the vehicle, please explain what happened right before you lost communication with the vehicle (please consider for your answer the most safety critical events occurring to you):

____

____

____

____

____

35. If you ever lost communication with the vehicle, please explain what you did to resolve the situation (please consider for your answer the most safety critical events occurring to you):

____

____

____

____

36. What is your gender

☐Male

☐Female

☐Other

☐I prefer not to say

37. How old are you?

☐18-29 years

☐30-39 years

☐40-49 years

☐50-59 years

☐60 years or older

38. Please indicate your highest level of education.

☐Primary/Elementary/High School Degree

☐Trade/technical training

☐Bachelor Degree

☐Master degree

☐PhD

☐Prefer not to say

39. Are you a professional driver in passenger transport?

☐yes

☐no

40. Are you a professional test driver?

☐yes

☐no

41. Have you received any AV specific training course before the ride?

☐yes

☐no

42. Please clarify the training duration:

☐Up to 8 training hours

☐2-3 full days of training

☐4-5 full days of training

☐3-4 weeks of training

☐more

Please state the training topics in short:

____

____

____

____

____

43. The training I received before the ride was:

☐Not at all sufficient

☐Slightly sufficient

☐Moderately sufficient

☐Very sufficient

☐Extremely sufficient

44. Upon its fulfilment, did you get any certification or test driver license?

☐yes

☐no

45. Please state your current profession if you are not solely a professional (and/or test)driver:

____

____

____

____

____

Thank you for participating!

More information about the European project SHOW can be found on https://show-project.eu/

VRU survey (passenger mobility)

This survey responds to the Vulnerable Road Users (pedestrians, cyclists, etc.) that are involved in the testing of dedicated for them automated solutions that have been developed and tested in the context of the SHOW project. It aims, in specific, to get a deeper understanding of the VRU’s needs, wants and acceptance of the specific solutions tried and for those that are going to emerge in the near future.

This survey addresses in specific Vulnerable Road Users that are not passengers of the automated vehicle itself, but they interact with that as a road user outside of the vehicle. The second part of the survey is anticipated to be filled-in by the test conductor of the specific trials for each participant.

The study is co-financed by the EU project SHOW and in realised in the context of the pilot evaluation across all its test sites in Europe.

By responding to the question in the web survey you also accept that we can use your answers in this research study.

You can withdraw whenever you want to without any reason. Your answers will be stored separately and treated anonymously, that means without any connection to you personally.

Language

English

French (français)

Spanish (español)

German formal (Deutsch)

Swedish (svenska)

Finnish (suomen kieli)

Danish (dansk)

Italian (italiano)

Greek (ελληνικά)

Dutch (Nederlands)

Czech (čeština)

I consent to participating in the survey. I understand that my responses are recorded anonymously and may be used in project deliverables and other types of scientific publications.

☐Yes

☐No

1. How would you describe your overall experience upon testing/trying the SHOW AV solution?

☐very positive

☐to some degree positive

☐neutral

☐to some degree negative

☐very negative

2. Move the slider in the following scales that best matches your view of the SHOW AV solution you tested/tried, across the several aspects.

According to my experience, the SHOW solution I have encountered is:

useless	1	2	3	4	5	useful
difficult to understand	1	2	3	4	5	easy to understand
unreliable	1	2	3	4	5	reliable
not corresponding to my needs	1	2	3	4	5	corresponding to my needs
something that I would not like to see in the future	1	2	3	4	5	something that I would like to see in the future

3. Please rate how important it is to get a notification/warning about Automated

Vehicles in the following traffic situations:

not at all important	somewhat important	very important	extremely important

Lack of visibility due to obstacle(s)

not at all important	somewhat important	very important	extremely important

Lack of visibility due to adverse weather conditions (e.g. rain or fog)

not at all important	somewhat important	very important	extremely important

At specific spots (i.e. non- signalised intersections)

not at all important	somewhat important	very important	extremely important

4. Please define the specific spot

____

____

____

____

____

5. How was the timing of warning?

much too early	somewhat too early	ideal	somewhat too late	much too late

6. How was the intensity of the warning?

much too weak	somewhat too weak	ideal	somewhat too intense	much too intense

7. Would you change the type of warning?

☐yes

☐no

8. What would you change?

____

____

9. Which negative aspects did you experience while testing/ trying the SHOW AV solution?

10. Which positive aspects did you experience while testing/ trying the SHOW AV solution?

11. What would you recommend to get improved in near future in the solution you tested/tried:

12. What is your gender?

☐Male

☐Female

☐Other

☐Prefer not to say

13. How old are you?

☐Under 18 years

☐18-29 years

☐30-39 years

☐40-49 years

☐50-59 years

☐60 years or older

14. Please indicate your level of education.

☐Primary/Elementary/High School Degree

☐Bachelor Degree

☐Master degree

☐PhD

☐Prefer not to say

15. Have you ever been a passenger in an automated vehicle before?

☐yes

☐no

16. Have you ever interacted with any type of automated vehicle as a road user before this test (being a passenger excluded)?

☐yes

☐no

Please hand the survey over to your test conductor to answer the following questions.

Name of the test conductor:

____

____

____

____

____

Entity of the test conductor:

____

Participant number:

Number of iteration for the participant:

17. The participant has participated in the evaluation as a:

☐Pedestrian

☐Cyclist

☐Motorcyclist

☐User with disability

☐Other

18. Please define the disability of the user, if applicable:

19. Please define other:

20. Road conditions during evaluation (multiple options are applicable, if needed)

☐Icy

☐Snowy

☐Frosty

☐Wet

☐Moisty

☐Dry

☐Traffic conditions during evaluation:

☐Light

☐Medium

☐Dense

☐Congestion

☐Time of day during evaluation:

☐Daylight

☐Dusk

☐Night

21. Please select below the wearable or other device the participant had to wear/use during the evaluation (and for the purposes of the evaluation):

☐Smartphone

☐Equipped smartphone

☐Other

☐Tablet

☐I car

22. What other wearable or other device did the participant have?

____

____

____

____

____

23. Please select which was the interaction channel(s) for the warning(s)/notification(s) produced for the specific iteration of the specific participant (more than one options are feasible, in case of multiple modes of warning):

☐Acoustical message from the vehicle (i.e. AV horn)

☐Visual message from the vehicle (i.e. headlights flashing)

☐Acoustical message from infrastructure (i.e. horn sound coming by traffic lights,

☐Warning buzzer at pedestrian crossings, etc.)

☐Visual message from infrastructure (i.e. flash warning coming by traffic lights)

☐Acoustical message to personal wearable

☐Visual message to personal wearable

☐Haptic message to personal wearable

☐Other

Which other interaction channel?

____

____

____

____

____

Thank you for participating!

More information about the European project SHOW can be found on (website link)

Surveys for Freight Mobility/ Logistics

Automated Logistics Pre-acceptance Questionnaire for Users

The aim of this survey is to get a deeper understanding of logistics service users' needs and requirements for logistics services today and in the future when automated solutions will be a part of the mobility system. Moreover, the pre-acceptance of automated logistics services is studied for logistics service users who do send materials periodically.

The study is co-financed by the EU project SHOW and in realised in the context of the pilot evaluation across all 5 logistics pilot sites all over Europe.

By responding to the question in the web survey you also accept that we can use your anonymized answers in this research study. You can withdraw whenever you want to without any reason. Your answers will be stored separately and are anonymous, that means without any connection to your person.

Language

English	
French	(Français)
German	(Deutsch)
Italian	(Italiano)
Greek	(Ελληνικά)

I consent to participating in the survey. I understand that my responses are recorded anonymously and may be used in project deliverables and other types of scientific publications.

☐Yes

☐No

I confirm that I am 18 years old or older.

☐Yes

☐No

Section 1 | THE USUAL SERVICES USED

1. How many purchases do you do in a month that foresee delivery services?

- More than once a week
- Once a week
- Two – three times in a month
- Once a month

2. Which type/purpose of shopping do you do?

- Leisure (clothes, cosmetics, other)
- Business (office equipment, other)
- Grocery (supermarkets, zoo-shops, etc.)
- Pharmacy
- Food (from restaurants, bars, etc.)
- Other *(please specify)*

3. Your experience of the current delivery service is:

1 Unsatisfactory	**2**	**3**	**4**	**5** Satisfactory

4. How much would you prefer to continue using your current method for the delivery of your purchases instead of having a new innovative method with respect to safety, punctuality and efficiency improvements?

1 No, I would prefer to change	**2**	**3**	**4**	**5** Yes, I would prefer to continue

5. **When sending your materials by a delivery service, how important are the following aspects to you?** [*1 = less important and 5 = more important*]

Safety (feeling safe to send materials)

1	2	3	4	5

Punctuality (on-time deliveries)

1	2	3	4	5

Real-Time tracking (track your shipment continuously)

1	2	3	4	5

Cleaning - Hygiene

1	2	3	4	5

Service useability (easy-to-use)

1	2	3	4	5

Cost (to use a delivery service)

1	2	3	4	5

Door-to-door delivery travel time

1	2	3	4	5

Security (no risk for your goods being theft or damaged)

1	2	3	4	5

Accessibility (all user types can reach the service)

1	2	3	4	5

Possibility to order to *locker* or any *retail point* for pick-up

1	2	3	4	5

Section 2 | THE AUTOMATED LOGISTICS SERVICES

Automated Logistics Service direct the use of management techniques or software to enhance the efficiency of logistics operations and processes. It usually involves methodologies that would be accomplished in a warehouse or urban distribution center by having minimal human intervention. In addition, there would be automated vehicles to deliver materials with human-on-board (*see the figure as an example of an automated logistics vehicle*).

Along a logistics supply chain such as procurement, distribution, customer service, logistics management, etc., all logistics service processes would be automated to have minimal human intervention.

6. **What is your level of knowledge about Automated Logistics Services (delivery with automated vehicle, drone, robot-rider, etc.)?** *[1 = don't have knowledge, 5 = have good knowledge]*

1 Novice (I don't know at all)	2	3 Intermediate	4	5 Advanced (I actively contribute to the development)

7. **Have you ever seen an automated logistics service operating in real life?**
   - Yes
   - No
   - Maybe, I am not sure

8. **How much would you prefer to use such an automated logistics option (*delivery drone, robot-rider, etc.*) instead of a traditional one for the delivery of your purchases?**

1 *Not prefer*	2	3	4	5 *Highly prefer*

9. **I would consider using (regarding noted fees) an automated logistics service without human-intervention to send usual packages-materials…** *[select one option for each]*

	0€	1€	2€	3€	4€	5€	10€	20€	50€
...to be so expensive that you would not consider using it?									
...to be priced so low that you would feel the quality couldn't be very good?									

	0€	1€	2€	3€	4€	5€	10€	20€	50€
...starting to get expensive, so that it is not out of the question, but you would have to give some thought to using it?									
...to be a bargain?									

10. I would use an automated logistics service to exchange materials for ... *[multiple choice]*

- Leisure (clothes, cosmetics, other)
- Business (office equipment, other)
- Grocery (supermarkets, zoo-shops, etc.)
- Pharmacy
- Food (from restaurants, bars, etc.)
- I will not choose an automated logistics service
- Other *(please specify)*

11. How useful do you think that an automated logistics service would be in the following areas? *[1 = not useful, 5 = very useful]*

1 *Not useful*	**2**	**3**	**4**	**5** *Very useful*

- Urban
- Peri-urban
- Rural
- Confined area (e.g., university, hospital, airport, etc.)

12. Please choose which statement(s) you would agree more. For the automated logistics service, you would prefer... *[1 = totally disagree, 5 = totally agree]*

	1 totally disagree	2	3	4	5 totally agree
ordering your delivery transport via an application					
ordering your delivery transport at a dedicated terminal in public areas					
ordering your delivery transport from a sales agent					
making a booking via a phone call					

	1 totally disagree	2	3	4	5 totally agree
not making a booking but waiting at a pick-up/drop-off point with fixed passage times					

13. Before using an automated logistics service for the first time, you would prefer…

	1 totally disagree	2	3	4	5 totally agree
A digital tutorial on the mobile phone or available on the internet					
Training carried out by the transporter					
A paper booklet					

14. For automated logistics service, you would prefer... [1 = totally disagree, 5 = totally agree]

	1 totally disagree	2	3	4	5 totally agree
paying with usual public transport subscription (free of charge while having subscription)					
paying using a mobile application					
paying directly in the vehicle by contactless credit card with availability of POS Device					
paying later at a date chosen by you with a given invoice					

15. **Concerning the automated logistics vehicles on road, I would prefer they operate:** *[select one option]*
    - On highways
    - On urban roads with mixed traffic
    - On dedicated lanes

16. **Please indicate the time slot(s) within the day where you think an automated logistics service would be useful for your deliveries.** [multiple choosing, no more than 4 options]

Morning sections	12-2 am	2-4 am	4-6 am	6-8 am	8-10 am	10 am - 12 pm
Evening sections	12-2 pm	2-4 pm	4-6 pm	6-8 pm	8-10 pm	10am - 12 am

17. **How important are the following statements to you when you choose an automated logistics service instead of a traditional one?** *[1-5 points for each sub-question]*

1	2	3	4	5

- I would be able to select delivery receiving time by choosing timeslot
- It would be delivered on time
- It would be cheaper than traditional logistics service
- There would be fewer accidents because human errors will be significantly decreased
- It would be more environmentally friendly
- It would cover parts of delivery transfer that are not covered until now
- The delivery transfer would be more reliable
- The service would be more frequent
- The delivery transfer would be faster
- Tracing/tracking of the deliveries would be easier

18. **Why would you refrain from using an automated logistics service?** *[Choose no more than 4 options]*

- It would be unreliable
- It would be expensive
- It would not be fast enough
- It would not be punctual enough
- It would not be environmentally friendly
- It would be too complicated to use it
- It would be difficult to access
- I would trust humans more than the [*autonomous solution*]
- I would be afraid that my personal data could be hacked
- The delivery transfer would not be safe and/or secure

19. ***For each statement, indicate your level of agreement, from 1 = totally disagree to 10 = totally agree.* I think the AUTOMATED LOGISTICS SERVICE with an automated VEHICLE would be… **Answer required.*** *[1-5 points for each sub-question]*

1	2	3	4	5

- safe
- easy-to-use
- environmentally friendly
- fast
- cheap

20. ***For each of the following statements, please indicate your level of agreement *Answer required.***

[1 (strongly disagree) / 5 (strongly agree) for each sub-question]

1	2	3	4	5

- I think an automated logistics service option will become an important part of the existing freight transport system.
- I think an automated logistics service will be well-accepted in society.
- I think I will use it frequently.
- I think an automated logistics service would be more efficient/faster than existing forms of freight transport.
- I think it would be easy to understand how to use an automated logistics service.
- I think it would not take me long to learn how to use an automated logistics service.
- I think I am more likely to use an automated logistics service if my friends and family used it.
- If it were affordable, I would use an automated logistics service.
- I think using an automated logistics service would be better and more convenient than an existing form of freight transport that I use now.

Section 3 | USER PERSONAL DATA

**In the following section, we would like to ask you to provide some personal data.*

21. What is your employment status?

- Higher managerial, administrative, and professional occupations
- Intermediate occupations
- Small employers and own account workers
- Lower supervisory and technical occupations
- Semi-routine and routine occupations
- Never worked and/or long-term unemployed
- Student
- Pensioner
- Unemployed
- Homemaker
- Other (*please specify*)

22. How old are you?
- Between 18 – 34 years
- Between 35 – 50 years
- Between 50 – 64 years
- Over 65 years
- Prefer not to say

23. What is your gender?
- Male
- Female
- Other
- Prefer not to say

24. What is your highest level of education?
- Primary/Elementary/High School Degree
- Bachelor's Degree
- Master's Degree
- Ph.D.
- Prefer not to say

25. In which geographical area do you live?
- Urban
- Peri-urban
- Rural
- Prefer not to say

26. What is the number of people who lives in your household?
- Single person household
- Multi-person household without children
- Multi-person household with children

27. The annual income of your household before tax is approximately
(Please SELECT your nearest estimate)
- Less than 10.000 EUR per year
- Between 10 001 EUR and 20 000 EUR per year
- Between 20.001 EUR and 40.000 EUR per year
- Between 40.001 EUR and 80.000 EUR per year
- More than 80.000 EUR per year
- Prefer not to say

Is there anything else you would like to let us know? *(skippable question)* ____
Thank you for participating! *More information about the European project SHOW can be found on* (website link)

Automated Logistics Pre-acceptance Questionnaire for Clients-Customers

The aim of this survey is to get a deeper understanding of logistics service clients' needs and requirements for logistics services today and in the future, when automated solutions will be a part of the system. Moreover, the pre-acceptance of automated logistics services is studied for operators/carriers/ couriers/business owners.

The study is co-financed by the EU project SHOW and in realised in the context of the pilot evaluation across all 5 logistics pilot sites all over Europe.

By responding to the question in the web survey you also accept that we can use your anonymized answers in this research study. You can withdraw whenever you want to without any reason. Your answers will be stored separately and are anonymous, that means without any connection to your person.

Language

English
French (Français)
German (Deutsch)
Italian (Italiano)
Greek (Ελληνικά)

I consent to participating in the survey. I understand that my responses are recorded anonymously and may be used in project deliverables and other types of scientific publications.

☐Yes

☐No

I confirm that I am 18 years old or older.

☐Yes

☐No

Section 1 | BUSINESS DATA

1. **What is the production scope of your business?**

Food products (ready meals, etc.)	Household appliances and telephones, computers, photographic items, etc.
Beverages	Household accessories
Groceries	Chemical products
Tobacco	Accessories
Stationery, paper, cardboard, etc.	Fuels (gas)
Pharmaceuticals, cosmetics, etc.	Building materials
Sporting goods	Live animals, animal food, etc.
Perfumery	Cleaning products
Books, records, newspapers, etc.	Laundry service
Flowers and plants	Other_______________________________

2. **Annual Gross Sales / Annual Gross Income**
   - 0-100.000 euro
   - 100.001-250.000 euro
   - 250.001-500.000 euro
   - 500.001-1.000.000 euro
   - Over 1.000.000 euro

3. **Do you have a possibility to make home-deliveries?**
   Yes – No

4. **How often do you usually have your materials/deliveries transfer by the listed services?**

	Daily basis	Once a week	Once a month	Rarely	Never
Cargo E-bike					
Commercial Car					
Van					
Truck					
Air services					
Rail services					

	Daily basis	Once a week	Once a month	Rarely	Never
Maritime services					

5. **Does your business have an availability of:**
    a. **storage |** Yes – No
    b. **vehicle for deliveries (both to send and receive) |** Yes – No
    c. **parking slot for delivery transport |** Yes – No

6. **What are the main problems your business faces regarding the delivery transport?** *Choose no more than 4 options*
    - Lots of paper-work (bureaucracy) for delivery transfer
    - Lack of pick-up/drop-off space (need of parking area for deliveries)
    - Long time of delivery
    - Lack of security of goods (danger of theft, loss or breakage)
    - Difficulty in transporting the goods from the place, where the vehicle stops, to the premises or vice versa
    - Lack of coordination when organizing different deliveries
    - Other (*please specify*)

7. **Does your business/organization have an interest in IT-System (digitalization) for tracking, processing, and other operational aspects of delivery transportation?**

☐Yes

☐No

☐Maybe

8. **Does your business/organization have an interest in Digital Document Control System for delivery transport?**

☐Yes

☐No

☐Maybe

9. **Does your business/organization have an interest in Digital Purchasing System for delivery transport?**

☐Yes

☐No

☐Maybe

10. Does your business/organization have an interest in digitalized procedure progress for delivery confirmations and for approval of delivery transfer?

Yes
No
Maybe

Section 2 | AUTOMATED LOGISTICS SERVICE

Automated Logistics Service directs the use of management techniques or software to enhance the efficiency of logistics operations and processes. It usually involves methodologies that would be accomplished in a warehouse or urban distribution center by having minimal human intervention. In addition, there would be automated vehicles to deliver materials without human-on-board (*see the figure as an example of an automated logistics vehicle*).

Along a logistics supply chain such as procurement, distribution, customer service, logistics management, etc., all logistics service processes would be automated to have minimal human intervention.

11. Do you have any experience on Automated Logistics as a Service? *[yes-no]*

☐Yes

☐No

☐Maybe

12. Please indicate your level of agreement to having an Automated Logistics Service for material-delivery transfer? *[1 (strongly disagree) / 5 (strongly agree)]*

1 strongly disagree	**2**	**3**	**4**	**5** strongly agree

13. Please indicate the time slot(s) within the day where you think an automated logistics service would be useful for your deliveries. *[select no more than 4 options]*

Morning sections	12-2 am	2-4 am	4-6 am	6-8 am	8-10 am	10 am - 12 pm
Evening sections	12-2 pm	2-4 pm	4-6 pm	6-8 pm	8-10 pm	10 pm - 12 am

14. **Would you choose an automated vehicle-based Logistics Service for your organization / delivery transfer?** *[yes-no]*

☐Yes

☐No

☐Maybe

15. **Please indicate your need of assistance to utilize an Automated Logistics Service for delivery transport?** *[1 = no need of assistance / 5 = strong need of assistance]*

1 *No need of assistance*	**2**	**3**	**4**	**5** *Strongly need of assistance*

16. **I would consider using (regarding noted fees) an automated logistics service without human-intervention to send usual packages-materials…** *[select one option for each]*

	0€	**1€**	**2€**	**3€**	**4€**	**5€**	**10€**	**20€**	**50€**
...to be so expensive that you would not consider using it?									
...to be priced so low that you would feel the quality couldn't be very good?									
...starting to get expensive, so that it is not out of the question, but you would have to give some thought to using it?									
...to be a bargain?									

17. **How much would you like to have a:**
    a. **Digital Document Control System for your business?**

1 (not at all) / 5 (very much)

1	**2**	**3**	**4**	**5**

    b. **Digital Purchasing System for your business?**

1 (not at all) / 5 (very much)

1	2	3	4	5

c. **Digital monitor system for relevant laws and standards?**

1 (not at all) / 5 (very much)

1	2	3	4	5

d. **Digital procedure for the delivery confirmations and transfer approvals?**

1 (not at all) / 5 (very much)

1	2	3	4	5

e. **Digitalized procedure for final pick-up activities by customers?**

1 (not at all) / 5 (very much)

1	2	3	4	5

f. **Digital check that all necessary tests have been carried out before shipment**

1 (not at all) / 5 (very much)

1	2	3	4	5

18. Please choose which statement(s) you would agree more. For the automated logistics service, you would prefer... *[select one option]*

… ordering your delivery transport via an application
… ordering your delivery transport at a dedicated terminal in public areas
… ordering your delivery transport from a sales agent
… making a booking via a phone call

19. Before using an automated logistics service for the first time, you would prefer…

	1 totally disagree	2	3	4	5 totally agree
A digital tutorial on the mobile phone or available on the internet					
Training carried out by the transporter					
A paper booklet					

20. For automated logistics service, you would prefer... *[1 = totally disagree, 5 = totally agree]*

	1 totally disagree	2	3	4	5 totally agree
paying with usual public transport subscription (free of charge while having subscription)					
paying using a mobile application					
paying directly in the vehicle by contactless credit card with availability of POS Device					
paying later at a date chosen by you with a given invoice					

21. Would you prefer using an automated logistics processing for delivery transport for your business?

1 (not at all) / 5 (very much)

1	2	3	4	5

Is there anything else you would like to let us know? *(skippable question)*

____

Thank you for participating!

More information about the European project SHOW can be found on (website link)

Appendix IV: SHOW updated KPI List

KPI Updated consecutive #	Impact Category	GA-Non GA	Impact	Description	Source
1.	**Road safety**	GA	Safety Enhancement	% of expected safety enhancement (from WP10 simulations)	Post-processing
2.	**Traffic, Energy, Environment**	GA	Number of passengers	Number of people transported throughout the project per automated vehicle/service type	Pilots
3.	**Societal, employability and equity**	GA	Person km travelled (by special groups)	Person km travelled by special groups of citizens (elderly, PRMs, children) per type of AV/service type	Pilots
4.	**Societal, employability and equity**	GA	Empty vehicle km	Percentage of vehicle-km run empty	Pilots
5.	**Societal, employability and equity**	GA	Operative cost	Operative cost of the travelled km	WP2/WP16
6.	**User acceptance**	GA	Traveller acceptance	Traveller acceptance rating	Survey
7.	**Project success**	GA	Number of UCs success	Number of SHOW UCs successfully deployed and tested in pilots	Post-processing
8.	**Project success**	GA	Realisation of each UC	Realisation of each UC under the pre-defined in section 1.3 (of proposal) operational and functional requirements	Post-processing
9.	**Project success**	GA	Business models	Number of novel business models created and tested	Post-processing
10.	**Project success**	GA	SMEs using SHOW marketplace	Number of SMEs that will use the SHOW services marketplace to develop services (during project's duration)	Post-processing
11.	**Project success**	GA	MoUs for services sustainability created	Number of MoUs for services sustainability created between various stakeholders at	Post-processing

KPI Updated consecutive #	Impact Category	GA-Non GA	Impact	Description	Source
				SHOW or new follower cities	
12.	**Project success**	GA	Business models-local synergies	Number of business models adopted that promote strategic partnering opportunities for local synergies	Post-processing
13.	**Project success**	GA	SHOW deployed fleets	Number of SHOW deployed fleets remaining at service after project end	Post-processing
14.	**Project success**	GA	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)	Post-processing
15.	**Project success**	GA	Alternative infrastructure schemes	Number of alternative infrastructure schemes to support deployment	Post-processing
16.	**Road safety**	Non GA	Road accidents	Total number of accidents that leads to at least a slight injury. As much information as possible about the circumstances of each accident should also be recorded. *An accident which occurred or originated on a way or street open to public traffic; resulted in one or more persons being killed or injured, and at least one moving vehicle was involved. Can be measured with TTC = 0s (Time-to-collision) or PET = 0s (Post-encroachment time). Circumstances of each accident should included.	Pilots

KPI Updated consecutive #	Impact Category	GA-Non GA	Impact	Description	Source
17.	**Road safety**	Non GA	Conflicts	Total number of conflicts with other road users (including VRUs) and infrastructure. Categories of the conflicting road users would need to be developed. *A conflict is a critical traffic situation in which two (or more) road users approach each other in such a manner that a collision is imminent and a realistic probability of personal injury or material damage is present if their course and speed remain unchanged. The circumstances of each conflict should be recorded (e.g., vehicle ahead, object, VRU, type of conflict). Can be measured with TTC ≤ 1.5s (Time-to-collision) or PET ≤ 5s (Post-encroachment time).	Pilots
18.	**Road safety**	Non GA	Illegal overtaking	Frequency of illegal overtaking: other cars that are illegally overtaking the AV (i.e., ego-vehicle)	Pilots
19.	**Road safety**	Non GA	Traffic flow	Number of vehicles per km, record average and standard deviation over time or road length	Third-party
20.	**Road safety**	Non GA	Lateral/longitudinal distances	Lateral/longitudinal distances between vehicles	Third-party
21.	**Road safety**	Non GA	Lateral/longitudinal headways	Lateral/longitudinal time distance between vehicles	Third-party
22.	**Traffic, Energy, Environment**	Non GA	Average speed	Average speed of pilot vehicles	Pilots
23.	**Traffic, Energy, Environment**	Non GA	Acceleration variance	Variance of pilot vehicle acceleration	Pilots
24.	**Traffic, Energy, Environment**	Non GA	Number of hard braking events per kilometre	Number of pilot vehicle decelerations over 3 m/s^2	Pilots

KPI Updated consecutive #	Impact Category	GA-Non GA	Impact	Description	Source
25.	**Traffic, Energy, Environment**	Non GA	Non-scheduled number of stops per kilometre	The number of non-scheduled vehicle stops per kilometre. A non-scheduled stop is recorded is a stop during a trip, e.g. stop for red light, congestion or avoid collision.	Pilots
26.	**Traffic, Energy, Environment**	Non GA	Scheduled number of stops per kilometre	The number of scheduled vehicle stops per kilometre. *Note: a scheduled stop refers to the vehicle stops for picking up and dropping off passengers, as well as that of fixed-route service at bus stops. The vehicle stops other than scheduled stops are Non-scheduled stops. Non-scheduled stop includes the stops for stop signs, traffic lights and traffic congestions, etc.	Pilots
27.	**Traffic, Energy, Environment**	Non GA	Service reliability	Punctuality for vehicles and passengers calculated as the difference between Planned departure/arrival times and Actual departure/arrival times	Pilots
28.	**Traffic, Energy, Environment**	Non GA	Kilometres travelled	Kilometers travelled by a pilot vehicle	Pilots
29.	**Traffic, Energy, Environment**	Non GA	Average speed	Average vehicle speed per vehicle type	Simulation
30.	**Traffic, Energy, Environment**	Non GA	Average vehicle delay	Average travel time delay per vehicle types	Simulation
31.	**Traffic, Energy, Environment**	Non GA	Vehicle stops	Number of vehicle stops per vehicle for all vehicle types	Simulation
32.	**Traffic, Energy, Environment**	Non GA	Hard braking events in traffic	The number of decelerations larger than X m/s^2 per vehicle per vehicle type	Simulation
33.	**Traffic, Energy, Environment**	Non GA	Total intersection delay	Total vehicle delays in an intersection	Simulation
34.	**Traffic, Energy, Environment**	Non GA	Total network travel time per vehicle type	Total travel time in network per vehicle type	Simulation

KPI Updated consecutive #	Impact Category	GA-Non GA	Impact	Description	Source
35.	**Traffic, Energy, Environment**	Non GA	Modal split	The share of each mode choice (in number of trips or distance travelled)	Simulation
36.	**Traffic, Energy, Environment**	Non GA	Total mileage	Total number of kilometres travelled in a network, per mode of transport and/or trip purpose	Simulation
37.	**Traffic, Energy, Environment**	Non GA	Total network delay	Average travel time delay over the entire network	Simulation
38.	**Traffic, Energy, Environment**	Non GA	Average network speed	Average vehicle speed in a network	Simulation
39.	**Traffic, Energy, Environment**	Non GA	Number of trips	Number of trips in the network, per mode and/or trip purpose	Simulation
40.	**Traffic, Energy, Environment**	Non GA	Energy use	Energy use per kilometre of a vehicle (g/km)	Pilots
41.	**Traffic, Energy, Environment**	Non GA	CO2, PM, NOx Emissions	Emissions of a vehicle (CO2, PM, NOx)	Simulation (to be clarified with TNO)
42.	**Traffic, Energy, Environment**	Non GA	Concentrations (air quality)	Concentrations of pollutants (e.g. NOx) along roads (mcg/m^3)	Simulation
43.	**Traffic, Energy, Environment**	Non GA	Noise	Noise levels along roads	Simulation
44.	**Societal, employability and equity**	Non GA	Amount of travel	Person kilometres of travel per year in an area	Simulation
45.	**Societal, employability and equity**	Non GA	Shared mobility rate	% of trips made sharing a vehicle with other	Pilots
46.	**Societal, employability and equity**	Non GA	Vehicle utilisation rate	% of time a vehicle is in motion (not parked)	Pilots
47.	**Societal, employability and equity**	Non GA	Operative revenues	Revenue from the service	WP2/WP16
48.	**Societal, employability and equity**	Non GA	Job loss	Percentage of jobs that have a high probability of being replaced by computer automation within the next two decades	BAX interviews

KPI Updated consecutive #	Impact Category	GA-Non GA	Impact	Description	Source
49.	**Societal, employability and equity**	Non GA	Job gain	Number of jobs created by the implementation of computer automation, and other systems (sensors, cameras etc) used in autonomous vehicles within the next two decades	BAX interviews
50.	**User acceptance**	Non GA	User reliability perception	User perception of travel reliability	Survey
51.	**User acceptance**	Non GA	User safety perception	User feeling of safety during travel	Survey
52.	**User acceptance**	Non GA	Travel comfort	User perception of travel comfort	Survey
53.	**User acceptance**	Non GA	Perceived usefulness	Experienced usefulness	Survey
54.	**User acceptance**	Non GA	Willingness to pay	User willing to pay for the new mobility service	Survey
55.	**User acceptance**	Non GA	Willingness to share a ride	User willing to share a ride in CAVs	Survey
56.	**User acceptance**	Non GA	Use of automated driving functions/ Manual takeover time	Share of kms driven within the ODD when the driver decides to use automation	To be clarified
57.	**Project success**	Non GA	External joint collaborations with Third parties	Number of external collaborations	Post-processing
58.	**Project success**	Non GA	Number of UCs obtaining financial support after project implementation	Willingness to invest	Post-processing
59.	**Logistics**	Non-GA	Punctuality of deliveries	Proportion of deliveries and pickups executed in their scheduled time slot.	Pilots
60.	**Logistics**	Non-GA	Precision of deliveries	Precision of deliveries & pickups: the proportion of packages that arrived to their destination without being lost, stolen, or damaged.	Pilots
61.	**Logistics**	Non-GA	Customer satisfaction	The perceived customer satisfaction stated by customers based on their experience with the AV delivery or pick-up service.	Survey or Interviews

KPI Updated consecutive #	Impact Category	GA-Non GA	Impact	Description	Source
62.	**Logistics**	Non-GA	Unit cost of delivery	Cost of delivery/pick-up service (per km, per shipment, per vehicle)	Pilots or Simulation
63.	**Logistics**	Non-GA	Load factor patterns	Load factor patterns (e.g. load factor proportion per AV stop/pick-up delivery) during the operation hours of AV.	Pilots or Simulation
64.	**Logistics**	Non-GA	Public acceptance	Public acceptance towards the use of an AV for urban deliveries compared to a non-AV service.	Survey
65.	**Logistics**	Non-GA	Willingness to pay for AV urban deliveries/logistics	The willingness to pay for AV urban delivery/logistics service	Surveys or Interviews
66.	**Logistics**	Non-GA	Number of accidents on site	The number and type of accidents that occurred	Pilots and Simulation
67.	**Logistics**	Non-GA	Accidents in facility or AV vehicle	Number of damaged parcels resulting from an accident	Simulation
68.	**Logistics**	Non-GA	Incidents of crime / theft	Number of incidents involving crime / theft. The number of violation on the shuttle's cargo transport (possible thieves) area before/during/after the transfer that is caused and accident (with a car or a passenger or a pedestrian, etc.).	Simulation
69.	**Logistics**	Non-GA	Number of incidents involving vandalism	Number of incidents involving vandalism in the AV or facility	Simulation
70.	**Logistics**	Non-GA	Loss and damage parcels	Number of loss or damaged parcels (therefore not because of a crime	Survey or Simulation
71.	**Logistics**	Non-GA	Fair and equal access to AV	User feeling of Fair and Equal access to AV	Survey or Interviews
72.	**Logistics**	GA	Ratio of average load	Ratio of average load to total vehicle freight capacity	Pilots
73.	**Logistics**	GA	Number of cargo transported	Number of cargo transported throughout the project per automated vehicle/service type	Pilots or Simulation

KPI Updated consecutive #	Impact Category	GA-Non GA	Impact	Description	Source
74.	**Logistics**	**Non-GA**	City population share	Urban population by city size is determined by population density and commuting patterns; this better reflects the economic function of cities. It aims also mention cities similarities to each other	Survey
75.	**Logistics**	**Non-GA**	Empty running	Empty runs are trips by a transport vehicle without any freight loaded, i.e. all trips trips of a truck without freight are empty runs. They can cause considerable costs.	Pilots or simulation
76.	**Logistics**	**Non-GA**	Journey length	The time taken to make a journey	Pilots or simulation
77.	**Logistics**	**Non-GA**	Journey speed	Effective speed of vehicle on a journey between two points	Pilots or simulation
78.	**Logistics**	**Non-GA**	Loading/Unloading activities (quantity and duration)	Loading and unloading means the process of getting goods and equipment in and out of the stallholders' vehicles and setting up or taking down the stall or pitch.	Pilots or simulation
79.	**Logistics**	**Non-GA**	Number of deliveries including quantity of goods delivered/collected	Number of deliveries that are reserved to be delivered to final customer by freight vehicle	Pilots or simulation
80.	**Logistics**	**Non-GA**	Time of delivery (pick-up)	The amount of time that it takes for goods that have been bought to arrive at the place where they are wanted	Pilots or simulation
81.	**Logistics**	**Non-GA**	Vehicle size/type	The capacity of vehicle to load/carry deliveries (volume, number of places, etc.)	Pilots
82.	**Logistics**	**Non-GA**	Customer satisfaction	Customer satisfaction is defined as a measurement that determines how satisfied/pleased customers are with an automated logistics service	Surveys

KPI Updated consecutive #	Impact Category	GA-Non GA	Impact	Description	Source
83.	**Logistics**	**Non-GA**	Final user-customer acceptance	The acceptance by the users/customer that an automated logistics service were delivered as specified	Surveys
84.	**Logistics**	**Non-GA**	Managerial and Operational costs	Operating and Managerial costs include both costs an automated logistics service and other operating-managing expenses	Interviews
85.	**Logistics**	**Non-GA**	Public acceptance	Acceptance of an automated logistics service is the act of using it or agreeing to have it by public (citizens)	Surveys
86.	**Logistics**	**Non-GA**	Punctuality	Proportion of deliveries and pickups made in right time slot.	Pilots or simulation
87.	**Logistics**	**Non-GA**	Quantity	Proportion of deliveries and pickups made in the right quantity (no loss or theft).	Pilots or simulation
88.	**Logistics**	**Non-GA**	Stakeholder acceptance	A stakeholder is defined as an individual or group that has an interest in any decision or activity of an organization.	Surveys
89.	**Logistics**	**Non-GA**	User acceptance	Acceptance of an automated logistics service to use or have it by users/customers	Surveys
90.	**Logistics**	**Non-GA**	Vehicle data (vehicle-kms, average load factor, utilisation factor)	vehicle-kilometers, average load factor, utilisation factor	Pilot or Simulation
91.	**Logistics**	**Non-GA**	Experience	Customer experience is how the users/customers or potential users receive and interact with an automated logistics service	Interviews
92.	**Logistics**	**Non-GA**	Information flow problems	Information flow policies define the way information moves throughout a system. Information flow in an information theoretical context is the transfer of information from a variable x to a	Interviews

KPI Updated consecutive #	Impact Category	GA-Non GA	Impact	Description	Source
				variable y in a given process. In au automated logistics service, it is an availability of tracking, booking to choose time of arrival, etc.	
93.	**Logistics**	**Non-GA**	Lack of a system to monitor the efficiency and effectiveness	Monitoring systems are responsible for controlling the technology used by a company (hardware, networks and communications, operating systems or applications) in order to analyse their operation and performance.	Interviews
94.	**Logistics**	**Non-GA**	Lack of involvement of stakeholders	Stakeholder involvement means sharing a common understanding and involvement in the project's decision-making process.	interviews
95.	**Logistics**	**Non-GA**	Lack of knowledge about stakeholders' requirements	An automated logistics service as a whole should fulfill to satisfy the stakeholder needs and requirements, and are expressed in an appropriate combination of textual statements, views, and non-functional requirements (evaluated by a questionnaire)	Interviews
96.	**Logistics**	**Non-GA**	Lack of knowledge about the operation of logistics process	A process that combines automated logistics service elements to form complete or partial system configurations in order to create a service specified in the stakeholders' requirements.	Interviews
97.	**Logistics**	**Non-GA**	Access availabilities (time-windows, load-factor)	availability of access to a logistics service to send-receive materials with time-respected final deliveries	Interviews
98.	**Logistics**	**Non-GA**	Changes in legislation (national or EU level)	Availability of a regulation or decree for automated logistics service. The	Surveys

KPI Updated consecutive #	Impact Category	GA-Non GA	Impact	Description	Source
				modification analysis if it is available	
99.	**Logistics**	**Non-GA**	Loading/Unloading areas and parking	Number of parking slots for loading/unloading operations in study area	Surveys
100.	**Logistics**	**Non-GA**	Lockers (availability in vehicle or external places)	Number of delivery lockers for loading/unloading operations in study area	Surveys
101.	**Logistics**	**Non-GA**	Transferring rate	Transfer rate is a standard metric that is used to measure the speed at which data or information travels from one location to another.	Surveys

*Rows in grey are provisional Logistic KPIs that are subject only to specific test sites.

**There are some additional performance related KPIs related to specific VRU cases that are very specific to the test sites and as such are not included in this list. Still, those are mentioned in the applicable sections of Appendix I.