Ref. Ares(2024)6135643 - 29/08/2024

SHared automation Operating models for Worldwide adoption

SHOW

Grant Agreement Number: 875530

D17.2: Best practices for implementation and application guidelines for Industry, Operators and Cities

This report is part of a project that has received funding by the European Union's Horizon 2020 research and innovation programme under Grant Agreement number 875530

Legal Disclaimer

The information in this document is provided “as is”, and no guarantee or warranty is given that the information is fit for any particular purpose. The above-referenced consortium members shall have no liability to third parties for damages of any kind including without limitation direct, special, indirect, or consequential damages that may result from the use of these materials subject to any liability which is mandatory due to applicable law. © 2020 by SHOW Consortium.

This report is subject to a disclaimer and copyright. This report has been carried out under a contract awarded by the European Commission, contract number: 875530. The content of this publication is the sole responsibility of the SHOW project

Executive Summary

This deliverable contains the final implementation and application guidelines for cities, PTAs/PTOs and industry. Its goal is to provide easy, understandable and comprehensive Shared Automated Mobility Service (SAMS) implementation application guidelines for the defined stakeholders, based on the project's collective learnings.

These application guidelines are divided into clusters addressing Cities, PTAs and PTOs, and industry guidelines (see chapters 3 and 4). Beside that an Application Guideline Charter for Cities and Public Transportation Operators and Authorities were created to be published online.

The key focus of the cities, PTAs and PTOs application guidelines is service planning, governance, accessibility and inclusive service as well as safety. In total, 12 guidelines were developed and formulated.

The industry application guidelines were developed and are formulated with a PESTEL-Analysis approach. This means that political, economic, social, ecological and legal aspects are considered and used as categories for the industry application guidelines to describe 42 guidelines in total in a step-by-step approach that can also be used as a check list when implementing CCAM services.

This deliverable was reviewed by the SHOW Advisory Board (AB) members. A challenge raised was the fact that the guidelines are not detailed and specific but rather are at a more generic level. This more general approach is a deliberate decision by the authors, as detailed in the introduction, as an attempt to balance guidelines which are practical, but widely applicable. Considering the diverse factors impacting individual CCAM deployment – from regulation to local climate conditions – make detailed guidelines impractical.

It was further questioned if the document puts too much attention on the public sector, as opposed to private industry. Some additions were made to the document to address this point, and it should be stressed that private industry and public stakeholders (including cities and PTOs/PTAs) are both vital in ensuring successful CCAM deployment.

Finally, it was noted that the document makes numerous references to other deliverables within the SHOW project. The authors have tried to create a set of guidelines which are easily digestible by the public and relevant stakeholders, without overdue reference to other parts of the project. Nevertheless, the document is part of a much wider project, and the corresponding connections from other deliverables serve to highlight the evidential basis for the guidelines.

Document Control Sheet

Start date of project:	01 January 2020
Duration:	48 months + 9-month extension
SHOW Del. ID & Title:	D17.2: Best practices for implementation and application guidelines for Industry, Operators and Cities
Dissemination level:	PU
Relevant Activities:	A17.1 – Best practices and application guidelines for different stakeholder groups A17.2 – Automation and SUMP assessment, scenarios and DSS
Work package:	WP17
Lead authors:	Jenny Weidenauer (IESTA), Clarisse de Cerjat (Eurocities), Henriette Cornet (UITP)
Other authors involved:	John McSweeney (UITP), Maria Gkemou (CERTH)
Internal Reviewers:	Maria Gkemou (CERTH)
External Reviewers:	Prof. Giannopoulos (Advisory Board member)
Actual submission date:	29/08/2024 (M56)
Status:	Final
File Name:	SHOW_D17.2_Best practices_ FINAL

Document Revision History

Version	Date	Reason	Editor
0.1	13/05/2024	Initial creation and first content	J. Weidenauer (IESTA)
0.2	16/05/2024	Inputs added for cities and PTAs/PTOs	Clarisse de Cerjat (Eurocities) and Henriette Cornet (UITP)
0.3	27/05/2024	Input Industry Application Guidelines	J. Weidenauer (IESTA)
1.0	12/06/2024	Version sent for internal peer review.	J. Weidenauer (IESTA)
2.0	16/06/2024	Peer reviewed version sent for submission.	M. Gkemou (CERTH)
3.0	10/07/2024	Version sent to Advisory Board for Review	John McSweeney (UITP)
Final	23/08/2024	Final version for submission	J. Weidenauer (IESTA)

Table of Contents

List of Tables

Abbreviation List

Abbreviation	Definition
AB	Advisory Board
ADS	Automated Driving Systems
AGs	Application Guidelines
AI	Artificial Intelligence
APIs	Application Programming Interfaces
AV	Automated Vehicle
CCAM	Cooperative, connected, and automated Mobility
CCAV	Centre for Connected and Autonomous Vehicles
DRT	Demand Responsive Transport
EU	European Union
GDPR	General Data Protection Regulation
HD	High Definition
HMI	Human Machine Interaction
ICT	Information and communication technology
IoT	Internet of Things
ITS	Intelligent Transport System
LaaS	Logistics as a Service
MaaS	Mobility as a Service
ODD	Operational Design Domain
OEM	Original Equipment Manufacturer
PDI	Physical and Digital Infrastructure
PT	Public Transportation
PTA	Public Transportation Authority
PTO	Public Transportation Operator
SAMS	Shared Automated Mobility Service
SME	Small-Medium-Enterprises
SUMP	Sustainable urban mobility plans
UK	United Kingdom
UN	United Nations
US	United States
V2X	Vehicle to Infrastructure
VEC	Vulnerable to Exclusion
VMT	Vehicle Miles travelled
VRU	Vulnerable Road Users
WP	Work Package

1 Introduction

1.1 Purpose and structure of the document

The main aim of this document is to present a final version of best practices and instructions for key stakeholders on the basis of pilot results and other key learnings from the project. These best practices and instructions take the form of application guidelines for cities & regions, public transport authorities (PTAs) and operators (PTOs), and industry.

Application guidelines (AGs) in this deliverable represent a set of generally formulated and optional measures based on the needs of the guideline users and are conceived as a collection of lessons learned from the SHOW pilot sites. These guidelines do not prescribe every measure stakeholders must take when implementing CCAM services – as creating such a comprehensive document would be challenging given the diverse regulations, standards, and documentation requirements across Europe. Consequently, overly detailed guidelines could be impractical. In fact, it might necessitate the development of bespoke guidelines for each individual EU member state.

The public sector is represented by the Cities & Regions and PTA/PTOs and the private sector is represented by the industry in this deliverable. The specific industry stakeholders are listed in chapter 2.3. These listed industry stakeholders are equally important when implementing a CCAM service as public authorities and their importance should not be underestimated.

The deliverable contains the following main chapters:

- Chapter 2: Providing the methodological approach for the different application guidelines
- Chapter 3: Final application guidelines for Cities, PTAs and PTOs
- Chapter 4: Final application guidelines for Industry
- Chapter 5: Conclusion
- Annex I: Booklet for Cities and Public Transport

1.2 Intended Audience

The current deliverable serves as an update to D17.1 - First issue of best practices and decision-making mechanisms for different stakeholder groups. As with D17.1, the current Deliverable addresses cities and regions, PTA/PTOs and industries working around shared cooperative, connected, and automated mobility (CCAM) services and the corresponding business environments, as well as parties which are interested to implement and use the CCAM concept for their mobility services.

1.3 Interrelations

Analysing the internal interrelations to other WPs/Activities and the external interrelations, the following could be identified:

- **Internal interrelations**
  - WP3 – Legal issues: WP3 provides relevant information about legal regulations at European, national and regional level which influence the business environment for shared automated mobility service (SAMS) and market introduction.

- WP12 – Pilot sites leaders provide relevant input for the application guidelines from the deployment perspective.
- WP17 – D17.1 is the basis for this deliverable and therefore feeds it with already existing information.

- **External interrelations**
  - Stakeholders which are external to the project (especially the Industry, Cities and PT/PTOs) working on all kinds of mobility. These provide relevant additional input or best practices to the application guidelines and serve as multiplier for the results.
    - Industrial Stakeholders include:
      - Mobility service providers/operators
      - Telecommunication providers
      - Road operators
      - Infrastructure and vehicle providers
      - Maintenance operators
      - IT providers
      - Safety providers
    - PTAs/PTOs include:
      - Regional PTAs/PTOs
      - National PTAs/PTOs
    - Cities & regions include:
      - SHOW partner cities
      - SHOW follower cities
      - Other cities
      - SHOW replicators
      - Other regions
    - Authorities including:
      - National authorities (e.g. ministries, local authorities)
      - International authorities (e.g. EU)
      - Standardization organisations (e.g. ISO, IEEE, UNECE)

2 Methodological Approach

The basis for this deliverable is the previous deliverable called *D17.1: First issue of best practices and decision-making mechanisms for different stakeholder groups* [1] and the methodology established therein. D17.2 is an updated version of D17.1 but includes a reduced and updated version of best practices and application guidelines (AGs) in the form of instruction manuals for different key stakeholders. This is done for different reasons:

- The first versions of the guidelines in D17.1 are highly detailed, and this may be overwhelming for stakeholders who want to use the guidelines to implement a Shared Automated Mobility Service (SAMS) service. Therefore, the guidelines are reduced to the most important information needed for service implementation. If SHOW partners are interested in more details, especially regarding decision-making mechanisms, please refer to D17.1.
- The guidelines of this deliverable will be published and available to the general public on the SHOW Website. Overly complex information could discourage interested stakeholders and users from using the guidelines for their SAMS implementation.

Based on this strategy, the basic approach of this deliverable is divided into the following steps:

- **Step 1**: Taking the existing application guidelines of D17.1 and updating them according to new information and knowledge gained since the submission of D17.1. This includes removing application guidelines that are no longer applicable and adding new application guidelines.
- **Step 2**: Condensing the complex application guidelines to a more digestible version.
- **Step 3**: Sending the updated and reduced application guidelines to selected SHOW partners and test sites and asking them to provide feedback in regard to correctness, completeness and comprehensibility.
- **Step 4**: Updating the application guidelines according to SHOW partner and test site feedback.
- **Step 5**: Mapping the application guidelines with the presented stakeholder groups.
- **Step 6**: Creating an application guidelines charter for cities and public transport.

It should be mentioned that the **implementation of shared CCAM services is the focus** of this deliverable. Therefore, operational guidelines are not included into this deliverable. If included, they would completely go beyond the scope of D17.2.

In the context of this deliverable, the term “shared CCAM” refers primarily to automated passenger shuttles. This is because most of the test sites within the SHOW project, which includes Cities and PTOs/PTAs, used shuttles as the main pilot vehicle.

2.1 Cities & Regions and PTA/PTO Application Guidelines Methodology

2.1.1 Categorisation over hierarchisation

Initially, the application guidelines relevant to cities and public transport were separated and selected. This process involved a detailed review of various guidelines and identifying those most applicable to urban environments and public transportation systems.

In response to the comments made following the submission of D17.1, Eurocities and UITP decided to categorise the application guidelines instead of hierarchising them:

- **Service planning** involves the strategic design and organisation of CCAM services.
- **Governance** refers to the regulatory and policy framework that oversees the deployment and operation of CCAM services.
- **Accessibility and inclusive service** focuses on making CCAM services available and usable for all segments of the population (e.g., physical accessibility and affordability).
- **Safety** is a paramount concern and involves ensuring that CCAM services operate without causing harm to users, pedestrians, and other road users.

This approach facilitated a more nuanced understanding of the different areas these guidelines address. The categorization made it easier to comprehend the application context and the specific focus of each guideline. Categories could include, for example, safety, operational efficiency, and user experience, ensuring that the AGs are organized in a manner that highlights their practical application.

2.1.2 Implementation implications for cities

The implementation implications for cities were specified by analysing how straightforward it is for cities to implement these guidelines. This involved considering factors such as resource availability, regulatory environment, infrastructure readiness, and potential challenges. The findings were detailed in the accompanying text, providing cities with insights into what they need to consider for successful implementation. This part of the process was critical to making the guidelines actionable and ensuring that they could be realistically adopted by urban stakeholders.

2.1.3 Verification with participating cities

To validate the relevance and applicability of the guidelines, verification was sought from cities involved in the SHOW project (that have allocated time and budget for these activities), including Bremen, Aachen, Trikala, Brno, and Tampere. This step involved exchanging with the representatives of these cities to gather their feedback and ensure that the guidelines are practical and aligned with on-the-ground realities. This feedback loop was essential for refining the guidelines and ensuring they were effective and feasible for the intended urban environments.

2.1.4 Contribution from UITP

For public transport, UITP elaborated on the level of importance and specified the implementation implications. This contribution involved a detailed analysis of how PTAs and PTOs could adopt the guidelines, considering operational constraints, passenger needs, and technological integration. The insights provided by UITP

ensured that the guidelines are tailored to the specific challenges and requirements of public transport systems.

By following this structured methodology, the deliverable ensured a comprehensive, practical, and validated set of application guidelines that are both relevant and implementable for cities and public transport agencies involved within and outside the SHOW project.

2.1.5 Application guidelines charter for cities and public transport

The application guidelines for cities and public transport were issued by Eurocities and UITP and translated into a Charter – namely the Booklet for cities and public transport: Application guidelines for shared CCAM services in Europe (available in Annex I). By doing so, Eurocities and UITP commit to promoting the SHOW values to their wider networks and continue building on the work conducted by the different pilot sites in the project.

2.2 Industries Application Guidelines Methodology

This chapter provides an overview of the specific methodology of the application guidelines for industry.

2.2.1 Overall Distinction of the Industry Application Guidelines

As already done in D17.1 the industry application guidelines are considered under the following categories of the so called PESTEL-Analysis:

- Political Application Guidelines for industry
- Economic Application Guidelines for industry
- Social Application Guidelines for industry
- Technological Application Guidelines for industry
- Ecological Application Guidelines for industry
- Legal Application Guidelines for industry

This is done to cover all possible points of view from all possible angles.

2.2.2 Reduced Industry Application Guidelines: Comparison between D17.1 and D17.2

As already mentioned, the application guidelines were reduced for this deliverable. This particularly applies to the industry application guidelines. Table 1 below shows the structure and information of the first version of the application guidelines used in D17.1 (with decision-making mechanisms such as indicators of an economic nature), Table 2 shows the reduced application guideline information (without decision-making mechanisms) given in this deliverable.

Table 1 Description of industry application guideline structure in D17.1

Column Name	Description
Identifier	Unique identifier of the single application guideline; can be used to build guidelines with sub-guidelines AG_1, AG_1.1…
Name of single application guideline	Title / Name of the single application guideline --> this could be a best practice or business model assumption, a guideline from SHOW or another research project, experiences…, a regulation, a business factor…

Column Name	Description
Description	Description of the single application guideline
Rationale	Description/Explanation why the guideline is necessary and should be considered
Key industry cluster concerned/involved	Shows the key industry cluster concerned or involved with the guideline
Source	Reference to source for the application guideline like SHOW, other EU or national RTD projects, studies, best practices from a market participant…
Realisation Phase	To be chosen from the following options: Research, Development, Market Entry_small (small deployment), Market Entry_large (large deployment) or all phases
Dedicated to	To be chosen from the following options: SAMS(P(erson)), SAMS(F(reight)) --> give information about the influence of the application guidelines on the shared automated mobility service types
Linkage to PTO/City guidelines	Shows if and how the single industry application guideline is connected to the PTO/City guidelines
Stakeholder groups involved	Shows which stakeholder groups are involved or affected by the application guideline based on the definitions in D1.1
Possible Impact/Effect	Description of the impact or effect of the single application guideline
Occurency (in %)	Please give the single application guideline an indication how relevant it is or how likely the guideline is to apply to your procedure
Severity (in €)	Please give an estimation (cost or revenues from 0 to xxx Mio. Euro) which is relevant for the single application guideline--> for cost use '-'; otherwise, it is a revenue ;-)
(Monetized) Impact (in €)	Is calculated by Occurency * Severity and acts as an indicator if the guideline should be realized or how important it is
Source/Rationale	Explanation where the numbers of the “Occurancy” and “Severity” categories comes from or how they are calculated

Table 2 Reduced industry application guideline structure in D17.2

Column Name	Description
Identifier	Unique identifier of the single application guideline; can be used to build guidelines with sub-guidelines AG_1, AG_1.1…
Name of single application guideline	Title / Name of the single application guideline --> this could be a best practice or business model assumption, a guideline from SHOW or another research project, experiences…, a regulation, a business factor…
Description	Description of the single application guideline

Based on this new structure, the highly detailed and possibly overwhelming format of D17.1 has been updated to a more understandable, simpler format which can be seen in chapter 4.

2.2.3 Data collection

After updating the industry application guidelines, selected SHOW industry partners and test sites were asked to provide feedback, on the basis of their knowledge and expertise gained throughout the project, concerning the correctness, completeness and comprehensibility of the guidelines. After receiving the feedback of the partners, the guidelines were updated accordingly.

2.3 Relevant stakeholder groups

Table 3 gives an overview of the relevant stakeholders for the linkage of application guidelines with the stakeholders. This list is originally from D1.1 [2] but was also used in D17.1.

Table 3: Stakeholder groups

Stakeholders		Definition
OEM and transport/mobility operators	***OEM (Original Equipment Manufacturer)***	An industrial customer purchasing a product with the aim of integrating it into another product to be sold on another industrial market or to a final consumer. Example: Renault (OEM) buys tires from Michelin to be fitted on cars which it will then sell to an end user.
	Transport/Mobility operators	A mobility operator is a service provider to whom it is possible to subscribe. Following signature, a user who subscribes to a mobility operator will be able to access a mobility service. A user can also buy a ticket for occasional use of the service offered by operator.
Industry such as Tier 1 suppliers, telecom operators, technology providers and services company	***Tier 1 Suppliers / Technology providers***	Tier 1 Supplier: Supplier who delivers directly to the company that produces, assembles or finishes the marketed product. Technology provider: a company which, for example, provides 5G technology.
	Services companies	Company that carries out activities that add value to any product. It may also act as a service provider for a private individual or another company, in return for remuneration.
	Telecom operators	A telecommunications operator is an entity that offers remote communication services.
Research and academia		An establishment, laboratory or research and teaching organisation specialising in technological and human sciences. They may specialise in basic research or may be oriented towards applied research. They may be linked in partnership with universities, companies and ministries.

Stakeholders		Definition
Passengers and other road users encompassing VEC		Passengers: A user of a vehicle who has no role in the operation of that vehicle. Other road users: All people who are not directly AV services' users but participate in the surrounding traffic.
Umbrella associations/Non-profit organisations		An umbrella association is an association (often linked to a specific industry) of institutions that work together to coordinate activities or a set of resources. A non-profit organisation can be an association, a society or a club. The members of a non-profit organisation do not receive any financial benefit from it. Any profit made must be reinvested in the organisation
Authorities (Cities, Municipalities, Ministries), policy makers, municipality agency and road operators	***Road operators***	Entity with the mission to operate and maintain the road domain, which is assigned to the needs of land traffic.
	Policy makers	Persons who have the power to influence or determine policy and practice at the national, regional, or local level
	Ministries	Administration, public services under the leadership of a minister.
	Cities and Municipalities	A municipality is the territorial administration of a communal-type entity that may include a single city or several agglomerations (villages, hamlets, localities, etc.).
	Municipality agency	An agency elaborating different programs of development in a specific field including the different investment funds on the national and international levels and certifications.

3 Application guidelines for Cities, PTAs and PTOs

This second version of the Application Guidelines addresses both a) local and regional authorities and b) Public Transport Authorities (PTAs) and Operators (PTOs). The document is designed for organisations with limited or no experience in deploying shared CCAM services and targets primarily decision-makers, city planners and the staff coordinating the deployment of new mobility solutions in their respective organisations. The aim of the Application Guidelines is to provide advice and raise issues which require special attention, based on the experience of several SHOW pilot sites.

3.1 Service planning

3.1.1 Integrating automation in SUMP

More cities are committing to sustainable urban mobility plans (SUMPs) to promote cleaner transport modes like walking, cycling, and public transport. The concept relies on integrating various urban mobility modes within a functional urban area. City authorities must provide a framework to justify investments from stakeholders, such as public transport, private companies, and research organisations, in shared CCAM services. Cities with existing or developing SUMPs should align automated AV deployment with SUMP objectives to ensure efficient, cost-effective, and inclusive services.

Driven by EU policies (e.g., the 2013 Urban Mobility Package) and climate change concerns, city administrations need to outline their climate objectives. As new crises and technologies emerge, **local governments must redefine their strategies**. By collaborating with research organisations, private stakeholders, and citizens, cities can determine demand and promote innovative transport modes. However, it is worthwhile considering the political landscape at the local level which might make it easier (or not) to integrate automation in SUMPs. Indeed, decision-makers are required – when planning the measures – to recruit political support for the measures and actions of the SUMP [3]. A set of principles and guidelines for SUMP Action Plan development was developed within the context of the EU-funded SUMPs-Up project [4].

3.1.2 Integrating shared CCAM services into public transport and other modes

Although cities are not frontline actors here, they **must create a trusting ecosystem for all urban stakeholders to collaborate effectively**. While most cities lack the technology expertise for shared CCAM services, they understand local needs and how these services can complement existing public transport networks, such as in Linkoping, where suburban services connect residents to the university. Local agents can work with service providers, sharing knowledge to meet citizens' demands. City authorities must commit a great deal of time and resources to take over this responsibility as facilitator. New shared CCAM services do not have a clear framework to work on and therefore this requires the local decision-makers to be innovative. As the large-scale deployment of these services is not widely applied, it remains difficult for cities to assess in which situations these new technologies could be a solution (i.e., cover a specific neighbourhood or whole urban area, integration of passenger and freight operations, etc.). Through SHOW, it remained clear that cities should get involved when CCAM services are integrated with other modes to avoid unfair competition (e.g., local market regulation of driverless on-demand door-to-door services and traditional taxi services). For instance, city authorities are also developing mobility-as-a-service (MaaS) to avoid market overlaps and competition. However, it is important to bear in mind that integrating shared CCAM services with public transport remains the responsibility of the service providers.

Integration of AV fleets within public transport systems is the only way to yield significant benefits for sustainability [5]. By promoting such integration, AV fleets can contribute to improved sustainability by reducing vehicle ownership rates, decreasing vehicle miles travelled (VMT), enhancing accessibility across regions, easing infrastructure demands, mitigating parking challenges, and fostering greater human connectivity.

It is imperative to **prevent competition between AV fleets and public transport systems**, as observed in certain U.S. cities where inadequate dialogue exists between Public Transit Authorities (PTA) and AV operators. Furthermore, it is essential to proactively address the proliferation of individually owned AVs to avoid exacerbating VMT and urban sprawl.

Integrating AV fleets into public transport systems requires a **comprehensive approach and strong authority support**. This includes developing policies for integration, fostering stakeholder partnerships, and adapting infrastructure for AV operations, such as creating new pick-up and drop-off points and building digital infrastructure for vehicle-to-everything communication (V2X). Regional and local authorities must also agree on data-sharing protocols with AV providers, particularly for incident reports. Pilot programmes like SHOW, which test AV services integrated within public transport in cities like Frankfurt and Monheim, are essential

for refining services, informing regulatory frameworks concerning safety and operational standards, and gathering passenger feedback. See project deliverables 13.5 for more information on passenger feedback/acceptance, and 15.8 for operational standards.

3.1.3 Building knowledge for shared CCAM services

As mentioned in D17.1 [1], local and regional authorities should **build their knowledge of the current capabilities of shared CCAM services by facilitating demonstrations and pilot activities**. In this case, city decision-makers have a better say on where they decide to implement these solutions based on their understanding of the citizen's needs (i.e., mobility patterns and urban planning). Cities, here, can also **mandate accessibility of CCAV services** and ensure that the operators consider people with reduced mobility or disabilities [6].

Most city authorities cannot build knowledge internally – such as coordinating demonstrations and pilots from A to Z. However, municipalities can **partner with the private sector or research organisations** to work on specific projects. For instance, the research centre CDV consulted the City of Brno in the context of SHOW to decide on the most useful location for the pilot site. In this way, the city was able to offer guidance on where the service would be more useful for people.

Pilot programs like SHOW are essential to **test and learn how to deploy AV services that are fully integrated within PT** (like in Frankfurt or Monheim). Such projects can produce knowledge and experience – as set out in this deliverable - which will be useful in future shared CCAM deployments. At the same time, it should be noted that each SAMS will need to complement this knowledge with its own learning process, taking into account local challenges. These include issues inherent to its geography, and environmental / weather conditions; demographic factors including populations with specific needs; and infrastructure requirements like charging stations, parking facilities, and telecommunication networks. These nuances must be grasped through on-the-ground experience. Such localised experience can be found in SHOW deliverables D12.2 – D12.7, which discuss the real-life demonstration experiences of SHOW pilot sites.

Implementing a "learning-by-doing" approach is key in building knowledge in the field of shared CCAM. While it is valuable to learn from the experiences of other cities, particularly through shared lessons learned within EU projects, each pilot site will inevitably face its unique challenges, as previously outlined. Therefore, PT stakeholders should **begin with small-scale fleet trials before considering expansion to understand the technical and operational challenges** of deploying an AV fleet (e.g., for charging, parking, and maintenance). Scaling up effectively requires establishing robust local partnerships within the existing ecosystem. Involving local PT stakeholders and

industry partners, such as AV manufacturers or Automated Driving System (ADS) providers, in discussions is crucial for understanding technological limitations, such as the precise Operational Design Domain (ODD) of each AV type and service. As a positive side effect, this collaboration enables industry partners to align their product and service development with the real needs of PT and cities. Moreover, standardization is vital to ensure consistent service scalability. This involves standardising training for personnel (including remote supervisors and field crews) and the software used for remote supervision. Such standardisation efforts should be advocated at least at the regional level to facilitate replication of services in other cities without starting from scratch.

3.2 Governance

3.2.1 Setting up local partnerships

Local partnerships should be considered at an early stage from cities as they can provide successful advanced journey planning solutions. Local or regional authorities are often the initiators. Cities can **be a bridge to facilitate exchanges between the actors involved in demonstrations and pilots**. For instance, municipalities should have a good understanding of what the local population (and specific groups) need from the services as well as the territorial implications (e.g., construction work, events). Starting a local partnership is already one thing, but setting up a strong and long-lasting partnership is another one. Based on interviews with SHOW pilot sites, cities can have a strong role in a partnership if they can **facilitate procedures, build confidence and trust amongst the stakeholders and ensure the success of shared CCAM services** [1]. When facilitating procedures for the deployment of CCAVs, local administrations can support the integration of the services in an open MaaS ecosystem [7]. Trust is another element for setting up a strong collaborative environment. In the context of SHOW, setting up a local demonstration board not only ensures that each city administration can inform the pilot leaders about the limits for the operations (e.g., in Frankfurt, the operations were speed limited to 30km/h), but can also represent a place where every stakeholder concerned by the implementation can express their point of view and concerns. There is no ‘one-size-fits-all’ solution to ensure the success of shared CCAV services. However, the involvement of cities can be highly beneficial to increase awareness of the services and the benefits they could have. Hence, municipalities can engage in joint marketing campaigns with the operators and other mobility providers to prove their confidence in some specific services and promote these technologies (if they are beneficial for the citizens).

Local partnerships are essential for CCAM deployment integrated within public transport. As evidenced in other places around the globe, when no strong partnerships exist – or simply: when the mandate to operate the AV fleet does not come from the local authority and the authorization is given at a higher governance level[1] – the deployed fleet will inevitably compete with the existing PT system and not generate the expected positive impacts on sustainability and car dependency. Although public-private partnerships pose challenges in procurement processes, which may limit innovation opportunities, **they are feasible and increasingly likely to become pivotal success factors for the deployment of shared AV fleets in the future**.

An example of a solid local partnership can be exemplified by the pilot site of Frankfurt: The implementation of the automated shuttle service in Frankfurt within SHOW was integrated into the established local partner network. This network included key stakeholders such as the regional PTA (RMV), the local PTA of Frankfurt (traffiQ, city-owned organization), the city's PTO (VGF) responsible for metro and tram services and rms GmbH, a consulting company. traffiQ provided recommendations on neighbourhoods where the automated Demand-Responsive Transport (DRT) service could complement existing public transport networks through setting up automated shared shuttles. This was achieved by providing first- and last-mile connectivity to existing transport hubs. Additionally, VGF supported the initiative by providing trained safety operators. The city of Frankfurt played an important role in setting the political framework for local mobility concepts and conveyed its demands and requirements through traffiQ. Furthermore, the consulting company rms GmbH supervised the pilot site and oversaw project management tasks.

3.2.2 Following a multi-step administrative and regulatory process

Given the heterogeneity of regulatory processes for the deployment of shared CCAV services in Europe, cities are essential to **guide actors in the process and raise awareness of the regulatory and administrative frameworks at different levels**. SHOW revealed a need for city administrations to familiarise themselves with certain concepts (e.g., intelligent traffic systems and automated driving) and to be involved throughout the demonstration and pilot phases to make sure these are respected. Moreover, cities need to be significantly involved throughout the deployment as they are responsible for ensuring that EU legislation is applied properly [8]. For instance, GDPR is a recurring topic in the context of automated driving pilots (i.e., cameras, data from users, etc.) and therefore cities need to be constantly in-the-know about these issues at different

[1] In San Francisco, AV operators are seeking approval for deploying AV services to the California Public Utilities Commission (CPUC) and not the city or local authority.

governance levels.

With time, administrative and regulatory processes are expected to become clearer as authorities become increasingly aware of these technologies. In the meantime, authorities **can offer information on the processes to get pilots on the streets**. For instance, the City of Helsinki provided an informative document, with Forum Virium and the Mobility Lab Helsinki, clearly stating which steps should be considered by operators to test autonomous logistics robots in Helsinki [9]. The document shares useful information about which regulations are enforced and which information needs to be submitted to the city administration.

City administrations are also recommended to **identify and create trust with the other relevant authorities** (regional, national and European) as early as possible to ensure that they can access reliable information to share. This can be done by having regular exchanges with them or even establishing more formal ways to collaborate (i.e., Memorandums of Understanding, Letters of Support, etc.).

Following the administrative and regulatory process is a mandatory step for public transport operators and other stakeholders involved in deploying the AV service safely and legally. Speed limits, the presence of a safety operator on board, and actions to be taken at intersections (e.g., validation by safety operator as in the Frankfurt pilot site) are requirements that must be known by the PTO deploying the service. Since CCAM is a relatively new field for PT, **some countries or regions have developed a regulatory process inclusive enough to enable feedback by the PTO to the regulating authority**. This is, for instance, the case in Austria, where the approval process for the service enables the PTO to require specific infrastructure (e.g., traffic signs or retrofitting of a bus stop) to operate the service optimally.

3.2.3 Preparing CCAM vehicle procurement

Preparing and ensuring a successful AV procurement is essential for public transport authorities to modernise their services, meet evolving passenger expectations, and contribute to the advancement of urban transportation systems. However, the public transport sector **faces challenges in AV procurement processes because of complex regulatory requirements, lengthy procurement timelines, and budget constraints**. Additionally, for AV services, procurement can be difficult because of limited supplier diversity and reliance on a few key vendors. Lastly, balancing the need for innovation with the requirement for proven technology is a delicate task for public authorities. Addressing these challenges requires careful planning, effective stakeholder engagement, and transparent procurement practices. Findings from the Marid pilot site also show that retrofitting existing,

conventional vehicles to enable automated operation has a low cost/benefit ratio. This is due to high upfront costs in purchasing the necessary equipment and carrying out the retrofitting, on top of the cost of the conventional vehicle itself.

Implementing a **successful procurement process for AVs within public transport agencies involves** several key steps:

- **A thorough market research** is essential to understand available AV technologies and their suitability for the specific needs of the transport agency and the expected service.
- **Clear procurement criteria and requirements**, including safety standards, operational capabilities, and compatibility with existing infrastructure, are required to ensure fair and transparent competition among vendors.
- The authority must **ensure a robust contract negotiation** including pricing, and warranties,
- An iterative Request for Information (RFI) process will need to be followed, as part of robust testing and evaluation processes to verify the performance and safety of the procured AVs before (pre-commercial) deployment.

By following these steps, PTAs and PTOs can effectively navigate the procurement process and successfully integrate AVs into their operations.

3.3 Accessibility and inclusive service in CCAM services

3.3.1 Promoting the use of shared CCAM services

Both cities and public transport authorities are key in promoting shared mobility services to offer viable alternatives to car usage. It's important to **communicate that the convenience and flexibility of car travel can also be achieved with shared CCAM services**, leading to seamless and comfortable journeys. Highlighting the environmental benefits, such as reduced emissions and less congestion, is crucial to encourage public transport use.

To foster the adoption of shared CCAM services, cities and public transport authorities must build trust through comprehensive marketing campaigns. These should educate the public about the benefits and usage of CCAM via informative materials, community sessions, and feedback collection. By emphasising convenience and environmental advantages, and addressing the needs of diverse populations, cities can increase public transport uptake. Tailored promotional efforts, informed by engagement with various user groups, are essential for promoting sustainable and inclusive urban mobility.

For example, SHOW pilot sites like Linkoping and Carinthia have

conducted information sessions at schools, senior homes, and tourist offices to **educate the public and build support**. Once pilots start, continuous citizen involvement through monitoring and feedback collection, such as focus groups and surveys, is necessary to ensure success and community support.

3.3.2 Making shared CCAM services inclusive

Public value is central to the objectives of cities' activities, and they should work toward mobility systems that are safer, cleaner and more inclusive [10]. Smart mobility innovations (e.g., DRT, AV, MaaS) can respond to some transportation disadvantages – defined by Butler et al. (2020) as "the difficulty of accessing mobility services required to complete activities associated with employment, shopping, business, essential needs, and recreation" (p. 1). Additionally, cities should ensure that disability and digital inclusion are considered in the services [11]. For instance, some sections of the population – such as non-tech-savvy people – might be excluded from services that are only available through apps. SHOW findings demonstrate that cities **could mandate the accessibility of CCAV services**, **put in place vehicle requirements** adapted to the environment (dimensions, weight, etc.) and type of service (e.g., door-to-door), **extend CCAM service provisions** to deploy their services to low-demand zones and off-peak hours and **collect public feedback** on the performance of the vehicles [12].

Inclusivity within the public transport sector is intricately linked with the concept of accessibility, encompassing both area coverage and tailored services to meet the needs of specific user groups. In terms of area coverage, many PTAs **mandate DRT services for areas with low passenger demand**, such as rural and peri-urban areas, where traditional bus services are financially unviable. In these regions, vehicles are dispatched to pick up and drop off passengers at locations based on their needs, often accessible via mobile app or telephone, for users less familiar with technology. However, DRT services can be costly and inefficient due to driver waiting times between bookings. CCAM solutions offer potential cost-efficiencies, exemplified by the Frankfurt pilot site's transition from manually driven DRT to on-demand automated shuttles.

Inclusivity also requires ensuring that certain user groups, particularly those with physical or cognitive impairments, can have mobility services tailored to their needs. For instance, a key indicator of effective inclusivity is the ability of passengers – independent of their physical or cognitive abilities – to safely and effortlessly board and disembark from a vehicle. While there is no one-size-fits-all solution, CCAM service designers can draw on learnings from the wider PT system. For instance, the EU-funded

TRIPS project[2] describes and demonstrates practical steps to place people with mobility challenges at the centre of the design of inclusive mobility solutions. The project includes industry recommendations and toolkits for co-creating inclusive mobility services

Adopting such an inclusive approach in the design and deployment of CCAM services can benefit all passengers, by making services easier to use and putting user-experience at the heart of service design. However, it is important to acknowledge that there will always be a need for human assistance for specific needs to ensure the full inclusivity of public transport services.

3.3.3 Establishing proactive measures for labour force evolution with CCAM

As development and deployment of CCAM progress, the labour force will be affected across three dimensions: a) employment, b) required worker skills and workers' wages, and c) working conditions. The public transport sector is seeing a **general decline in drivers entering the workforce**, leading to recruitment challenges and operational disruptions. For instance, the International Transport Forum (ITF) mentions in its report "Making Automated Vehicles Work for Better" that Île-de-France Mobilités, the public transport authority of the Paris region, reduced services by 7-8% due to recruitment issues. Similarly, UK rail companies cut nine of their 40 daily services due to driver shortages [13]. This highlights the motivation for PTAs to explore CCAM and its potential for enhancing PT operational stability and passenger service quality.

Regarding skills and working conditions, differences arise between current CCAM services deployed in Europe (as those in the SHOW project) and the long-term vision for driverless PT services without operators on-board. In most of the SHOW pilot sites, **safety drivers were present on-board and were responsible for ensuring vehicle safety and passenger well-being**. This role involved a wide range of skills, including driving, IT proficiency, and customer interface, often leading to task overload.

In the long term, as CCAM evolves, the on-board safety operator role is expected to diminish. However, the wide-scale adoption of **CCAM is expected to lead to an increase in various roles, from maintenance and onsite support to remote supervision and other office-based roles**. Experience from pilot sites such as Madrid show a high degree of interest and acceptance by employees, when engaged constructively about the introduction of CCAM. PTOs should be prepared for a significant change in the types of roles they will need to fill, along with associated skill

[2] https://trips-project.eu/

sets and pay scales.

3.4 Safety related infrastructure

3.4.1 Setting up and managing physical infrastructure

Local public administrations can facilitate large-scale CCAM pilot testing by **ensuring access to essential information, such as road maintenance and urban cleaning schedules**. This helps keep operations safe and provides certainty to service operators. Cities play a crucial role in adapting infrastructure to meet the needs of people and services, deciding on aspects like the placement of charging stations. Effective cooperation is required not only between service operators and solution providers but also among various city departments (e.g., waste management, road works, infrastructure). While cities are dealing with many emerging technologies and services which need to work together, local decision-makers will have to balance properly the interests of the community (i.e., public and private service operators, end users, investors, solution providers, etc.). This becomes particularly important when talking of smart city development [12]. City authorities must develop the right planning structures and smart infrastructure integration to ensure that cities are prepared to host these new technologies and services and that they respond best to the needs of their inhabitants. Generally speaking, good quality lane marking and signalling benefit both AVs and non-AVs [13] in urban areas.

Public transport stakeholders **depend on high-quality physical infrastructure** to operate both manually driven and CCAM services safely and efficiently. Clear lane markings are helpful for both manually driven and automated services. Furthermore, the topic of pick-up and drop-off points (also addressed within the field of “curb management” in the U.S.) needs to be defined for the various actors. Are AVs allowed to use bus stops? How long can they stop there? These bus stops may need retrofitting to enable automated shuttles to board and alight passengers considering for instance the height of the curb, or the type of information displayed at the bus shelter. Designated areas to park the AVs while they don’t carry passengers are also needed and should be proposed by the city to avoid AVs driving without passengers when no service is required (and generate so-called “empty miles”).

3.4.2 Setting up and managing the digital and communication infrastructure

In the context of the Digital Cities Challenge, the European Commission issued recommendations for designing digital transformation strategies in EU Cities [15]. For shared CCAM services, I**ntelligent Transport Systems (ITS) and data accessibility are essential.** Using innovative technologies – including ITS, Information and communication technology (ICT), and Artificial Intelligence (AI) - has many benefits for travellers, transport operators, urban planners and city governments. Cities must be already well equipped with digital infrastructure before putting shared AV shuttles on the streets [11]. Cities also have the responsibility to define if and under which conditions CCAV operators are allowed to make use of dedicated public transport infrastructure (e.g., C-ITS equipment that enables positioning and prioritisation of vehicles, etc.) [6]. This is particularly important when it comes to introducing dynamic curb-side management for on-demand mobility services as local authorities will define the rules and processes for curb-side management. Cities are also improving the broadband connections necessary for these services. Local administrations should ensure access to critical data, as data ownership is shifting to the private sector in the sharing economy. Open ITS architecture and standards should be considered to allow CCAVs to operate in a multi-operator and multi-vendor environment, supporting city management in areas like traffic and roadworks [6].

Setting up and managing digital and communication infrastructure for the operation of shared CCAM services is paramount for the future of public transport. Even with manually driven services, this infrastructure facilitates seamless communication between vehicles, infrastructure, and control centres, enabling real-time data exchange and coordination. With CCAM services, digital infrastructure becomes even more critical as it supports the integration of automated vehicles with existing public transport systems. It ensures efficient operation, **enhances safety through constant (real-time) monitoring and communication**, and provides passengers with up-to-date information and services. Moreover, digital infrastructure enables the optimization of routes, schedules, and passenger flows, contributing to improved efficiency and reliability.

Standardization will play a key role in the implementation of CCAM by public transport stakeholders since it will enable replication and scalability and attract AV providers who will be able to deploy their services in multiple cities. Data management protocols and cybersecurity measures will have to be established to support CCAM operations securely, including standardized software for remote supervision centres (closely linked with operational deployments) and their communication with the

fleets, system architecture models[3], and robust and secure cellular networks to enable real-time monitoring.

The topic of open HD maps is also investigated in EU projects such as ULTIMO[4] and AUGMENTED CCAM[5] but it has to be proven yet if the concept of shared HD maps will be manageable from a city/authority point of view (with the issue of high maintenance costs and risk of rapid obsolescence) and from the AV provider side who is for now developing its own HD maps (through heavy investments).

[3] As proposed within WP4 and deliverable D4.4

[4] https://ultimo-he.eu/

[5] www.augmentedccam.com)

4 Application guidelines for Industry

This chapter includes the industry application guidelines as described in chapter 2.2 in Table 4 to Table 9. The guidelines are built up in a step-by-step manner (like, for example, a regular manual instruction when building a bookshelf at home) that cover all possible actions which might be relevant/needed when implementing a CCAM service in the industry sector. Even simple expressions which might already be known by the user like “Researching of what documents, approvals, etc. are needed to implement an automated mobility service” (PI_2.1) are included for completeness of the guidelines. If wanted the presented guidelines for industry might as well be used as checklist.

These guidelines are mainly directed to the industry stakeholders, which were defined in chapter 2.3. They describe a general formulated approach when implementing CCAM services that can be used everywhere by any industry stakeholder located within the European Union. The general approach was done because each EU member state might have (if we take PI_1.1 as an example) a different authorised contact ecosystem within the local authorities when it comes to CCAM. If the guidelines would be too specific and detailed, the result could be that for each EU member state own specific developed guidelines would be needed to cover the individual CCAM implementation requirements of each EU state. And that is not the aim of this deliverable.

4.1 Political Application Guidelines for industry

Table 4: Political Application Guidelines for industry

Political Application Guidelines for industry	
PI_1	*Support of local Authorities*
Description: Support and collaborate with local authorities for the creation of political goals or motivation to lay the base for Shared Automated Mobility Services (SAMS)	
PI_1.1	Finding and contacting the authorised contact ecosystem for automated mobility topics
PI_1.2	Supporting the (organizations and) authorities with necessary information about shared automated mobility service concepts
PI_1.2.1	Preparing documents, papers, and presentations for local authorities to enable better understanding of the planned automated mobility service concept and the potential and limitations of fleets and accompanying services
PI_1.2.2	Presenting/discussing the prepared documents, papers and presentations
PI_1.2.3	Have regular meetings to show and discuss the progress of the development and integration of the automated mobility service
PI_1.3	Supporting the authorities with other aspects regarding shared automated mobility services (Consultation services)

PI_1.3.1	Technical consultation service supporting the authorities within the decision process
PI_1.3.2	Legal/Standardization consultation service supporting the authorities within the decision process
PI_1.3.3	Other consultations service supporting the authorities within the decision process (environmental, economic, traffic…)
PI_2	*Collaborating with local authorities for creating the relevant permit documentation*
Description: Support local authorities in the creation of the relevant documentation or paperwork to lay the base for SAMS	
PI_2.1	Researching what documents, approvals, etc. are needed to implement an automated mobility service
PI_2.1.1	International (EU) administrative requirements
PI_2.1.2	National administrative requirements
PI_2.1.3	Local/Regional administrative requirements
PI_2.2	Providing local authorities feedback about necessary documentation, permits and other documents
PI_3	*New insurance policies*
Description: Investigate legal framework and updates regarding the impact on insurance policies, strategies and implementation to be able to determine responsibilities regarding safety issues and operation of SAMS	
PI_3.1	Identifying current problems/gaps in legal framework regarding responsibilities regarding Automated Driving (AD)
PI_3.1.1	Identifying and analysing relevant international legal frameworks (UN, European Union)
PI_3.1.2	Identifying and analysing relevant national legal frameworks
PI_3.2	Creating recommendations for the identified problems/gaps
PI_3.2.1	Creating recommendations for international legal frameworks (UN, European Union)
PI_3.2.2	Creating recommendations for national legal frameworks

4.2 Economic Application Guidelines for industry

Table 5: Economic Application Guidelines for industry

Economic Application Guidelines for industry	
EI_1	*Active customer involvement from the business environment and linked value chains*
Description: Actively involve customers in collaboration with the rest of the ecosystem, via different feedback loops and methods (interviews, events, Satisfaction surveys) for the optimisation of provided Shared Automated Service (SAMS) or deployment of new SAMS	
EI_1.1	Identifying relevant stakeholders from the business environment and relevant economic value chains
EI_1.1.1	Identify relevant businesses and value chains of the city/area
EI_1.1.2	Identify relevant inhabitants of the city/area
EI_1.1.3	Identify other relevant stakeholders
EI_1.2	Contacting identified stakeholders from the business environment and relevant economic value chains
EI_1.2.1	Contact relevant businesses of the city/area
EI_1.2.2	Contact relevant inhabitants of the city/area
EI_1.2.3	Contact other relevant stakeholders
EI_1.3	Including the stakeholders in the development and integration of the automated mobility service
EI_1.3.1	Preparing events for stakeholders such as workshops, demonstration events, etc.
EI_1.3.2	Preparing demand and needs surveys
EI_1.4	Keeping the stakeholders informed
EI_1.4.1	Organising regular information meetings
EI_1.4.2	Creating a monthly newsletter
EI_1.4.3	Creating surveys if needed regarding changes
EI_2	*Time related cost & revenue optimization*

Description: To optimize costs and revenues in a timely manner it is necessary to analyse the value chain and the corresponding business environment continuously and just-in-time.	
EI_2.1	Identifying and analysing the service owned needs
EI_2.1.1	Identifying and analysing continuously the service needs
EI_2.1.2	Adapting continuously to the needs
EI_2.2	Finding and involving value chain participants needed to cover needs
EI_2.2.1	Finding value chain participants to cover needs
EI_2.2.2	Contacting and involving value chain participants
EI_2.2.3	Changing value chain participants according to needs
EI_2.3	Creating and updating business environment for cost and revenue optimization
EI_3	*Marketing Revenues*
Description: Selling spaces on vehicles or stations (not only for self-advertising) can be an important revenue stream when properly exploited and can help to make the service more profitable.	
EI_3.1	Set pricing
EI_3.1.1	Inform yourself about the typical prices when selling vehicle spaces (check the competitors)
EI_3.1.2	Check the sizes and general revenues of the local companies/organizations which could be possibly interested to use vehicles as marketing opportunity (smaller companies will not have the money for such marketing, if the price is too high --> What could they afford?)
EI_3.1.3	Set the price based on competitor offers and the size of local companies/organizations
EI_3.2	Promote Marketing space possibility to possible customers
EI_3.2.1	Letting possible customers known that there is the possibility to use vehicles/stations as marketing space
EI_4	*SME potential for the business environment and relevant economic value chains*

Description: Using the potentials (like adaptability, creativity, flexibility …) of the SMEs is a great chance to optimize the business as well as the services themselves.	
EI_4.1	Identifying relevant SMEs and their potentials and contacting them
EI_4.1.1	Identifying SMEs and their potential for the SAMS
EI_4.1.2	Contacting SMEs to start cooperation
EI_4.2	Introducing and integrating the different SMEs and their potentials into the SAMS
EI_4.2.1	Introduce SME to the SAMS
EI_4.2.2	Integrate the SME into the SAMS
EI_4.2.3	Fix the service(s) of the SME via a contract
EI_5	*Business Environment Analysis*
Description: A good business environmental analysis should be the basis for all businesses – do not forget to update on regular base.	
EI_6	*Usage time optimisation*
Description: By optimizing the non-usage times of vehicles (considering the limits of the used technology) the service runs more efficiently, creating (more or more constant) revenues while also optimizing the costs side.	
EI_6.1	Identifying non-usage time of the vehicle
EI_6.2	Create a concept on how to optimize the non-usage times
EI_6.2.1	Using the vehicles at night for other than anticipated/regular tasks (e.g. instead of person transport, freight transport)
EI_6.2.2	Charging/maintenance of vehicles during non-usage time
EI_6.3	Implement concept of non-usage times
EI_6.3.1	Updating and adapting concept if needed
EI_7	*Technology usage & update*
Description: If the existing technology is not used in a correct way, and especially if updating is not done accordingly, can cause a loss of revenues.	
EI_7.1	Becoming informed about different technologies available on the market

EI_7.1.1	Vehicles
EI_7.1.2	Hardware & Interfaces
EI_7.1.3	Software & Interfaces
EI_7.1.4	Road Infrastructure
EI_7.1.5	Cooperative technologies & solutions
EI_7.2	Selecting the most suitable technologies
EI_7.3	Intensifying knowledge about used technologies
EI_7.3.1	Getting information from the developer company
EI_7.3.2	Reading instruction manual
EI_7.3.3	Asking experts
EI_7.3.4	Other means of acquiring information
EI_7.3.5	Continuous updating on new versions
EI_7.4	Hiring personnel familiar with the used technologies or targeted training of already existing personnel
EI_7.4.1	Hiring new personnel familiar with the technologies
EI_7.4.2	Sending/Organizing targeted trainings for personnel
EI_7.5	Creating concept on how to maintain and update the used technology
EI_7.5.1	Maintenance concept for vehicles, hardware and infrastructure
EI_7.5.2	Updating concept of software (including software of vehicles, hardware and infrastructure)
EI_7.5.3	Break down concepts for vehicles, hardware, software and infrastructure
EI_8	*Customer Knowledge*
Description: To know one's own customers and their needs (city vs. rural, and react with a standard approach) is elementary to design and update the SAMS	
EI_8.1	Involving customers (in the economic view) from the beginning / as soon as possible

EI_8.1.1	Preparing events for stakeholders such as workshops, demonstration events, etc.
EI_8.1.2	Preparing demand and needs surveys
EI_8.2	Having a reliable and good customer service
EI_8.3	Updating and informing the customers of changes
EI_8.3.1	Organising regular information meetings
EI_8.3.2	Creating a monthly newsletter
EI_8.4	Doing different things to get the customer's needs and demands
EI_8.4.1	Creating surveys if needed regarding changes
EI_8.5	Reacting to customer demands and needs
EI_9	*Be aware of the complexity of business value chain and the necessary members*
Description: Over- or underestimating the complexity of the value chain will endanger the economic success.	
EI_10	*Capital Expenditure/Operational Expenditure (OPEX/CAPEX)*
Description: Do not underestimate OpEx costs in relation to the CapEx	
EI_10.1	Systematic recording of all OPEX and CAPEX costs
EI_10.1.1	Recording of all OpEx costs for a certain holding period
EI_10.1.2	Recording of all CapEx costs for a certain holding period
EI_10.2	Analysing and comparing the OpEx and CapEx costs to see which impact they finally have in the total cost structure of the service
EI_10.2.1	Comparing sum of CapEx and OpEx with each other
EI_10.2.2	Comparing the sum of CapEx with the made revenues
EI_10.2.3	Comparing the sum of OpEx with the made revenues
EI_11	*Basic SAMS Definition*

Description: Offered services do not need to be too specialised (concentrated on a too small market niche)	
EI_11.1	Analysing if the current service meets the needed demand
EI_11.2	Adapting to the demands by widening the services offered to cover more market niches
EI_12	*Customer & Trust for LaaS*
Description: Monitor und integrate trust issues of the customers in case of LaaS to avoid revenue losses	
EI_12.1	Receiving order via software (digital purchasing, e-mail or phone call)
EI_12.1.1	Creating concept for Digitalized Ordering Process
EI_12.1.2	Creating Digital Ordering Platform (including all necessary functions for the service)
EI_12.1.3	Adapting warehouse and inventory workings and personnel to Digital Platform
EI_12.1.3.1	Adaption of internal automated warehouse and inventory distribution
EI_12.1.3.1.1	Implementing a system for automated analysis of stocking goods (to know what needs to be re-ordered)
EI_12.1.3.2	Adaption of internal manually warehouse and inventory distribution
EI_12.1.3.3	Training for personnel for handling the Digitalized Ordering Process
EI_12.1.4	Digital ordering from customers
EI_12.1.4.1	Processing of order
EI_12.1.4.2	Approving of order
EI_12.1.4.3	Automated warehouse distribution to send-portal
EI_12.1.4.4	Automated packaging and shipping
EI_12.1.4.5	Creating automated digital receipt
EI_12.1.5	Sending order
EI_12.1.5.1	Automated transportation

EI_12.1.5.2	Sending tracking number to customer
EI_12.1.6	Receiving confirmation that the order has been received by the customer
EI_12.1.6.1	Trust improvement of the customer by receiving their order in a good condition
EI_12.1.6	Intelligent Costly Errors
EI_13	*Complexity of technology and solutions*
Description: Make a realistic estimation regarding implementation and complexity and the technical products to be used for a SAMS	

4.3 Social Application Guidelines for industry

Table 6: Social Application Guidelines for industry

Social Application Guidelines for industry	
SI_1	*Customer Management*
Description: Customer management means services such as short waiting times, answering when questions are asked over the service hotline or per e-mail as well as providing the possibility for the customer to have some kind of personal contact to take care of problems (especially important for elderly)	
SI_2	*Actual company strategies considering social aspects*
Description: Update own company strategy to increase attractiveness of SAMS	
SI_2.1	Transferability of strategy: considering current relevant national and European strategies for the update of the company strategy
SI_2.2	Implementing SAMS & Stakeholders' view, including passengers and logistics clients, for a successful service
SI_3	*Increase trust of customer considering societal aspects*
Description: Trust issues of the customers, taking into account social aspects (age, culture, knowledge level) regarding the service and/or the technology used, can lead to revenue losses	
SI_3.1	Ensured accessibility and safety to the service
SI_3.2	Keep passengers informed about what to do in emergency situations (like in airplanes)

SI_3.3	Monitor passenger acceptance to improve the service
SI_4	*SAMS update cycle covering social aspects*
Description: Improve regularly your SAMS to increase reliability for customer	
SI_4.1	Congestion reduction by using traffic management service
SI_4.2	Travel time reduction by using traffic management service
SI_4.3	Update Human Machine Interface (HMI) to all active actors involved (safety driver, remote operator, other) and communication channels to increase reliability of the service

4.4 Technological Application Guidelines for industry

Table 7: Technological Application Guidelines for industry

Technological Application Guidelines for industry	
TI_1	*Maintenance influence for service operation*
Description: Proper operation of the service is only possible by keeping the service's assets in good shape. Therefore, a good maintenance team is needed.	
TI_1.1	Create a maintenance concept and a list of what personnel is needed for what kind of maintenance
TI_1.1.1	Vehicle maintenance
TI_1.1.2	Infrastructure maintenance
TI_1.1.3	Software maintenance and organise Software over-the-air updates as part of the product
TI_1.1.4	Sensor maintenance
TI_1.1.5	Other maintenance (buildings, etc.)
TI_1.2	Hire personnel according to maintenance needs
TI_1.3	Personnel training according to maintenance needs if required
TI_2	*Continuously monitor, identify and implement technologies provided by new or existing value chain SME*

Description: Exploit added value services from SMEs to optimise the overall service offered.	
TI_2.1	Continuously monitor what SMEs are offering
TI_2.2	Contacting them if offers are interesting for own service
TI_2.3	Developing implementation concept of new technology
TI_2.4	Implementing new technology
TI_3	*Technology usage & update*
Description: Not using the existing technology in a correct way, and especially updating it accordingly, can cause the loss of customers (customer acceptance for the service is decreasing).	
TI_3.1	Digital customer services
TI_3.1.1	Digital customer service
TI_3.1.1.1	Analysing which customer services are needed
TI_3.1.1.2	Developing needed customer services (e.g. Hotlines, Applications, real-time information always available, etc.)
TI_3.1.1.3	Implementing developed customer services into the app
TI_3.1.1.4	Regular updates and adaptions of customer services according to changing needs
TI_3.1.2	Intelligent Confirmation
TI_3.1.2.1	Analysing which kind of intelligent confirmation is needed and suits best the needs
TI_3.1.2.2	Developing needed intelligent confirmation app or software
TI_3.1.2.3	Implementing developed intelligent confirmation app/software
TI_3.1.2.4	Regular updates and adaptions of application/software according to changing needs
TI_4	*Carefully designing the fleet's ODD along with the associated boundaries*
Description: Designing the ODD for the vehicle fleet and the associated boundaries is crucial for the service to operate properly.	
TI_4.1	Identification of service area

TI_4.1.1	Road characteristics
TI_4.1.1.1	Type of streets
TI_4.1.1.2	Difficulties such as roundabouts, rails, etc.
TI_4.1.2	Signalling
TI_4.1.2.1	Road signs
TI_4.1.2.2	Traffic lights
TI_4.2	Definition of weather and other external requirements and restrictions
TI_4.3	Identify which use cases are outside the ODD
TI_4.3.1	Describe the ODD in details, for the definition of the level of automation
TI_4.4	Traffic volume/density analysis
TI_4.5	Define service parameters
TI_4.5.1	Service speeds
TI_4.5.2	Passenger numbers (if relevant)
TI_5	*Catering for security and trust services for customers*
Description: Avoid trust losses of customers regarding relevant interfaces, used technologies and comfort functionalities	
TI_5.1	Management of vehicles' usage-time
TI_5.2	Integrate technologies such as microphones, cameras and speakers into and outside the vehicle for emergency cases
TI_5.3	Definition of the proper emergency procedures in case of any safety/security issue
TI_6	*Technology Management* *Smart and Sustainable Supply Chain Management*
Description: Implement an active technology management to handle the technological issues of smart contracts and the IT system landscape (e.g. scalability, energy consumption, and performance restrictions).	
TI_6.1	Implementation of Automated Traceability Technology

	Best Practices for Automated Traceability
TI_6.2	Software Quality and Framework in a logistic SAMS application Best Practices for Automated Traceability
TI_6.2.1	Ordering and Stocking goods for warehouses
TI_6.2.1.1	Creating a (technical) concept for an automated ordering and stocking process
TI_6.2.1.2	Acquiring and implementing Internet of Things (IoT) -based sensors for stock monitoring (scanning of QR and Barcodes)
TI_6.2.1.3	Acquiring IoT/Sensors and mobile applications to monitor temperature and status of stored products
TI_6.2.1.4	Acquiring and implementing general (not only for applications) software for stock monitoring
TI_6.2.1.5	Implementing software/application for alerting personnel and warehouse manager regarding low stock or bad quality of stocked products
TI_6.2.2	Intelligent Product Picking
TI_6.2.2.1	Creating concept for intelligent product picking
TI_6.2.2.2	Stocking material storage with all necessary packing material needed for the different products
TI_6.2.2.3	Implementing software and hardware for the intelligent product picking (sensors, software with all data needed for the process, etc.)
TI_6.2.2.4	Each packaging material is marked with an individual number/symbol so that systems can recognize and select the correct packaging material.
TI_6.2.2.5	Allocation of the packaging materials to the appropriate products
TI_6.2.3	Intelligent Packaging
TI_6.2.3.1	Concept for intelligent packaging
TI_6.2.3.2	Implementing software and hardware for intelligent packaging (sensors, scanners, software with the needed data for the process)
TI_6.2.3.3	Programming the software according to needs (providing support and assistance for packing activities, scanning and monitoring packed containers for e.g. missing pieces)
TI_6.2.3.4	Transportation of products from warehouse to container or vehicle

TI_6.2.4	Route optimization
TI_6.2.4.1	Choosing the system that fits the business needs best
TI_6.2.4.2	Installing the chosen system in all business owned vehicles
TI_6.2.4.3	Using the system during every transport with business owned vehicles
TI_7	*CCAVs Cooperative vs individualistic decision-making*
Description: Balance cooperative & individualistic decision-making for the deployment and operation of SAMS to minimise conflict potential with the other impact areas	
TI_8	*Sensor configuration*
Description: Ensure proper sensor configuration to optimise information flow for safety aspects and customer trust	
TI_8.1	Configure Sensors on a regular basis
TI_8.2	Check if sensors are working as they should on a regular basis (functionality test)
TI_9	*Consideration of PDI (Physical and Digital Infrastructure) support in the deployment area to assume into the service to enhance and extend its operation*
Description: PDI support within the deployed area of the service should be considered to enhance the service and possibly extend the service operation	
TI_9.1	Physical Infrastructure
TI_9.1.1	Identification of adaptations required on physical infrastructure for the smoothest possible operation of CAVs. Consideration of relevant schemas informing about this and depending on the level of automation and the vehicle features (i.e. ISAD, PIARC schemas, ACCAM, etc.)
TI_9.1.2	Identification of special types of infrastructure involved in operation (i.e. critical infrastructures, etc.) and special precautions concerning them.
TI_9.2	Digital Infrastructure
TI_9.2.1	Identification of adaptations required on digital and communication infrastructure for the smoothest possible operation of CAVs. Consideration of relevant schemas informing about this and depending on the level of automation and the vehicle features (i.e. ISAD, PIARC schemas, ACCAM, etc.)
TI_9.2.2	Environment mapping & HD maps

TI_9.2.3	Virtual road availability
TI_9.2.4	Digital and Communication Infrastructure and enabled services for the "Sense" and "Plan" part of vehicles. Cross-check to which extent those are assumed by the specific CAVs.
TI_10	*Technology update for all relevant components, sub-systems and systems for the operation of SAMS*
Description: Define, monitor and update applicable interfaces (HMI for customer, for service providers)	
TI_10.1	Standard data interface
TI_10.1.1	Create Communication interface between vehicle and operator in case of challenges and update it regularly
TI_10.1.1.1	Definition of responsibilities for the updates
TI_10.1.1.2	Definition of workflows for the updates
TI_10.2	Public information interface
TI_10.2.1	Create information system for the customers and update it regularly
TI_10.2.1.1	Off-Board System Interface (e.g. Apps for Younger People, real-life vocal information announcements on stations for elderly)
TI_10.2.1.1.1	Definition of responsibilities for the updates
TI_10.2.1.1.2	Definition of workflows for the updates
TI_10.2.1.2	On-Board System Interface (e.g. real-life vocal information announcements inside the vehicles or Screens with Information)
TI_10.2.1.2.1	Definition of responsibilities for the updates
TI_10.2.1.2.2	Definition of workflows for the updates
TI_11	*Integration into the transport system*
Description: The degree of success of a new deployment/operation is largely dependent on its level of integration and cooperation into the overall transport system	
TI_11.1	Design interaction models for interaction with traffic participants
TI_11.2	Design interaction models for interaction with vulnerable road users (VRU)

TI_11.3	Design methods for assessment of acceptance of other traffic participants
TI_11.4	Sustainable vehicle trajectory planning
TI_11.5	Design methods for Smart Routing
TI_11.6	City mobility planning
TI_12	*High level of interoperability*
Description: Ensure a high level of interoperability, especially for (data) communication, traffic management and all relevant HW and SW interfaces	
TI_12.1	Development and Definition of APIs
TI_12.1.1	APIs between Software
TI_12.1.1.1	Vehicle
TI_12.1.1.2	AD-System
TI_12.1.1.3	Booking Application
TI_12.1.1.4	Traffic Control Centre

4.5 Ecological Application Guidelines for industry

Table 8: Ecological Application Guidelines for industry

Ecological Application Guidelines for industry	
ECI_1	*Environment & Marketing*
Description: Increase ecology image by the selection of environmentally friendly and sustainable companies to attract more customers	
ECI_1.1	Using trackable green energy resources from sustainable energy providers to have a positive impact on the environment
ECI_2	*Coverage of SAMS & Environmental effects*
Description: Offered services do not need to be too specialised (concentrated on a too small market niche) from the ecology point of view e.g. by covering a high number of market/customer requirements for mobility to increase the ecological effect of the SAMS (combining person and freight transport can decrease the number of travels/vehicles	

ECI_3	*Air pollution reduction*
Description: Be aware of traffic management systems and integrate their services to lower pollutants and to increase the ecological image to positively stimulate the revenues	
ECI_4	*Land Consumption Reduction*
Description: Consider SAMS to decrease land consumption. ITS solutions optimize the use of existing road infrastructure which supports reducing land consumption due to increasing demand in the long term.	
ECI_5	*Optimizing SAMS routing*
Description: (Continuously) Optimize the routing of the service regarding energy consumption (low distance, less hills) in combination with number of customer targets and pick-ups on the route.	
ECI_5.1	Sustainable vehicle trajectory planning
ECI_5.2	Design methods for Smart Routing (Avoid "empty kilometres")

4.6 Legal Application Guidelines for industry

Table 9: Legal Application Guidelines for industry

Legal Application Guidelines for industry	
LI_1	*Consider European and national legal framework*
Description: Consider the relevant current legal frameworks, regulations by analysing them and identify relevant parts for the planned SAMS.	
LI_1.1	Consideration of European policy and legal studies
LI_1.2	Consideration of relevant national regulation of the identified markets/countries
LI_2	*Working towards updating legal and regulatory frameworks and harmonise them across Europe*
Description: Working on updating legal and regulatory frameworks effecting the planned SAMS and their deployment and harmonise them.	
LI_2.1	Check and work on clear definition of the vehicle's ODD
LI_2.1.1	Standardisation of ODDs

LI_2.2	Go for legal flexibility and adaptation
LI_2.2.1	Review current legislation
LI_2.2.2	Define liability responsibilities of infrastructure changes caused by legal regulations
LI_2.2.3	Define liability in terms of subsidiarity in case of e.g. accidents
LI_2.2.4	Define time span the operator must be able to reach the vehicle in case of an emergency, as well as the emergency procedure itself
LI_2.3	Identify and collaborate with all ecosystem towards harmonisation of legal and regulatory frameworks
LI_3	*Regularly check and consider European and national regulations and procedures in obtaining a driving permit from the legal point of view*
Description: Timeline towards deployment and accompanied cost and time investments are highly dependent on regional procedures for road permits	
LI_4	*Homologation*
Description: Include changes for new homologation processes as soon as possible to avoid delays and interruptions in the introduction and operation of SAMS	
LI_4.1	Identifying and analysing relevant legal framework
LI_4.1.1	Identifying and analysing the relevant legal framework regarding AD functions, tasks and trainings necessary for homologation
LI_4.1.2	Identifying what is needed for the planned service (this could differ from service to service, e.g. Person transport vs. Freight transport)
LI_4.1.3	Identifying and analysing the gaps
LI_4.2	Creating recommendations for authorities regarding identified gaps
LI_4.2.1	Creating recommendations for international legal frameworks (UN, European Union)
LI_4.2.2	Creating recommendations for national legal frameworks
LI_5	*Regularly check on new insurance policies*
Description: Clear legal framework established (including the ODD, fault analysis, and infrastructure & human interaction) to be able to determine responsibility in case of incidents and accidents	

4.7 Stakeholder groups connected to the Industry Application Guidelines

The following Table 10 provides an overview of the different stakeholder groups defined in D1.1 and the corresponding industry application guidelines, which apply to them as well as a short description what the applications focus on for the specific stakeholder group.

Table 10: Industry application guidelines for the identified stakeholder groups

Stakeholder groups	Application Guideline Identifier	Focus on
OEM and transport/mobility operators	PI_1, PI_2, PI_3 EI_1, EI_2, EI_3, EI_4, EI_5, EI_6, EI_7, EI_8, EI_9, EI_10, EI_11, EI_12, EI_13 TI_1, TI_2, TI_3, TI_4, TI_5, TI_6, TI_7, TI_8, TI_9, TI_10, TI_11, TI_12 SI_1, SI_2, SI_3, SI_4 ECI_1, ECI_2, ECI_3, ECI_4, ECI_5 LI_1, LI_2, LI_3, LI_4, LI_5	**Politic**: Focus on legal frameworks and policies, communication with legal authorities and stakeholder **Economy**: Focus on cost and revenue optimisation on different levels, different detailed analyses and using potentials of SMEs, customers, concepts and the value chain **Technology**: Focus on technology integration, management, monitoring, optimisation, configuration, usage and updates **Society**: Focus on customer management and trust increase, service and Service attractiveness improvement **Ecology**: Focus on air pollution and land consumption reduction, marketing and route optimization **Legal**: Focus on checking national and European legal frameworks, new policies and permits and Homologation
Passengers and other road users encompassing VEC	EI_1, EI_2, EI_6, EI_8, EI_12 TI_3, TI_5, TI_10, TI_11 SI_1, SI_2, SI_3, SI_4 ECI_3, ECI_4, ECI_5	**Economy**: Focus on stakeholder engagement, time optimisations on different levels and customer knowledge & trust **Technology**: Focus on trust in technology, system updates and transport system integration **Society**: Focus on customer management, customer trust, and service improvement

Stakeholder groups	Application Guideline Identifier	Focus on
		Ecology: Focus on air pollution and land consumption reduction and optimisation of service routing
Umbrella associations/Non-profit organisations	EI_1 LI_1, LI_2	**Economy**: Focus on stakeholder involvement **Legal:** Focus on considering and updating legal regulations and frameworks
Research and academy	EI_1 TI_4 LI_1, LI_2, LI_4	**Economy**: Focus on stakeholder involvement **Technology**: Focus on designing ODD along with the associated boundaries **Legal**: Focus on considering and updating legal regulations and frameworks and Homologation
Authorities (Cities, Municipalities, Ministries), policy makers, municipality agency and road operators	PI_1, PI_2, PI_3 EI_1, EI_10 TI_7, TI_8, TI_9, TI_11 SI_3, SI_4 ECI_1, ECI_2, ECI_3, ECI_4, ECI_5 LI_1, LI_2, LI_4	**Politic**: Focus on legal frameworks and policies, communication with legal authorities and Insurance policies **Economy**: Focus on customer involvement and OPEX/CAPEX considerations **Technology**: Focus on monitoring, updating and prioritising infrastructure, integration in existing transport systems and sensor configuration **Society**: Focus on improvement of the service and increasing customer trust **Ecology**: Focus on air pollution and land consumption reduction, marketing and route optimization **Legal:** Focus on considering and updating legal regulations and frameworks and Homologation
Industry such as Tier 1 suppliers, telecom operators, technology providers and services company	PI_1, PI_2, PI_3 EI_1, EI_2, EI_3, EI_4, EI_5, EI_6, EI_7, EI_8, EI_9,	**Politic:** Focus on new policies, stakeholder engagement and supporting the local authorities **Economy**: Focus on cost and revenue optimisation on different levels, different

Stakeholder groups	Application Guideline Identifier	Focus on
	EI_10, EI_11, EI_12, EI_13 TI_1, TI_2, TI_3, TI_4, TI_5, TI_6, TI_7, TI_8, TI_9, TI_10, TI_11, TI_12 SI_2, SI_3 ECI_1, ECI_2, ECI_3, ECI_4, ECI_5 LI_1, LI_2, LI_3, LI_4, LI_5	detailed analyses and using potentials of SMEs, customers and concepts **Technology**: Focus on technology integration, monitoring, optimisation, configuration, usage and updates **Society**: Focus on increasing customer trust in service and rise attractiveness of the service **Ecology**: Focus on air pollution and land consumption reduction, marketing and route optimization **Legal**: Focus on checking national and European legal frameworks, new policies and Homologation

5 Conclusion

In conclusion, the evolution of shared CCAM services marks a pivotal shift towards a more efficient, safe, and sustainable transportation landscape. The active collaboration among cities, PTOs, PTAs, and industry stakeholders is essential for the successful deployment of these innovative mobility solutions. Recognising the complexities involved, the development of streamlined and practical guidelines is paramount.

The guidelines presented in this deliverable, alongside those in D17.1, aim to provide clear and actionable strategies for stakeholders. By refining and simplifying these guidelines in D17.2, we ensure that cities, PTOs/PTAs, and industry players can more readily adopt and implement CCAM services. For cities and PTOs/PTAs, the focus is on comprehensive service planning, robust governance, inclusivity, and safety. Meanwhile, the industry guidelines address a holistic view encompassing political, economic, social, technological, ecological, and legal aspects.

These concerted efforts and structured guidance will facilitate a smoother transition to automated mobility services, ultimately leading to a transformative impact on urban transportation systems worldwide.

References

[1] SHOW, 'D17.1: First issue of best practices and decision-making mechanisms for different stakeholder groups. Deliverable of the Horizon-2020 SHOW project, Grant Agreement No. 875530'. 2022.

[2] SHOW, 'D1.1: Ecosystem actors needs, wants & priorities & user experience exploration tools. Deliverable of the Horizon-2020 SHOW project, Grant Agreement No. 875530'. 2020.

[3] European Platform on Sustainable Urban Mobility Plans, 'National Support Frameworks for Sustainable Urban Mobility Planning: National SUMP Supporting Programmes [Paractitioner Briefing]'. 2019. [Online]. Available: https://urban-mobility-observatory.transport.ec.europa.eu/document/download/13917fc6-0e5a-4351-8866-97a1fd08ff78_en?filename=national_support_frameworks_for_sumps.pdf&prefLang=sl

[4] S. Rupprecht, L. Brand, S. Böhler-Baedeker, and L. M. Brunner, 'Guidelines for Developing and Implementing a sustainable Urban Mobility Plan'. 2019. [Online]. Available: https://sumps-up.eu/fileadmin/user_upload/Tools_and_Resources/Publications_and_reports/Guidelines/guidelines_for_developing_and_implementing_a_sump.pdf

[5] UITP, 'Policy Brief 'Autonomous vehicles: a potential game changer for urban mobility''. 2017. [Online]. Available: https://cms.uitp.org/wp/wp-content/uploads/2020/06/Policy-Brief-Autonomous-Vehicles_2.4_LQ.pdf

[6] SHOW, 'D3.3: Recommendations for Adapting Regulatory and Operational Strategies for CCAV deployment at Local and Regional Level. Deliverable of the Horizon-2020 SHOW project, Grant Agreement No. 875530'. 2020.

[7] European Platform on Sustainable Urban Mobility Plans, 'Mobility as a Service (MaaS) and Sustainable Urban Mobility Planning [Practitioner Briefing]'. 2019. [Online]. Available: https://urban-mobility-observatory.transport.ec.europa.eu/document/download/6b706858-11c6-41c2-b9f7-466e2bec0499_en?filename=maas_and_sustainable_urban_mobility_planning.pdf

[8] European Parliament's Policy Department for Citizens' Right and Constitutional Affairs, 'The role of cities in the institutional framework of the European Union [Study]'. 2017. [Online]. Available: https://www.europarl.europa.eu/RegData/etudes/STUD/2017/596813/IPOL_STU(2017)596813_EN.pdf

[9] Mobility Lab Helsinki, 'Logistics robots – What's possible and how to do in in practice in Helsinki? [Guidelines]'. 2022. [Online]. Available: https://mobilitylab.hel.fi/app/uploads/2022/09/Logistics-robots-how-does-piloting-work-in-Helsinki.pdf

[10] M. A. Richter, M. Hagenmaier, O. Bandte, V. Parida, and J. Wincent, 'Smart cities, urban mobility and autonomous vehicles: How different cities needs different sustainable investment strategies', *Technol. Forecast. Soc. Change*, vol. 184, p. 121857, Nov. 2022, doi: 10.1016/j.techfore.2022.121857.

[11] G. Goggin, K. Ellis, and W. Hawkins, ‘Disability at the centre of digital inclusion: assessing a new moment in technology and rights’, *Commun. Res. Pract.*, vol. 5, no. 3, pp. 290–303, Jul. 2019, doi: 10.1080/22041451.2019.1641061.

[12] SINFONICA, ‘D1.1: Mobility needs and requirements of European citizens. Deliverable of the Horizon-2020 SINFONICA project, Grant Agreement No. 101064988’. 2023.

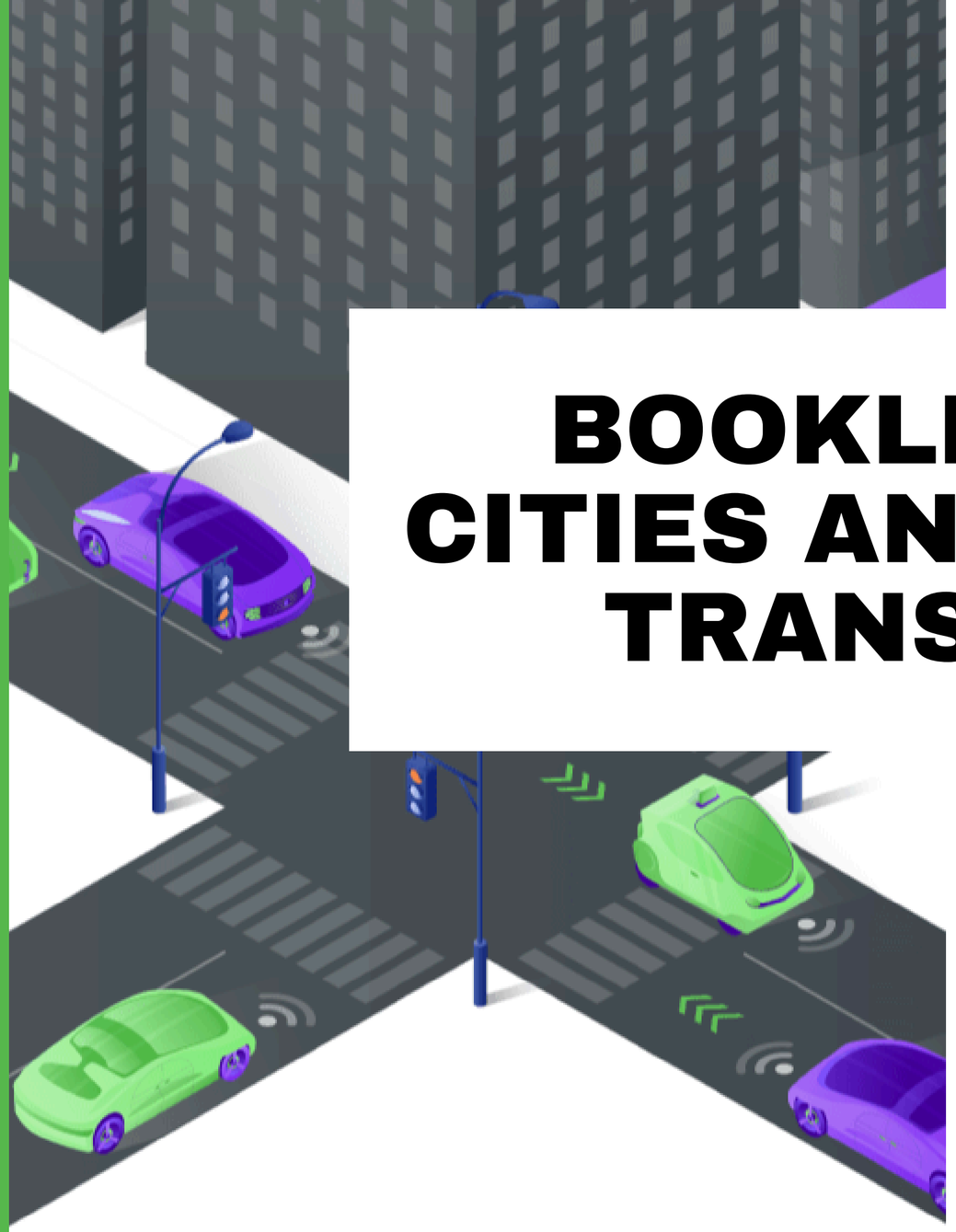
[13] ITF, ‘Making Automated Vehicles Work for Better Transport Services: Regulating for Impact’, International Transport Forum Policy Papers 115, Jun. 2023. doi: 10.1787/2ea70307-en.

[14] International Electrotechnical Commission, ‘Orchestrating Infrastructure for sustainable Smart Cities [White Paper]’. 2015. [Online]. Available: https://www.ceps.eu/wp-content/uploads/2015/01/iecWP-smartcities-LR-en.pdf

[15] Executive Agency for Small and Medium sized Enterprises., *Designing digital transformation strategies for EU cities in the 21st Century: challenges and recommendations.* LU: Publications Office, 2019. Accessed: May 28, 2024. [Online]. Available: https://data.europa.eu/doi/10.2826/91778

Annex 1

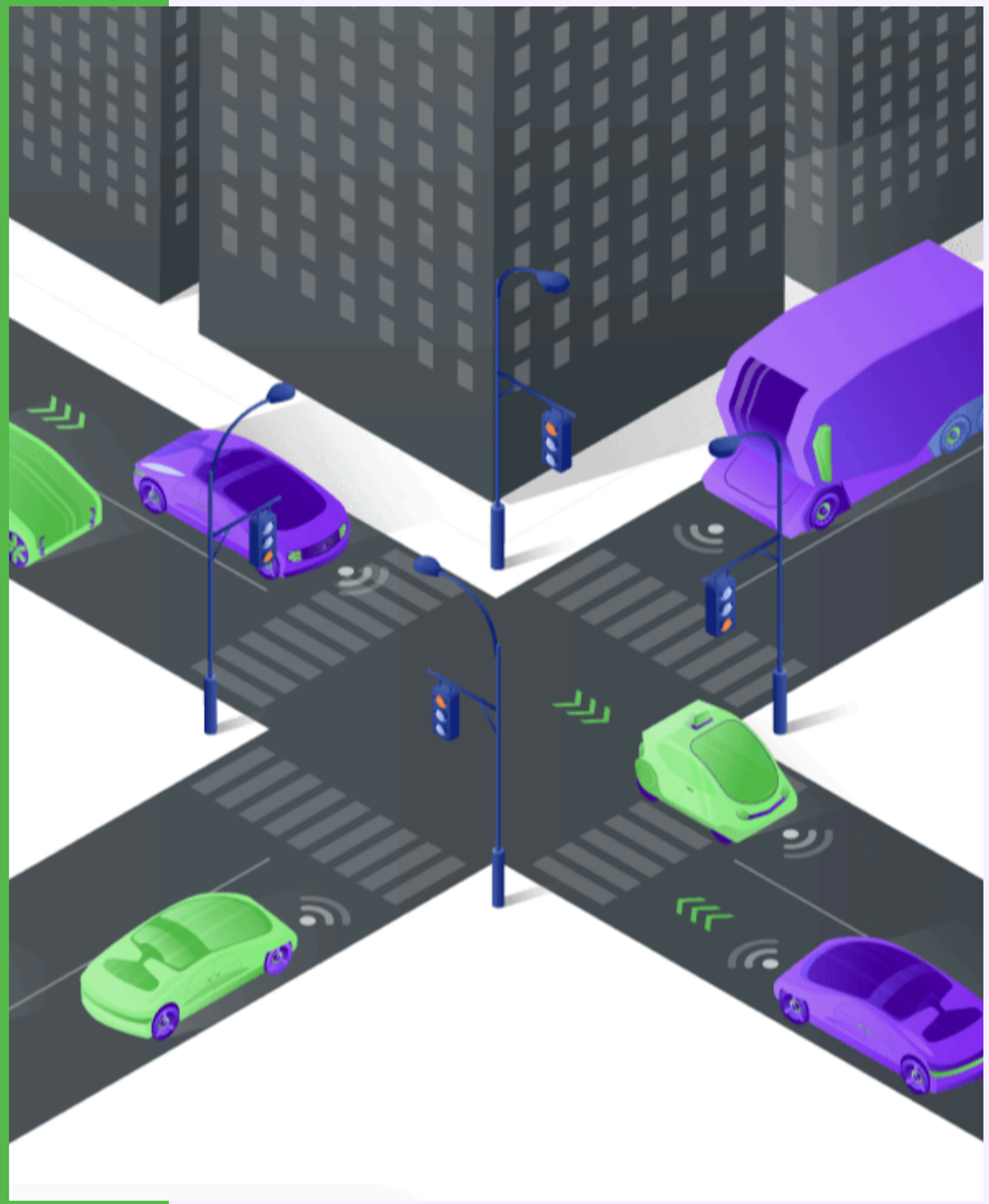
Booklet for Cities & Public Transport



BOOKLET FOR CITIES AND PUBLIC TRANSPORT

Application guidelines for shared cooperative, connected, and automated mobility (CCAM) services in Europe

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 875530.



Introduction

The EU-funded project ‘SHared automation Operating models for Worldwide adoption’ (SHOW) aims to enhance urban mobility by deploying advanced shared, connected, and automated mobility (CCAM) solutions across 16 pilot projects in 20 cities. This booklet **provides recommendations for cities (🏙) and public transport (🚍) entities with little or no experience in deploying shared CCAM services**. Drawing from SHOW partners' inputs, the booklet offers guidelines for cities, public transport authorities (PTAs), and operators (PTOs).

This booklet lays down various application guidelines that **showcase solutions employed by SHOW partners to address specific challenges in the deployment and operation of shared CCAM services**. Aimed at decision-makers, planners, and authorities responsible for coordinating these services, the guidelines are categorised into four distinct layers:

- **Service planning**: the strategic design and organisation of CCAM services.
- **Governance**: the regulatory and policy framework that oversees the deployment and operation of CCAM services.
- **Accessibility and inclusive service**: making CCAM services available and usable for all segments of the population (e.g., physical accessibility and affordability).
- **Safety**: involves ensuring that CCAM services operate without causing harm to users, pedestrians, and other road users.

Involving local and regional authorities and public transport organisations in shared CCAM services in Europe is essential for tailoring these services to local needs and preferences, setting policies that ensure safety and efficiency, and fostering stakeholder collaboration for seamless integration. These authorities optimise infrastructure and ensure compliance with safety and environmental standards, while public transport organisations provide complementary shared mobility solutions. This inclusive approach ensures that CCAM services are sustainable, efficient, and responsive to the unique characteristics of different European regions.

SERVICE PLANNING

1

Integrating automation in SUMP

More **cities are committing to sustainable urban mobility plans (SUMPs)** to promote cleaner transport modes like walking, cycling, and public transport. The concept relies on integrating various urban mobility modes within a functional urban area. City authorities must provide a framework to justify investments from stakeholders, such as public transport, private companies, and research organisations, in shared Connected, Cooperative, and Automated Mobility (CCAM) services. Cities with existing or developing SUMPs should align automated vehicle (AV) deployment with SUMP objectives to ensure efficient, cost-effective, and inclusive services.

Driven by EU policies (e.g., the 2013 Urban Mobility Package) and climate change concerns, city administrations need to outline their climate objectives. As new crises and technologies emerge, **local governments must redefine their strategies**. By collaborating with research organisations, private stakeholders, and citizens, cities can determine demand and promote innovative transport modes. However, local political landscapes can affect the integration of automation in SUMPs. Decision-makers must recruit political support for SUMP measures. The EU-funded SUMPs-Up project has developed principles and guidelines for SUMP Action Plan development.

AV used in residential area for the Linkoping pilot site in SHOW © VTI

2

Integrating shared CCAM services with public transport and other modes

Cities must **create a trusting ecosystem** for all urban stakeholders to collaborate effectively. While most cities lack the technology expertise for shared CCAM services, they understand local needs and how these services can complement existing public transport networks, such as in Linkoping, where suburban services connect residents to the university. Local agents can work with service providers, sharing knowledge to meet citizens' demands. City authorities are also developing mobility-as-a-service (MaaS) to avoid market overlaps and competition. However, integrating shared CCAM services with public transport remains the responsibility of the service providers.

Integrating AV fleets into public transport systems requires a **comprehensive approach and strong authority support.** This includes developing policies for integration, fostering stakeholder partnerships, and adapting infrastructure for AV operations, such as creating new pick-up and drop-off points and building digital infrastructure for vehicle-to-everything communication. Regional and local authorities must also agree on data-sharing protocols with AV providers, particularly for incident reports. Pilot programmes like SHOW, which test AV services integrated within public transport in cities like Frankfurt and Monheim, are essential for refining services, informing regulatory frameworks, and gathering passenger feedback.

Integration of CCAM service into PT's MaaS app for the Frankfurt pilot site in SHOW © RMV/Christof Mattes

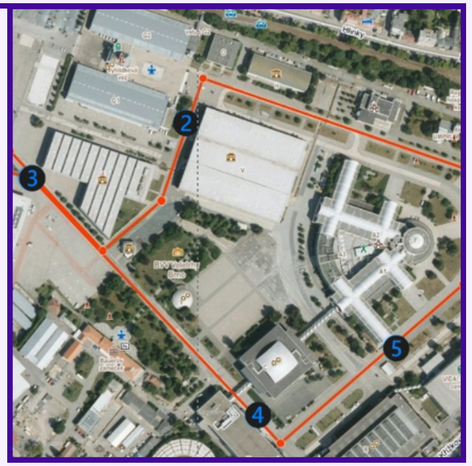
SERVICE PLANNING

3

Building knowledge for shared CCAM services

Most city authorities cannot build knowledge internally – such as coordinate demonstrations and pilots from A to Z. However, **municipalities can partner with the private sector or research organisations** to work on specific projects. For instance, the research centre CDV consulted the City of Brno in the context of SHOW to decide on the most useful location for the pilot site. In this way, the city was able to offer guidance on where the service would be more useful for the people.

A ‘learning-by-doing’ approach is essential for gaining expertise in shared CCAM. While learning from other cities' experiences is valuable, each pilot site will face unique challenges. Public transport stakeholders should start with small-scale trials to understand the technical and operational challenges of deploying an AV fleet, such as charging, parking, and maintenance. Effective scaling requires strong local partnerships within the existing ecosystem. Engaging local public transport stakeholders and industry partners, such as AV manufacturers or automated driving systems (ADS) providers, is crucial to understanding technological limitations and aligning product development with real needs. Standardisation is also vital for scalable services, including training for personnel and software for remote supervision. These efforts should be promoted regionally to enable service replication in other cities without starting from scratch.



Route of the vehicles in operation at the Brno pilot site in SHOW © CDV

GOVERNANCE

1

Setting up local partnerships

Establishing a robust, long-term partnership is crucial for the success of shared CCAM services. Interviews with SHOW pilot sites reveal that cities can play a significant role by facilitating procedures, building trust among stakeholders, and integrating services into an open MaaS ecosystem. For example, setting up a local demonstration board allows city administrations to inform pilot leaders about operational limits and provides a forum for stakeholders to voice concerns. While there is no universal solution for successful CCAM services, **city involvement can raise awareness and demonstrate confidence in these services** through joint marketing campaigns with operators and other mobility providers.

Local partnerships are essential for CCAM deployment integrated within public transport. As evidenced in other places in the world, when no strong partnerships exist – or simply, when the mandate to operate the AV fleet does not come from the local authority but from a higher level – the deployed fleet will inevitably compete with the existing PT system and not generate the positive impacts expected on sustainability and car dependency. Although public-private partnerships pose challenges in procurement processes, which may limit innovation opportunities, **they are feasible and increasingly likely to become pivotal success factors** for the deployment of shared AV fleets in the future.

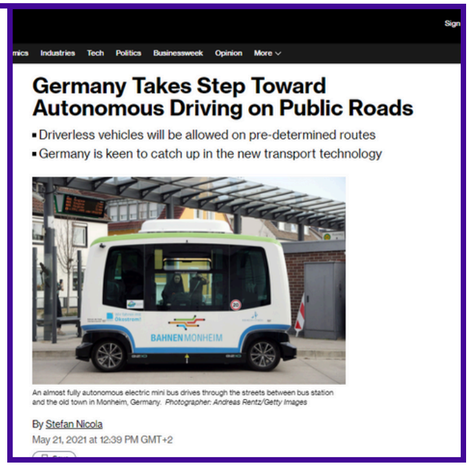
Engagement with local stakeholders at the Monheim pilot site in SHOW © Bahnen Monheim

2

Following a multi-step administrative and regulatory process

Given the heterogeneity of regulatory processes for the deployment of shared CCAV services in Europe, **cities are essential to make actors aware of the regulatory and administrative frameworks** at different levels. SHOW revealed a need for city administrations to familiarise themselves with certain concepts (e.g., intelligent traffic systems and automated driving) and to be involved throughout the demonstration and pilot phases to make sure these are respected. Moreover, cities need to be significantly involved throughout the deployment as they are responsible for ensuring that EU legislation is applied properly. For instance, GDPR is a recurring topic in the context of automated driving pilots (i.e., cameras, data from users, etc.) and therefore cities need to be constantly in-the-know about these issues at different governance levels.

Since CCAM is a relatively new field for PT, **some countries or regions have developed a regulatory process inclusive enough to enable feedback by the PTO to the regulating authority**. This is, for instance, the case in Austria, where the approval process for the service enables the PTO to require specific infrastructure (e.g., traffic sign or retrofitting of a bus stop) to operate the service optimally.



Sign

mics Industries Tech Politics Businessweek Opinion More

Germany Takes Step Toward Autonomous Driving on Public Roads

- Driverless vehicles will be allowed on pre-determined routes
- Germany is keen to catch up in the new transport technology

An almost fully autonomous electric mini bus drives through the streets between bus station and the old town in Monheim, Germany. *Photographer: Andreas Rentz/Getty Images*

By Stefan Nicola

May 21, 2021 at 12:39 PM GMT+2

Screenshot of Bloomberg article

GOVERNANCE

3

Preparing CCAM vehicles procurement

Preparing and ensuring a successful AV procurement is essential for public transport authorities to modernise their services, meet evolving passenger expectations, and contribute to the advancement of urban transportation systems. However, the public transport sector **faces challenges in AV procurement processes** because of complex regulatory requirements, lengthy procurement timelines, and budget constraints. Additionally, for AV services, procurement can be difficult because of limited supplier diversity and reliance on a few key vendors. Lastly, balancing the need for innovation with the requirement for proven technology is a delicate task for public authorities. Addressing these challenges requires careful planning, effective stakeholder engagement, and transparent procurement practices.

Implementing **a successful procurement process for AVs within public transport agencies involves** several key steps:

- **A thorough market research** is essential to understand available AV technologies and their suitability for the specific needs of the transport agency and the expected service.
- **Clear procurement criteria and requirements**, including safety standards, operational capabilities, and compatibility with existing infrastructure, are required to ensure fair and transparent competition among vendors.
- The authority must ensure **a robust contract negotiation** including pricing, and warranties. An iterative Request for Information (RFI) process will need to be followed, as part of robust testing and evaluation processes to verify the performance and safety of the procured AVs before (pre-commercial) deployment.

By following these steps, PTAs and PTOs can effectively navigate the procurement process and successfully integrate AVs into their operations.

Madrid's Autonomous Bus Depots pilot site in SHOW © EMT

ACCESSIBILITY AND INCLUSIVE IN CCAM SERVICE

1

Promoting the use of shared CCAM services

Both cities and public transport authorities are key in promoting shared mobility services to offer viable alternatives to car usage. It's important to **communicate that the convenience and flexibility of car travel can also be achieved with shared CCAM services**, leading to seamless and comfortable journeys. Highlighting the environmental benefits, such as reduced emissions and less congestion, is crucial to encourage public transport use.

To foster the adoption of shared CCAM services, cities and public transport authorities must **build trust through comprehensive marketing campaigns**. These should educate the public about the benefits and usage of CCAM via informative materials, community sessions, and feedback collection. By emphasising convenience and environmental advantages, and addressing the needs of diverse populations, cities can increase public transport uptake. Tailored promotional efforts, informed by engagement with various user groups, are essential for promoting sustainable and inclusive urban mobility.

For example, SHOW pilot sites like Linkoping and Carinthia have conducted information sessions at schools, senior homes, and tourist offices to **educate the public and build support**. Once pilots start, continuous citizen involvement through monitoring and feedback collection, such as focus groups and surveys, is necessary to ensure success and community support.

Promotional event organised in the Graz pilot site in SHOW © VIF

2

Making shared CCAM services inclusive

Public value is central to the objectives of cities' activities, and they should work toward mobility systems that are safer, cleaner and more inclusive. Smart mobility innovations, such as Demand-Responsive Transport (DRT), AVs, and MaaS can respond to some transportation disadvantages. SHOW findings demonstrate that cities could **mandate the accessibility of CCAV services**, **put in place vehicle requirements** adapted to the environment (dimensions, weight, etc.) and type of service (e.g., door-to-door), **extend CCAM service provisions to deploy their services to low-demand zones and off-peak hours** and **collect public feedback on the performance** of the vehicles.

Inclusivity within the public transport sector is intricately linked with the concept of accessibility, encompassing both area coverage and tailored services to meet the needs of specific user groups. In terms of area coverage, **many PTAs mandate DRT services for areas with low passenger demand**, such as rural and peri-urban areas, because traditional bus services are financially not viable. However, DRT services can be costly and inefficient due to driver waiting times between bookings. CCAM solutions offer potential cost-efficiencies, exemplified by the Frankfurt pilot transition from manually driven DRT to on-demand automated shuttles.


User with a wheelchair accessing the vehicle in the Carinthia pilot site in SHOW © SURAAA

ACCESSIBILITY AND INCLUSIVE SERVICE

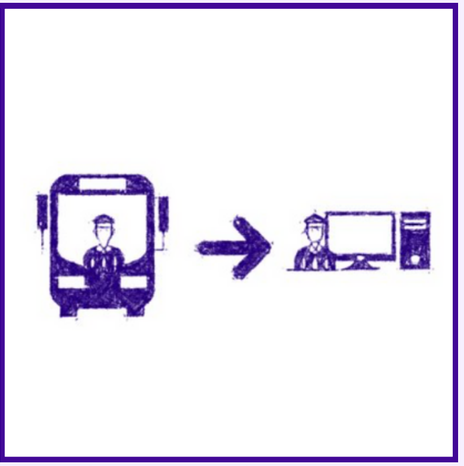
3

Establishing proactive measures for labour forces evolution with CCAM

As the development and deployment of CCAM progress, labour forces will be affected across three dimensions: employment, required worker skills and workers' wages, as well as working conditions. The public transport sector is seeing a **general decline in drivers entering the workforce**, leading to recruitment challenges and operational disruptions. For instance, the International Transport Forum (ITF) mentions in its report 'Making Automated Vehicles Work for Better Transport Services' that Île-de-France Mobilités, the public transport authority of the Paris region, reduced services by 7-8% due to recruitment issues. Similarly, UK rail companies cut nine of their 40 daily services due to driver shortages. This highlights the motivation for PTAs to explore CCAM and its potential for enhancing PT operational stability and passenger service quality.

Regarding skills and working conditions, differences arise between current CCAM services deployed in Europe (as in the SHOW project) and the long-term vision for driverless PT services without onboard operators. In most of the SHOW pilot sites, **safety drivers were present onboard and were responsible for ensuring vehicle safety and passenger well-being**. This role involved many skills, including driving, information technology (IT) proficiency, and customer interface, often leading to task overload.

In the long term, as CCAM evolves, the onboard safety operator role is expected to diminish. However, the wide-scale adoption of **CCAM is expected to increase various roles, from maintenance and onsite support to remote supervision and other office-based roles**. Experience from pilot sites such as Madrid shows a high degree of interest and acceptance by employees when engaged constructively about the introduction of CCAM. PTOs should be prepared for a significant change in the types of roles they will need to fill, along with associated skill sets and pay scales.



Extract from presentation for SHOW Consortium on remote operations © Transdev

SAFETY

1

Setting up and managing physical infrastructure

Local public administrations can facilitate large-scale CCAM pilot testing by **ensuring access to essential information**, such as road maintenance and urban cleaning schedules. This helps keep operations safe and provides certainty to service operators. Cities play a crucial role in adapting infrastructure to meet the needs of people and services, deciding on aspects like the placement of charging stations. Effective cooperation is required not only between service operators and solution providers but also among various city departments (e.g., waste management, road works, infrastructure).

Public transport stakeholders depend on high-quality physical infrastructure to operate both manually driven and CCAM services safely and efficiently. Clear lane markings are beneficial for both types of services. The placement of pick-up and drop-off points needs careful consideration; for example, the use of bus stops by AVs must be regulated, and these stops might need modifications to accommodate automated shuttles. Designated parking areas for AVs are also necessary to prevent 'empty miles' when the vehicles are not in service. Cities should propose these areas to ensure efficient operation and reduce unnecessary driving.

Signalling on the route of the Carinthia pilot site in SHOW © SURAAA

2

Setting up and managing the digital and communication infrastructure

In the context of the Digital Cities Challenge, the European Commission recommends designing digital transformation strategies for EU cities. For shared CCAM services, **intelligent transport systems (ITS) and data accessibility are essential**. Cities are also improving the broadband connections necessary for these services. Local administrations should ensure access to critical data, as data ownership is shifting to the private sector in the sharing economy. Open ITS architecture and standards should be considered to allow CCAVs to operate in a multi-operator and multi-vendor environment, supporting city management in areas like traffic and roadworks.

For CCAM services, digital infrastructure ensures efficient operation, **enhances safety through real-time monitoring and communication**, and provides passengers with up-to-date information. It also optimises routes, schedules, and passenger flows, improving efficiency and reliability. Standardisation is crucial for implementing CCAM, enabling replication and scalability, and attracting AV providers to deploy services in multiple cities. Secure data management protocols and cybersecurity measures are needed, including standardised software for remote supervision centres, robust system architecture models, and secure cellular networks for real-time monitoring.

Physical and digital infrastructure integration enabling ride on the spot at the Crest pilot site in SHOW © Beti

Legal disclaimer

The information in this document is provided ‘as is’, and no guarantee or warranty is given that the information is fit for any particular purpose. The above-referenced consortium members shall have no liability to third parties for damages of any kind including without limitation direct, special, indirect, or consequential damages that may result from the use of these materials subject to any liability which is mandatory due to applicable law. © 2020 by SHOW Consortium.

This report is subject to a disclaimer and copyright. This report has been carried out under a contract awarded by the European Commission, contract number: 875530. The content of this publication is the sole responsibility of the SHOW project.

Co-author: Clarisse de Cerjat (Eurocities)
Co-author: Henriette Cornet (UITP)

EUROCITIES

UITP ADVANCING PUBLIC TRANSPORT