SHared automation Operating models for Worldwide adoption

SHOW

Grant Agreement Number: 875530

D3.3: Recommendations for Adapting Regulatory and Operational Strategies for CCAV deployment at Local and Regional Level

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Executive summary

The SHOW project aims to pave the way for large-scale deployment of shared connected, cooperative and automated mobility (CCAM) integrated with local transport systems. D3.3 addresses the current regulatory and operational aspects of CCAM deployment with a specific focus on the urban and regional dimension, considering the existing gaps and barriers and providing recommendations for potential future interventions – these will be referred as regulatory recommendations (RR) in this report. As the higher levels of jurisdiction define the regulatory role of cities and regions, D3.3 also presents a basic overview of legislative and regulatory frameworks at international, European and national level as well as a first set of recommendations for each level of governance, preparing the ground for the final SHOW deliverable 'Policy Recommendations and Roadmap' (D17.5). Recommendations for adapting operational strategies – or operational recommendations (OR) - are described in the final chapter of the present deliverable.

While European type-approval and technical standards for CCAVs are progressively developed in close coordination with the United Nations Economic Commission for Europe (UNECE) and relevant standardisation bodies at the European and international level, Chapter 3 highlights that the regulatory landscape across European countries provides a more complex and fragmented picture. Even more so when considering other legal aspects that will affect the future operation of shared CCAM services, including for example public service obligations, data protection and exchange, liability, etc.

Harmonisation of national strategies for CCAM in line with EU regulations and UNECE activities should be a key priority, as this will allow manufacturers to design a single vehicle for all markets. In addition, EU type approval regulation for CCAVs needs to move beyond small series and very specific use cases to enable upscaling. As an alternative to a harmonised EU type approval framework, procedures for mutual recognition of testing prototype permissions between Member States should be considered. In countries where the legal responsibility for approving the testing and deployment of CCAVs are shared between the national and regional level (e.g., Germany), it is important to clarify the procedure and competences between the vertical administrative levels, but also to harmonise requirements between regions in line with European and international developments.

Considering the regulatory complexity at international, European and national level, it comes as no surprise that local governance of shared CCAM services has so far been underexposed. Although cities have limited competences in terms of 'hard' legislation, Chapter 4 shows that they can play a decisive role in the future deployment of shared CCAM services in urban areas by applying 'soft' regulation and policy interventions – including for example licencing, incentives, recommendations, guidelines, codes of conduct, memorandums of understanding etc. - in combination with conventional instruments such as curb side management and road space allocation, speed regimes, access regulation, etc.

To prepare for large-scale deployment, local authorities should develop an imaginative and forward-looking vision on how to maximise the potential benefits of shared CCAVs in providing safe, sustainable, and inclusive mobility, while avoiding some of the currently perceived risks, including for example increased congestion, unfair competition with other sustainable modes and limited accessibility. This vision should be based on long-term policy goals and related indicators formulated in Sustainable Urban Mobility Plan (SUMPs) and take into account the lessons learned from the introduction of other 'disruptive' shared on-demand mobility services such as ride-hailing and micro-mobility.

Document control sheet

Start date of project:	01 January 2020
Duration:	48 months
SHOW Del. ID & Title:	Recommendations for Adapting Regulatory and Operational Strategies for CCAV deployment at Local and Regional Level
Dissemination level:	PU
Work package:	WP3: Ethical and Legal Issues
Lead authors:	Peter Staelens (Eurocities) Dominik Schallauer (Austriatech) Pablo Rodriguez (IDIADA)
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Internal Reviewers:	Maria Gkemou (CERTH/HIT), Peter Schmitting from ERTICO
External Reviewers:	Under revision by AB members
Actual submission date:	02/02/2023
Status:	Final
File Name:	SHOW_D3.3_ Recommendations for Adapting Regulatory and Operational Strategies for CCAV Deployment at Local and Regional Level_Final

Document revision history

Version	Date	Reason	Editor
0.1	23/06/2022	First draft including Austriatech, Idiada and Eurocities contributions on regulatory aspects	Pablo Rodriguez (IDIADA) Peter Staelens (EUROCITIES) Dominik Schallauer (Austriatech)
0.2	15/07/2022	Second draft: contributions on regulatory aspects complemented by section on operational aspects and general pages	Pablo Rodriguez (IDIADA)
1.0	14/10/2022	Third draft: consolidated version for quality review	Peter Staelens (EUROCITIES)
1.9	30/11/2022	First final consolidated version with comments addressed	Peter Staelens (EUROCITIES)
2.0/ Final	01/02/2023	Final version for submission with all comments from peer review resolved	Peter Staelens (EUROCITIES)

Table of Contents

List of Tables

Abbreviation List

Abbreviation	Definition
ACEA	European Automotive Manufacturers' Association
ADS	Automated Driving Systems
ALKS	Automated Lane Keeping System
AV	Automated Vehicle
CCAV	Connected Cooperative and Automated Vehicle
CCAM	Cooperative, Connected Automated Mobility
DSSAD	Data Storage System for Automated Driving
ECF	European Cyclists' Federation
FOT	Field Operational Test
GA	Grant Agreement
ITF	International Transport Forum
iRAP	International Road Assessment Program
KBA	Kraftfahrtbundesamt
KET	Key Enabling Technology
KFV	Kuratorium für Verkehrssicherheit
MVP	Minimum Viable Product
ODD	Operational Design Domain
OECD	Organisation for Economic Co-operation and Development
OR	Operational Recommendation
PTO	Public Transport Operator
PTA	Public Transport Authorities
RR	Regulatory Recommendation
UC	Use Case
UNECE	United Nations Economic Commission for Europe

1 Introduction

1.1 Purpose and structure of the document

In contrast to the US and China, where companies like Cruise, Waymo and Baidu recently started operating shared driverless robo-taxi services under a commercial licence, the deployment of shared automated mobility services in Europe appears to be at a more experimental stage: local pilots are usually limited in terms of duration and performed with a small number of vehicles that are typically at SAE level 3, with national legislation requiring a test driver on board. Apart from the technical complications that arise from operating in a mixed traffic environment, also the different national permit applications and exemption procedures for testing of CCAVs often constitute a major obstacle [1]. Hence, this deliverable intends to shed light on the regulatory and operational barriers for large-scale CCAM deployment.

To do so, it has deployed a mix of quantitative and qualitative methodologies such as desk research, online multi-stakeholder survey, city task force meetings, online workshops and two international workshops (see in chapter 2).

D3.3, finally, provides an analysis of - and recommendations for - regulatory and operational strategies at the urban and regional levels to enable safe, sustainable and inclusive deployment of shared, connected, cooperative and automated mobility (CCAM) services that are integrated with public transport. As the regulatory scope and competence of local and regional authorities are defined by legislative frameworks at a higher level, it also addresses the national, European and international dimensions of CCAM regulation (chapter 3). D3.3 describes the status as well as gaps and barriers of CCAM regulation at each level of governance, and also presents potential interventions to enhance the future market uptake of shared CCAVs, taking into account societal and environmental aspects (chapter 4).

D3.3 also analyses operational challenges that may arise from large-scale deployment of CCAVs and provides suggestions on how to adapt future strategies (chapter 5).

The inputs concerning the regulatory framework for CCAM and freight transport remain minimal at this stage, hence this deliverable focuses on shared CCAM for passenger transport.

1.2 Intended Audience

- Local decision makers, transport planners and traffic managers
- Public Transport Operators and Public Transport Authorities
- Policy makers at EU and national level
- Mobility service providers
- CCAM Partnership Expert Community

1.3 Interrelations

Overall: D3.3 is the main output of A3.3 ‘Regulatory and operational aspects’, which is part of WP3 ‘Ethical and Legal Issues and interconnects with WP1 ‘Ecosystem views and SHOW Use Cases’ and WP2 ‘Business and operating models’. The specific contribution provided in this deliverable provides the basis for any type of CCAM deployment to occur on local and/or regional level, either in the context of the SHOW project (WP11 and WP12) or beyond that (SHOW follower sites and more).

Input: A3.1 ‘Legal requirements at European and sites level’ provided insights into existing national regulatory frameworks and procedures for requesting permits and exemptions for testing of CCAVs on public roads, as well as regulatory CCAM developments at international and European level.

Output: D3.3 provides a basis for D17.5 ‘Roadmap towards CCAV implementation in cities and policy recommendations’ (M46) and as well as the recommendations for future commercial operations (WP16 ‘Exploitation and economic impact assessment’).

2 Methodological Approach

A mix of quantitative and qualitative methodologies was applied to perform an analysis of the regulatory and operational state-of-play, as well as the gaps and barriers towards large-scale deployment of shared CCAM services. The development and validation of recommendations mainly depended on collaborative and interactive sessions organised with project partners as well as external European and international stakeholders. The following methodologies were applied:

- Desk research and analysis of relevant legislation, publications, reports, scientific articles and studies, policy statements and information portals
- Organisation of an online multi-stakeholder survey where 89 responses were collected
- Organisation of two city task force meetings
- Organisation of an online workshop with project partners
- Organisation of two international workshops with related initiatives
- Organisation of an online (validation) workshop with project partners

Publications that were consulted in the desk research phase are listed at the end of the deliverable and referenced as footnotes when quoted. All contributors tried to take as much as possible relevant (draft) reports from recently finished and ongoing projects into account, including for example Sohyoa [5] and AVENUE [33].

Further input was collected through an online multi-stakeholder survey, which ran from September 2021 to January 2022, with the aim to understand which regulatory and operational aspects of CCAM needed to be considered at local level to accelerate deployment of shared CCAM, ensure seamless integration in a multimodal and multi-operator transport system, and contribute to safer, more sustainable, more inclusive and more efficient mobility across the wider urban area (results are described in Section 4.2 - Regulatory Gaps and Barriers at Local Level).

Eurocities organised **two online taskforce meetings** with city representatives – respectively in November 2021 and March 2022 - to identify potential areas of intervention, and to formulate common recommendations from the perspective of local authorities (see section 4.2).

The initial findings from A3.3 were also presented to and discussed with the Japanese CooL4 Demonstration Project and a dedicated ITF-OECD Working Group on ‘Regulatory Framework for Automated Vehicle-Based Services’. As the insights and feedback from these initiatives were provided over July and August 2022, the submission of D3.3 was postponed from June to January 2023.

A collaborative document was set up throughout April and May 2022 to collect inputs from 17 partners across the consortium on the perceived regulatory and operational gaps and barriers across different levels of governance, as well as suggestions for recommendations. A **final online validation workshop** with SHOW partners was organised on 13 May 2022 to discuss and fine-tune the proposals. This deliverable consolidates the outcomes from the different activities for this project.

3 Regulatory and Institutional Frameworks at International, EU and National/Regional Level

3.1 State-of-Play

The analysis in SHOW deliverable D3.1 (Analysis report on legal, regulatory, institutional frameworks) has shown that today's national frameworks for the test & trial operation of automated mobility come with very different requirements and possibilities. Meanwhile, countries like France and Germany have also introduced national regulatory frameworks for real-life operation of highly automated mobility systems. At EU level, a draft for the type-approval of ADS for fully automated vehicles in pre-defined use cases has been released [2]. After completing the consultation process, this framework regarding "[…] uniform procedures and technical specifications for the type-approval of the automated driving system (ADS) of fully automated vehicles" entered into force in September 2022 as implementing regulation (EU) 2022/1426.

These recent developments outline the progressive shift from test and trial operation to real-life commercial operation.

Nevertheless, this progressive shift is challenging since legislation for traffic and transport is historically based on the division of functional responsibilities between vehicle – infrastructure – driver behaviour. Automation challenges this historical approach in many aspects. Well-established international organisations are aware of the challenges of automation, but mainly work within their respective fields of expertise. The necessary "horizontal approaches" are still under development.

This complexity may be one of the reasons why agreeing in common frameworks on international level takes a lot of effort and time. The introduction of ALKS has been a major effort in the field of advanced driver assist systems (SAE L3) – although in SHOW we aim to take a step further [3].

The fleets of SHOW are expected to be fully automated (driverless; even if there is a formal obligation for a safety driver to be present in the vehicle) in real operation (usually L4). A significant feature of such fleets is, that the safe operation is usually limited to a predefined operation area and that experts operate them (on-board and/or remote.)

The type-approval of ADS in fully automated vehicles is only one aspect to serve as a precondition and shall be considered as the first step for enabling the real-life operation of fully automated transport services. Through the type-approval, automated vehicles that are "safe enough" for market introduction will be available at some point in the near future.

Nevertheless, the appropriate operational frameworks still need to be set up – as also implementing regulation (EU) 2022/1426 states, that "[…] this regulation is without prejudice to the right of Member States to regulate the circulation and the safety of operation of fully automated vehicles in traffic and the safety of operation of those vehicles in local transport services" [2].

Some countries like Germany or France may be prepared early in this respect since they have developed their own regulatory frameworks for the real-life operation of AVs during the last years. Still, even within those frameworks not all challenges have been fully resolved. Open questions might even be as simple as how the warning triangle is being set up in case of a breakdown.

Since the safety of operation and operation of transport services is handled in various national legal frameworks, the aim of this chapter is to provide suggestions and

recommendations on what should be taken into consideration when introducing automation, specifically in relation to the context of SHOW (i.e., large-scale demonstration of shared fleets of connected, cooperative and automated vehicles integrated with public transport services).

In some European countries, the responsibility for approving the testing of CCAVs on public roads is distributed over different administrative levels. The summary below is adopted from D3.1 and further enriched with information from the European Knowledge Base on Connected and Automated Driving (CAD) [4] and other project reports such as, the 'Legal Framework' [5] of the Sohjoa Baltic and the 'First Report on Regulatory Requirements and Compliance Plan' of the AVENUE project [6]. Focusing on the countries where SHOW demonstrations are taking place, Annex 2 describes the different procedures and entities involved in the approval process for testing of CCAVs on public roads.

As can be concluded from the Annex 2 table, all European countries where SHOW demonstrations are taking place have a regulatory framework and permit acquisition or exemption process in place to accommodate testing of CCAVs on public roads. These regulatory testing frameworks are mainly set at national level, however, in Germany, Italy and Greece, also the regional level has a role in the approval process. In the case of Greece also the approval of local authorities is required, while in Italy they may initiate the certification process.

The differences between national regulatory strategies for approving testing of CCAVs as well as the distribution of legal competence across different levels of governance within a given country adds complexity and constraints to the procedure, which may delay the permit application process.

3.2 Regulatory Gaps and Barriers at EU and National/Regional Level

This chapter addresses gaps and barriers that have been identified when reviewing the draft EU CCAV type-approval legislation, as well as the challenges related to the introduction of appropriate legal frameworks for the operation of those vehicles in transport services, which will be the main focus of our recommendations.

3.2.1 EU Type-Approval Rules for CCAVs

As specified in Delegated Regulation (EU) 2022/2236, the type-approval of fully automated vehicles is now possible in small series, which means that 1500 vehicles of one type per year can be introduced to the market. This is a good first step, but it might also limit market development since the process requires a lot of effort. It is possible that manufacturers do not take this effort if the total number is limited.

Even though the ADS has to demonstrate its capabilities in a set of mandatory scenarios, the ODD is defined by the manufacturer. If ADS with limited capabilities are type-approved, it may result in even more effort required on national/regional level to ensure the safety of operation.

Lastly, it is foreseen that in-service monitoring data is collected by the manufacturer and specific data is reported to the type-approval authority. Certain, particularly safety-relevant occurrences must be reported monthly, while other occurrences must be reported annually. This mostly concerns vehicle data related to the granted type-approval. There seems to be a lack of consideration regarding data that might be important for monitoring operational safety. Moreover, it is unclear what would happen if the manufacturer cannot collect the required data anymore (e.g., because of a bankruptcy) but the service is still operated.

3.2.2 Regulation of CCAM at Regional Level

As described above, regional authorities in Germany, Italy and Greece have legal competence in the permit acquisition and exemption process for testing of CCAVs on public roads. In this section, we briefly analyse some of the related challenges that need to be considered, also regarding the future role of regional authorities in regulating (commercial) deployment of CCAM.

When comparing regulatory frameworks across European countries, it is clear that the roles of the different authorities involved in the approval process are not harmonised, there is also no clear communication path and step-by step description of the process that applicants need to follow. Although the vehicle type-approval has been defined through EU regulations, it will also need to be clarified who will provide traffic authorisation. Having different approaches across Europe will make it more difficult for companies and operators to deploy similar and competitive vehicles and services in different European countries or regions. The involvement of multiple stakeholders/agencies in the approval decision adds different layers of complexity leading to prolonged approval processes and planning difficulties manufacturers and operators.

Regional authorities have a deeper understanding of operations in their specific territory - and sometimes also act as managing transport authority – but sharing responsibility for the approval process with the national level complicates the procedure, also as different entities are focusing on different aspects. Legal responsibility for CCAM deployment also requires specific technical knowledge, which may be challenging for a regional (or local) administration to acquire. Another complication may arise from the fact that regional authorities adapt regulation to enable OEMs or technology providers to progress. This implies that also within a given country regulation across regions may be developed at a different pace.

3.2.3 Operation of Shared, Automated Transport Services

Apart from homologation and type-approval of CCAVs, operation of shared, automated transport services on public roads will also have to comply with other legal requirements related, for example, to public service obligations, data protection, liability and insurance, which are typically set at national level and derived from EU regulation.

As these legal requirements are not yet adapted to the future deployment of shared automated vehicles, it will be important to address this in an integrated manner, specifically with relation to safety and security. Aspects that will need to be considered include for example the role of ‘remote intervention operators’, authorisation processes for setting up sites, monitoring of daily operation, passenger safety and passenger rights, terms of service, data to be share, etc.

3.3 Recommendations for EU and National/Regional Regulation

The following recommendations illustrate - by way of example and by no means completely - that, in addition to the technical guidelines for the classification of CCAVs now available at EU level, a series of additional technical, organisational, legal and procedural measures are necessary in order to be able to transfer fully automated passenger and goods transport from theory to reality.

In describing the recommendations, the overall system (vehicle - infrastructure - driver) was taken as the starting point; however, the respective recommendations are each described for the individual subsystems by way of example.

In addition to recommendations for the further improvement of the EU type-approval framework, aspects of the national transport law are highlighted, which plays a central role for the implementation of automated, public passenger transport services in reality.

The most important question that arises is whether it should be up to the national states to adapt their national passenger transport law to accommodate future uptake of shared CCAVs, or whether it would be better to develop uniform legislation at EU level for automation. The development of a uniform EU 'passenger transport law for automated vehicles' would be a logical step now that there is already an "EU-type approval" for automated vehicles.

A uniform 'EU passenger transport law for automated vehicles' would also provide increased legal certainty for all stakeholders involved (e.g., national authorities, international operators) and also guarantee a uniform EU development speed for fully automated public passenger transport on the road (at least in theory). However, as the needs, transport cultures, geographical and environmental conditions in the EU member states can be very different, a future 'EU passenger transport law for automated vehicles' should leave room for national and regional specifics.

A uniform EU legal framework would also be desirable, among other things, because important roles (e.g., remote intervention operator) and safety-relevant operating processes (e.g., for emergencies) still need to be defined for automated public passenger transport. It would be opposing to the European concept if each Nation State had to develop its own definitions and processes.

3.3.1 Recommendations for EU Type-Approval

- **RR_1** Go beyond small series (consider costs and efforts for type-approval). Extension of the European Type-Approval to unlimited series as a top priority to enhance CAV development. A first evaluation to go beyond small series is planned for 2024.
- **RR_2** Strengthen the integration of physical and digital communication infrastructure in the approval process since the dependence on specific infrastructure elements is very different from system to system.
- **RR_3** Ensure system liability so it performs equally safe when under test than in real world operation. Wide variety of real-world scenarios must be handled as safely as the ones in controlled environments such as test-tracks.
- **RR_4** Ensure adequate monitoring (and possibly enforcements) processes that take into account that manufacturers might compete by applying different risk distribution strategies (e.g., vehicle passengers vs. other road users). Those behavioural aspects of CCAVs cannot be monitored by regular traffic police.

3.3.2 Recommendations for Adapting National/Regional Regulation

- **RR_5** Define clear roles for each decision maker who is currently involved in the approval procedure. Also define which aspects are regulated at regional level, and which aspects fall within the scope of a wider national regulation.
- **RR_6** Vehicle type approval is covered by EU regulation. Responsibility for exemption procedures, traffic authorisation or operational deployment has to be clarified with EU, national, regional and local authorities.
- **RR_7** Promoting harmonised regulations and standards will facilitate market-uptake and cross-border deployment across EU Member States and their respective regions. FAME project, EU funded project has a goal to provided EU harmonised procedure for testing AV.

- **RR_8** Regulations need to be aligned with capacities and possibilities of newer (already safe) CCAV technologies. Nations/Regions that adapted regulation to accommodate these new technologies and more advanced industrial standards should be followed as an example by other nations/regions to push the CCAV and business development.
- **RR_9** Regions within the same country should apply standardised procedures allowing mutual recognition of already approved use cases.

3.3.3 Recommendations for Operation of Automated Transport Services

As soon as type-approval has been granted and all capabilities and limitations of the system are known, CCAVs are ready to perform their designated use cases (across a defined ODD).

As a next step, the operation of fully automated transport services can be authorised. Currently there is no common framework for such an authorisation.

Therefore, the following fundamental question needs to be raised: should fragmented regulation for commercial transport services be amended at the member state level to cover aspects of automated mobility, **or** should an additional dedicated EU regulation be put into place?

To overcome this fragmentation, the EU could support knowledge sharing between its member states authorities, e.g., by introducing/funding a dedicated exchange format, maybe grouped into regions with similar prerequisites, provide training for regional and local officers to handle the authorisation, and publish official guidelines with common principles regarding operation. These guidelines should address authorisation of operation sites, remote intervention and new skillsets required respectively, passenger safety, monitoring of commercial operation.

3.3.3.1 Authorisation of Operation Sites

Through the type-approval process, fully automated vehicles for specific use cases, ODD, and with specific capabilities and limitations are available for operating transport services. In a next step, the authorisation of the operational context in accordance with the capabilities and limitations of the automated driving system (ADS) can be undertaken. This may include the operational area as well as operational conditions, based on the specific constraints of the driving system.

Top priority is ensuring the sensible, safe and secure operation of the ADS and avoiding risks for passengers or third parties. Similar to setting up a conventional bus line, where for example the tractrix curve or the overhead clearance has to be checked, the foreseen route/area needs to be examined in detail to verify its compatibility with the ADS. As a matter of course, automation adds a variety of criteria that have to be assessed. At least the following points should be considered:

- ✓ Apply a standardised method for the assessment of the route/area, including physical and digital infrastructure. This can either be done only in the occasion that vehicles are deployed on specific routes/ in specific areas or be provided for the whole road network.
- ✓ Provide a checklist (easy to understand), including the capabilities and limitations of the AVs (as a result of type-approval). This is the basis for checking the compatibility with the desired route/area before planning the deployment.
- ✓ Consider that infrastructure constantly changes. Define responsibilities, e.g., regarding the information about planned construction sites and constant

clearance of the operational routes from unwanted/unexpected obstacles (i.e., parked cars).
- ✓ Clarify responsibilities of regular infrastructure maintenance (important for reliability & costs).

Since EU-member states are mandated to regularly inspect their major road network regarding road safety (based on [7]), a structured approach for conducting road safety inspections is already available. In several countries, this method is also used to inspect the lower-level street network / urban roads and was already used as a basis for the extension of the criteria catalogue regarding the needs for specific use cases, e.g., for motorcycling routes [8].

Based on the structured approach for road safety inspections, a criteria catalogue to assess the risk potential for automated driving systems on certain routes has been developed. This catalogue was then integrated in a "Route Segmentation Tool" [9], which has been used by several SHOW sites to assess their routes.In the longer term (if technical progress allows high levels of automation on a major part of the road network), it could be considered to assess and rate the whole network's readiness for the operation of automated driving systems, similar to the iRap star ratings for the level of safety [10].

3.3.3.2 Remote Intervention Operators

The operation of fully automated transport services will introduce new job profiles, some of which including challenging tasks and responsibilities, e.g., remote intervention operators who are in charge of the operation of several vehicles. Therefore, at least the following aspects should be considered:

- ✓ Define required responsibilities, education and training requirements covering the technological background and driving skills for this function.
- ✓ Define or refer to existing HMI standards to ensure highest possible safety.
- ✓ Define a clear liability/responsibility of connectivity service providers and onboard operator if existent (e.g., 5G services) in case of connection loss, cell-handover or handover between international service providers.
- ✓ Define adequate requirements regarding work environment (especially regarding HMI)
- ✓ Define monitoring and fall-back rules (what if…), processes and routines.
- ✓ Clarify liability. Determine limitations on CAVs per operator and its expected contributions on each scenario (e.g., only to monitor or also to intervene).

3.3.3.3 Passenger Safety

Bus or taxi drivers usually fulfil a number of tasks that go beyond the driving task. For the operation of fully automated transport services, at least the following aspects should be considered to guarantee the safety of passengers:

- ✓ Consider different evolution levels with or without on-board service staff.
- ✓ Consider defining a timespan (e.g., 5 minutes) within which a representative of the operator must be able to be at the vehicle e.g., in case of a (medical) emergency.
- ✓ Revise passenger obligations/duties (terms of service).
- ✓ Consider imposing mandatory briefings for passengers including safety protocols but also security and protection policy parts. Since passengers might be totally alone in an emergency situation, it should be ensured that they are informed about what to do in case of an emergency in a convenient way before the trip.

3.3.3.4 Permanent Monitoring of Commercial Operation

Since the authorisation of the operation goes hand in hand with the definition of the operation area and may include specific obligations and restrictions, a continuous monitoring process to ensure safety of operation should be implemented. Such a process should already be fully in place as soon as the first operational authorisation is granted. The monitoring process should also enable authorities to take immediate measures to safeguard the health, safety and security of passengers and third parties, if necessary. When setting up the process, the following points should be taken into consideration:

- ✓ Define standardised data interface and format to be used by the operator and the authorities.
- ✓ Define mandatory data sets regarding safety and security of operation.
- ✓ Define means of submission that allow for efficient monitoring.
- ✓ Define who is responsible for submission of operational monitoring data.
- ✓ Consider what data should be made publicly available.
- ✓ Ensure that the provisions comply with fundamental rights and, in particular, data protection, specific regulations are required, especially regarding the data material to be recorded and stored, the addressee(s) of the data storage and transmission obligation, the storage location, the storage period and the access authorisation.
- ✓ Ensure adequate protection against manipulation (e.g., deletion or manipulation of data).
- ✓ Ensure confidentiality of information in line with legal requirements.

Technical monitoring systems in the service of road safety are already mandatory in specific subsectors of transport, including for example the Smart Tachograph (Art. 8, 9 and 10 of [11]) and the Data Storage System for Automated Driving (DSSAD)[1] in UN Regulation No. 157 (ALKS) [3].

In addition, the proposal for a regulation on harmonised rules for artificial intelligence (AI), published by the European Commission in April 2021, also includes a monitoring instrument. For high-risk AI systems, it requires that automatic logs must be created during the operation of the AI system, which record the period of each use of the system [12].

[1]A DSSAD is a system that aims to give a clear picture of the significant interactions between driver and the ADS by storing a set of data to determine who was controlling the vehicle at a given time or whether if the driver was requested to take over the control of the vehicle.

4 Adaptation of Regulatory Strategies at Local level

4.1 State-of-the-Art

The legal framework for the future operation of shared, driverless mobility services in European cities will be mainly defined at higher levels of jurisdiction. Applicable rules for homologation, type-approval, road use, vehicle registration and operation, passenger transport, data protection, liability, insurance and criminal offences are typically set at national level, and derived from overarching EU directives, regulations and decisions as well as international conventions.

Local councils and administrations will however play an important role in defining how these rules will be applied in an urban setting, as mobility policy and planning, management of public space and roads, data and traffic management, public procurement, (multilevel) public transport governance, access regulation and parking are core municipal competences.

When defining the scope for regulatory interventions at local level, it is important to distinguish between 'hard law' that is legally binding, and 'soft law', which includes for example licensing rules, incentives, recommendations, guidelines, codes of conduct, memorandums of understanding, non-binding resolutions, and standards [13]. In the context of new mobility services – including for example shared on-demand (micro) mobility - local regulation is also framed as 'governance' or 'policy'. In some cases, such as in Greece, the local administrations have a greater role by approving the operations of autonomous vehicles – of urban bus type – on public roads, as long as the operation of the vehicle is carried out as part of municipal transport [36] [37].

Another important distinction that needs to be considered is the difference between shared CCAM services that will be provided as a service of general interest within a geographically restricted territory and procured by a competent authority or public entity (e.g. local government, public transport operator, transport authority, hospital, educational institution), and services that will be provided as a commercial offering, under private or PPP business schemas, (e.g. by shared mobility companies, digital platforms etc.).

In a European context, when provided as a public passenger service, shared CCAM services will need to comply with the EU Public Service Obligation Regulation (PSO) [14] as well as the applicable laws, regulations and administrative provisions that are in force in the respective Member States. Consequently, Public Transport Operators (PTOs) offering shared CCAM services will be required to meet public service obligations set out by Public Transport Authority (PTAs) in public service contracts defining quality and level of service, price setting, environmental performance, integration with conventional public transport etc.

Local authorities, PTOs and PTAs will however also need to prepare for a future scenario where on-demand CCAM services will be provided on a commercial basis by ride-hailing or taxi companies. As demonstrated by various studies [15], commercial app-based ride-hailing services could potentially lead to adverse effects in terms of increased congestion and pollution and unfair competition with conventional public transport (see 5.2). In the case of the Trikala pilots, the taxi drivers have also expressed their concerns about unfair competition with the robo-taxis. For this reason, our focus will be on how to adapt local regulation for commercially deployed on-demand CCAM services.

4.1.1 Sustainable Urban Mobility Planning Strategies and Indicators

In a European context, the local vision and ambitions for achieving clean, sustainable and inclusive mobility are typically defined in Sustainable Urban Mobility Plans (SUMPs) or equivalent strategies, a planning approach developed at European level which describes the long-term objectives, processes and actions for "satisfying the mobility needs of people and businesses in cities and their surroundings for a better quality of life" [16]. Through the development and implementation of these strategies, local authorities aim to move towards a transport system that improves the efficiency, cost-effectiveness and inclusiveness of the transportation of persons and goods, enables access to key destinations and services, and also reduces air and noise pollution, greenhouse gas emissions and energy consumption.

Linked to the concept of SUMPs, the European Commission also encourages cities to apply a set of 18 Sustainable Urban Mobility Indicators[5], allowing for a standardised evaluation and progress monitoring of local mobility systems against the main SUMP objectives. The indicators and corresponding calculation methodologies were originally developed by the World Business Council for Sustainable Development, and further tested and refined by the EU-funded SUMI project [17]. The core indicators are focusing on 'Affordability of public transport for the poorest group', 'Accessibility of public transport for mobility-impaired groups', 'Air pollutant emissions', 'Noise hindrance', 'Road deaths', 'Access to mobility services', 'Greenhouse gas emissions', 'Congestion and delays', 'Energy efficiency', 'Opportunity for active mobility', 'Multimodal integration', 'Satisfaction with public transport', and 'Traffic safety of active modes'.

Although the SUMI project also revealed that in reality urban areas across Europe apply a diverse set of indicators and calculation methodologies to monitor progress against sustainable urban mobility objectives, the European Commission aims to push for further harmonisation, for example by making SUMPs as well as selected indicators mandatory for urban nodes, i.e. cities that have a functional role on the Trans-European Transport Network.

Future operators of shared CCAM services in Europe should consider SUMPs and SUMIs as the guiding policy framework at local level, although they may also need to comply with local objectives formulated in related local strategies including for example Sustainable Urban Logistics Plans (SULPs), Sustainable Energy and Climate Action Plans (SEAPs/SECAPs) [18] or the United Nation's Sustainable Development Goals [19].

4.1.2 Local Strategies for Regulating Deployment of Shared CCAVs

Although European cities are actively participating in the testing of connected and automated mobility services, information on dedicated local regulation of CCAM cannot be found. The new EU-funded FAME project, which manages a European portal website that gathers knowledge on past and ongoing CCAM projects [4], offers an extensive overview of regulatory initiatives at international, European and national level, but does not provide any examples related to the regulatory dimension at urban level. The same applies to the EU-funded GECKO project [20], which established an international dashboard, compliance map and repository on national and local governance for new mobility solutions, including automated vehicles.

There are also indications that not all cities perceive the large-scale deployment of shared CCAM services as a priority or even as a future reality. This was for example demonstrated by an in-depth city needs assessment which was carried out in 2021 in the framework of the EU-funded FastTrack project, which aims to accelerate the take-up of urban transport innovations. Out of the 24 European cities that were involved in

the extensive consultation process [21], none expressed interest in the deployment of automated mobility services.

In the context of SHOW, two city taskforce meetings on local CCAM regulation - organised by Eurocities in the framework of A3.3 - confirmed that the participating local authorities, including city representatives from Hamburg and Amsterdam, did not have any immediate intention to develop a dedicated regulatory strategy for shared, automated mobility services [22]. The lack of urgency at the local level can be mainly attributed to the fact that shared CCAM services are still at an experimental level. The lack of urgency can also be explained by the fact that public transport operators are prioritising recovering from the Coronavirus (e.g., high costs of services) while trying to decarbonise as much as possible. At the same time, the overarching legislative frameworks at international, European, and national levels - which eventually define the regulatory scope for local authorities – are fragmented and developing at a slow pace, making it difficult for policy makers to understand which regulatory interventions would be required at local level.

However, as the example of SHOW demonstrates, local administrations already have specific expectations and requirements regarding the testing of CCAVs on public roads. Being represented in the project local demonstration boards, they are in close contact with the project demo site leaders and together with emergency services they have a decisive voice in the selection of routes, use of infrastructure (including for example bus stops) or the service operational boundaries. The city authority of Frankfurt, for example, required the local demonstration to limit operations to a 30 km/h area, to avoid that automated shuttles slow down traffic on roads with higher speed limits. For similar reasons, the city authority of Turin did not allow the local CCAM operator to make use of a road with dedicated bus lanes out of concern that they would hinder conventional buses.

When looking at (commercial) deployment of automated vehicles in cities outside Europe, specifically focusing on Singapore, the US and Japan, there is no indication yet that local authorities have started developing or adapting regulatory strategies. The city-state of Singapore created a legislative framework for the testing of automated vehicles under the Road Traffic Act [23], which describes rules for authorisation, liability, insurance and vehicle maintenance. However, in a European context these rules would typically fall under EU and national jurisdiction.

In the US, the legal conditions for testing and commercial deployment of CCAVs are defined at federal and state level. San Francisco acted as the public testing ground for fully driverless vehicles operated by tech companies Waymo, Cruise and Nuro under the Automated Vehicles Program rules and permit application procedure of the California Motor Vehicle Department (MVD). In June 2022, automated ride-hailing company Cruise became the first company to acquire a permit to charge for self-driving car rides in San Francisco. According to [24], the permit was opposed by local fire, police and transit officials who expressed concerns about unusual behaviour of the vehicles, including blocking of a fire engine and public transport services, picking up and dropping of passengers in the middle of the street, as well as the company’s inability to provide services in low-income and minority neighbourhoods, or to accommodate wheelchairs. Interestingly, they recommended the California Public Utilities Commission to require further approval before expanding the number of CCAVs and to establish a new Working Group including state and local officials. This seems to indicate-Francisco have little or no control over the authorisation process. Also in Phoenix, Arizona, where since October 2020 Waymo gradually started opening its fully driverless ride-hailing services to the public, the deployment is authorised by Executive Order 2018-04 from the State of Arizona, with no reference to specific regulatory interventions at local level.

In the case of Japan, at a dedicated workshop on regulatory and operation aspects organised on 24 June 2022 between SHOW and the Japanese Cool4 project, the Japanese team of legal experts confirmed that the testing and deployment of CCAM services in urban areas requires permission of the mayor and the local police department, while certification of CCAVs is managed by the Regional Transport Bureau, which is a division of the Ministry of Land, Infrastructure, Transport and Tourism. Further exchange confirmed that also cities in Japan are not yet considering developing or adapting local regulation to accommodate deployment of shared CCAM services.

4.1.2.1 Managing Mobility Disruption at Local Level

The absence of local regulation for shared CCAM services does not imply that cities are completely unprepared for the transition. Apart from being expected to align with established sustainable urban planning processes and related objectives and indicators, the eventual deployment of CCAVs will also have to comply with the more 'conventional' instruments that local authorities already apply to manage mobility in urban areas, including for example road categorisation and space allocation, traffic signs and markings, speed regimes, access regulation (including congestion zones, low emission zones and circulation plans), prioritisation of high-occupancy vehicle and public transport, parking and management (including depot, loading/unloading, pick-up and drop-off points, charging points, etc.) [25]. In connection with CCAM and shared mobility services in general, it will be important that cities define where, when and under which conditions shared CCAVs will be allowed to pick up and drop off passengers. Early experiences from SHOW demonstrations already indicated that on-demand door-to-door CCAM services are not possible when local regulation requires CCAVs to use public transport stops (e.g., Geneva), and that virtual stops also need to support physical accessibility.

Lessons can also be learned from how cities have regulated – and adapted to – other types of new mobility services that were introduced by commercial operators and technology providers in recent years, including for example shared (free-floating) cars, bikes, mopeds and e-scooters, ride-hailing, crowd-sourcing navigation, MaaS/LaaS, urban air mobility, etc. This approach was for example applied by the North Sea Region Interreg project ART-Forum [26], which compared regulatory instruments and processes applied to micro-mobility services against future regulation of local CCAM services. Also, the H2020 GECKO project [20], which focused on regulatory schemes enabling the implementation of disruptive technologies and business models in transport systems, studied regulatory approaches of CCAM in combination with other types of new mobility services.

An even more relevant analogy can be found in the way local authorities across the world have responded to the arrival of commercial app-based ride-hailing offered by companies like Uber, Lyft, DiDi, etc. The International Transport Forum – OECD published two reports [27] which provided a global overview of – and recommendations for - regulatory interventions at local level, focusing for example on market entry restrictions and control, pricing, safety and security, quality of service, societal and environmental impacts, etc. A report from the Rudin Centre for Transport on 'E-Hail Regulation in Global Cities', describes the current and planned regulatory strategies of 13 international cities, providing a benchmark for urban regulation of e-hail vehicles worldwide. The interventions described in these reports can serve as inspiration for local authorities on how to best manage the future deployment of shared, on-demand driverless mobility services.

4.2 Regulatory Gaps and Barriers at Local Level

With legislative initiatives at international, European and national level at an early stage of development, the regulatory gaps and barriers at local level currently remain unclear. However, various reports, studies, public consultations, discussion papers and policy statements provide an insight on the (perceived) potential risks and benefits of shared CCAM deployment in urban areas [28] [29] [30].

In terms of opportunities, the positive scenarios foresee reduced traffic, energy consumption, emissions and accidents, optimisation of network capacity and public space, and improved access to jobs and services. On the other side of the spectrum, negative scenarios foresee an increased pressure on the urban transport system caused by local residents moving to car-dependent locations, users switching from conventional public transport and active modes to on-demand robo-taxis, and unused vehicles occupying road space. Other potentially negative effects include increased accidents with vulnerable road users, limited physical, digital and geographical accessibility, and lack of trustworthiness among certain user groups due to absence of staff, fear of cyberattacks and loss of privacy.

Taking the above potential impacts into consideration, A3.3 organised an online stakeholder consultation and two dedicated city taskforce meetings to understand which potential policy interventions could be considered at local level to maximise the benefits and to reduce the risks of future shared CCAM deployment in urban areas.

4.2.1 Results from SHOW A3.3 Survey on Local Regulation of Shared CCAM

From September 2021 until January 2022, SHOW conducted an online multi-stakeholder survey to identify regulatory gaps and barriers at local level, complemented by two online city taskforce meetings which respectively took place 18/11/2021 and 25/03/2022. The purpose of the survey was to understand which regulatory and operational aspects of shared, connected and automated vehicle fleet needed to be considered at local level to:

- Accelerate the deployment of shared and electrified CCAVs with a high level of automation (SAE level 4 to 5) including shuttles, minibuses, buses, robo-taxis and delivery vehicles.
- Ensure seamless integration of CCAV fleets in a multimodal and multi-operator transport system, complementing public transport.
- Contribute to safer, more sustainable, more inclusive and more efficient mobility across the wider urban area.

The survey consisted of two parts, including ‘General Information’ and ‘Regulatory and Operational Aspects of CCAM at Local Level’. In the second part, respondents were requested to indicate to what extent they agreed or disagreed – based on [31] methodology – with 24 propositions that were developed in a collaborative manner between all A3.3 partners, taking inspiration from relevant projects and demonstrations, as well as policy statements and discussion papers issued for example by Polis, Eurocities, UITP, ACEA, ECF, etc.

The opening question inquired from a more general perspective if regulation at local level was needed to accelerate deployment of shared CCAM services in urban areas in an efficient, safe, sustainable and inclusive manner, while the propositions – grouped in thematic categories – addressed potential areas of intervention. An open comment box under each of the propositions allowed respondents to provide more details regarding their opinion.

The table below presents the full set of thematically structured propositions:

Table 1: A3.3 online survey propositions.

Safety and Security: local regulation of shared CCAM is needed to ensure
1. Services are accessible, available (time- and location-independent) and affordable for all types of users regardless of their age, physical and mental condition, level of income or digital skills
2. Shared CCAVs adapt their speed in case of planned or extraordinary events (e.g.: road works, hazards, demonstrations…)
3. Operations are monitored to ensure the safety and security of people in and around the shared CCAVs, in compliance with data protection & privacy rules
4. Assistance is provided in case of emergencies, accidents and incidents
Environmental Sustainability: local regulation of shared CCAM is needed to ensure
5. Routing and fleet management are optimised to improve energy performance of shared CCAVs and CCAM services
Quality of Services and Vehicles: local regulation of shared CCAM is needed to ensure
6. Minimum quality standards are put in place regarding service availability and service reliability
7. Minimum quality standards are put in place regarding comfort and cleanliness of vehicles
8. Passengers have the possibility to request assistance
9. Passenger satisfaction and system performance are monitored and evaluated on a regular basis and results are shared and discussed with local authorities
10. A transparent procedure for complaints handling and redress is put in place
Fair competition and access to market: local regulation of shared CCAM is needed to ensure
11. Transparent rules and requirements are applied to ensure fair competition between different means of transport and operators
12. CCAM workers (e.g., on-board/on-site stewards, repair and maintenance staff, remote operators, etc.) enjoy an adequate level of social protection
13. The number of shared CCAM operators and vehicles is restricted
Multimodal Integration: local regulation of shared CCAM is needed to ensure
14. Shared CCAM services provide connections with multimodal hubs and complement high-capacity public transport lines
15. Shared CCAM services are integrated with multimodal travel information, planning, reservation and ticketing systems
16. Shared CCAV fleet management including teleoperation is integrated into local Traffic Management centres
Data Sharing: local regulation of shared CCAM is needed to ensure
17. CCAM operators share relevant and anonymised data with local (transport) authorities for mobility management and sustainable mobility planning purposes (including for example data related to ticket sales, location, expected and actual trip, etc.)

Physical, digital and communication infrastructure: local regulation of shared CCAM is needed to ensure
18. Roadside equipment, sensors and digital maps required for the operation of shared CCAM services are interoperable
19. Shared CCAVs communicate with local Traffic Management Centres
20. Shared CCAVs can access dedicated public transport lanes, interchanges and stops
21. Shared on-demand door-to-door CCAM services are not required to make use of official public transport stops to pick up and drop off passengers
22. Shared CCAM services operate within a pre-determined geographical scope
23. Shared CCAVs adapt their routes taking into account planned or extraordinary events
24. Shared CCAVs only allow onboarding and disembarking of passengers at designated pick-up/drop-off points

In total, **89 responses were collected**, in the range of which, 72 respondents provided feedback to most of the questions and statements, with the majority representing either a public authority, a public transport operator or a commercial entity (vehicle manufacturer, technology supplier). Concerning the level of CCAM expertise, 64 respondents considered themselves to be at mid, advanced or expert level. Most responses were collected from respondents in Austria, Belgium, Finland, Germany, Italy, Spain, Sweden and the UK.

For most of the propositions, a majority of respondents (strongly) agreed that local regulation was required, without specifying what type of intervention could be applied. In general, for each of the proposed aspects at least one of the respondents had doubts whether regulation at national or European level would be more appropriate (which also depends on the national context).

For some of the statements the results were less conclusive:

- ✓ The majority of respondents were either neutral or (strongly) disagreed that local regulation should be applied to restrict the number of shared CCAM operators and vehicles, the main concern being that this would limit the development of the market and discourage operators to improve the quality of services.
- ✓ The question if local authorities should put regulation in place to ensure that shared CCAV fleet management including teleoperation is integrated into local Traffic Management Centres did not generate a clear picture. Most respondents neither agreed nor disagreed, others indicated that this depends on the type of service and that coordination with central traffic management should be sufficient as full integration would 'limit competition for the best solution'.
- ✓ The proposition that local regulation is needed to ensure shared CCAVs can access dedicated public transport lanes, interchanges and stops is supported by most of the respondents, especially if they are operated as public transport service. Several comments however point out that they should not be allowed on high-capacity bus lanes if they cannot adapt to the higher speed of the buses.
- ✓ With respect to the issue above, the question is raised whether local authorities should put regulation in place so that shared on-demand door-to-door CCAM services are not required to make use of official public transport stops to pick-up and drop-off passengers. The majority of respondents neither agreed nor

disagreed, although the example of Geneva illustrated that the absence of specific regulation would make it impossible for operators to provide such services. An alternative option could be to program 'virtual bus stops' in the on-demand mission software and user apps, as for example is the case for the SHOW demonstrations in Frankfurt and Madrid, and the AVENUE demonstration in Geneva.

Some respondents suggested additional actions that potentially require local regulation, including provision of dedicated parking spaces and charging infrastructure for shared CCAVs, defining standard intervention procedures in case of accidents and incidents, applying common visual elements, allowing passengers and road users to easily recognise shared CCAM services (similar to common branding of taxis), establishing a structured dialogue between providers of shared CCAM services and local authorities, and provision of an emergency call option connected with video surveillance.

ACEA, the European Automobile Manufacturers' Association, preferred not to respond to the propositions as formulated in the survey, and sent in a separate statement in which the organisation expressed concern whether commercial CCAM services would have to comply with more local regulation than other new mobility services, as this would lead to market fragmentation and discourage innovation and scale-up. In ACEA's opinion, governance of commercial CCAM services should also be based on common metrics and positive incentives rather than on negative penalties, while technical standards of CCAM services related for example to UVAR communication, geofencing of CCAM services and RTTI communication should rather be addressed in an EU delegated act.

4.2.2 Results From the City Taskforce Meetings

As part of A3.3, two online city taskforce meetings were organised by Eurocities to collect specific views from local authorities on regulation of shared CCAM services. The meetings were attended by city representatives from Hamburg, Amsterdam, Tallinn, Prague, Oslo, Leeds, Barcelona, Aachen, Birmingham, Vienna, Varna and Valencia, Helmond, Dortmund, London and Munich, and supported by A3.3 partners Austriatech, RISE and IDIADA.

The first taskforce meeting - organised in November 2021 - aimed to identify which aspects of shared CCAM services potentially require regulation at local level, starting with an overview of regulatory initiatives at international, European and national level, and followed by a presentation on the preliminary results of the online survey and an interactive session where city representatives were invited to indicate which elements or considerations were missing from an urban perspective, and what role local authorities could play in regulating shared CCAM services. The second taskforce meeting – organised in March 2022 – provided an overview of lessons learned from real-life demonstrations in Linköping and Geneva (respectively presented by VTT and UNIGE), with the aim to stimulate discussion on how cities can support the deployment of shared CCAM services and what kind of recommendations they could provide regarding the regulatory dimension.

4.3 Recommendations for Adapting Regulatory Strategies at Local Level

As technological and regulatory barriers for CCAV deployment are gradually being removed, there is a momentum for cities to develop an imaginative and forward-looking vision on how shared CCAVs could complement and reinforce local ambitions in achieving modal shift and improving road safety, energy-efficiency, accessibility, air quality and quality of public space across the functional urban area.

Although ‘hard’ legislation is defined at higher levels of jurisdiction, local authorities will have an essential role in complementing and applying the rules, combining ‘soft’ legislation and policy interventions with ‘conventional’ instruments such as road categorisation, curb side management and road space allocation, speed regimes, access regulation etc. Considering the legal complexity and potential risks associated with CCAV deployment, it will be important to systematically involve local authorities in the further development and adaptation of CCAM legislation at European and national level.

While the results from the desk research, public consultation, taskforce meetings and validation workshops performed within A3.3 did not find evidence of existing local regulation for commercially operated CCAM services, inspiration can be taken from the innovative governance which cities have applied to maximise the benefits and reduce the negative externalities of new and disruptive mobility services, especially with relation to app-based ride-hailing. Our recommendations for local regulation and policy interventions are mainly developed with commercial operation in mind. They can be grouped in 8 thematic categories, including ‘Pricing and Revenues’, ‘Energy and Environment’, ‘Quality of Services and Vehicles’, ‘Fair Competition and Access to Market”, ‘Multimodal Integration’, ‘Data Sharing’, “Physical, Digital and Communication Infrastructure” and ‘Network and Demand Management’. Overarching principles and approaches are grouped in the category ‘General’. Wider local authority competences and functions are significantly varying from country to country, it is therefore important to note that the applicability of the recommendations will depend on the specific national context [32].

4.3.1 General

- **RR_10** Develop vertical and horizontal working groups and structures: the deployment of CCAM requires a system-based approach and coordination between local, regional and national administrations, transport authorities and operators, as well as cross-departmental and public-private cooperation at local level.
- **RR_11** Create an open ecosystem for transport innovation: develop a local strategy for smart mobility; foster cooperation, dialogue and data exchange between public and private actors; establish a living lab for experimentation in real-life and virtual settings and involve citizens in the co-creation and testing of services and technologies; build technical capacity, skills and capabilities on connected, cooperative and automated mobility and on data handling and analysis.
- **RR_12** Align deployment of CCAVs with SUMP objectives: monitor and guide the deployment of shared CCAM services against the long-term vision, actions, targets and indicators formulated in the Sustainable Urban Mobility Plan; organise citizens’ dialogues to understand their concerns and expectations regarding driverless vehicles.
- **RR_13** Put in place a licensing scheme for new mobility services and CCAM: actors involved in the smart mobility ecosystems need to collaborate and there is a need to define how the license of private actors to publish data might look like (e.g., using a Creative Commons licence).

4.3.2 Pricing and Revenues

- **RR_14** Define maximum and minimum prices for using CCAV services: minimum prices will help to avoid predatory pricing, excessive use and unfair competition with other modes; maximum prices will ensure that shared CCAV services are affordable for the majority of the population (see also ‘Accessibility, Affordability and Quality’).

- **RR_15** Introduce smart road pricing: dynamic pricing based on vehicle type, time and location can be used as an instrument to discourage short or single-use trips and reduce congestion; revenues can be re-invested in sustainable alternatives.
- **RR_16** Apply charges to adapt and upgrade infrastructure: commercial operation of CCAVs will require investment in digital (and communication) and physical infrastructure, this may be compensated for by selling licenses to operators or by charging per trip or per vehicle.
- **RR_17** Anticipate drop in parking revenues: shared CCAVs are expected to reduce parking demand, leading to a drop in parking fees and fines; this may be compensated by charging operators for making use of designated pick-up and drop off points.

4.3.3 Environment and Energy

- **RR_18** Reduce the ecological footprint of CCAV services and vehicles: require CCAM operators to provide 100% zero-emission operations and to also indicate the share of renewable energy; support the roll-out of designated charging infrastructure at strategic locations (e.g., hospitals, hotels, etc.) and multimodal interchanges and introduce durability/recyclability requirements for vehicles.

4.3.4 Accessibility, Affordability and Quality

- **RR_19** Mandate accessibility of CCAV services: operators of shared CCAVs should ensure accessibility of services for persons with disabilities and persons with reduced mobility taking into account specific needs of those who are blind or partially sighted, deaf or hard of hearing, as well as those who have cognitive or psychosocial disabilities.
- **RR_20** Put in place vehicle requirements: vehicle weight, dimensions, engine power and capacity should allow for safe and efficient use adapted to the local context (e.g., historical centres with narrow streets, pedestrianised areas, etc.) and type of service (e.g., local door-to-door, regional, etc.).
- **RR_21** Extend CCAV Service Provision: create formal partnerships with CCAM operators to extend CCAV services to low-demand zones and off-peak hours.
- **RR_22** Collect public feedback on the performance of CCAVs: create a central contact point for passengers and road users to report their experience and observations directly to local administrations; this will also require CCAV operators to clearly indicate the brand name and fleet number on each of the vehicles.

4.3.5 Fair Competition and Access to Market

- **RR_23** Establish a ‘duty to notify’: require CCAV operators to inform and consult the local administration and police before testing and deploying shared CCAM services.
- **RR_24** Establish a licensing scheme for commercial operators: by establishing a licensing scheme based on common rules, quality standards and minimum prices, local authorities can create a level-playing field for all commercial operators, and avoid that predatory pricing leads to market monopolisation, excessive use and unwanted shift from sustainable modes.
- **RR_25** Set a cap on operator licenses and number of vehicles: by putting a cap on operator licenses and the unlimited deployment of shared CCAVs lead to congestion and increased pressure on the urban transport system.

- **RR_26** Integrate (door-to-door) CCAV services with the local taxi market: with the arrival of app-based ride-hailing, the distinction between traditional taxi services and new mobility service providers is gradually fading. To avoid unfair competition, local market regulation of driverless on-demand door-to-door services should be applicable both to taxi and shared CCAV operators.

4.3.6 Multimodal Integration

- **RR_27** Ensure connectivity and complementarity: require CCAV operators to provide connections with transfer points and multimodal hubs, and – if operated on a regular schedule and fixed routes - to synchronise timetables with other operators. Avoid duplication of (high capacity) public transport services.
- **RR_28** Support integration into an open MaaS ecosystem: encourage and accommodate integration of CCAV services in open MaaS ecosystems to create cooperation and trust with mobility and service providers, and allowing users to plan, book and pay for CCAV services from a single app and as part of a multimodal trip.
- **RR_29** Set up joint marketing campaigns: engage CCAV operators and other mobility providers in co-marketing campaigns to promote the combined strengths and synergies.

4.3.7 Data Sharing, Network and Demand Management

- **RR_30** Require CCAV operators to provide anonymised (real-time) data on passenger flows and vehicle movements: anonymised data related to trip origins and destinations, travel time, routes and distances allow local authorities to monitor and analyse passenger flows, and to identify gaps and bottlenecks in the transport system. By having access to vehicle movement and destination data, local traffic managers are able to monitor the location and journey of vehicles, as well as curb side stopping and parking behaviour. Vehicle movement data also allow traffic managers to optimise capacity of the network. As a general principle, data should be made available in a machine-readable format, and ensure that personal data and trade secrets are fully preserved.
- **RR_31** Define minimum occupancy rates for CCAVs: individual door-to-door trips and empty running of vehicles will lead to more congestion. This could be avoided by requiring operators to apply dispatching algorithms that optimise vehicle capacity and pooling of passengers (see also Pricing and Revenues, Data Sharing).

4.3.8 Physical, digital and communication infrastructure

- **RR_32** Apply common visual elements to CCAVs vehicles and infrastructure: CCAV services should be distinguishable both for passengers as for other road users to ensure smooth operation as well as visibility of services. Common visual elements may be applied to the vehicles, stops, signage, routes and intersections.
- **RR_33** Develop a categorisation system for urban roads: clearly describing the functions, characteristics and hierarchy of the different roads in the urban transport network (e.g., arterial roads, connecting roads, residential streets, pedestrianised areas, etc.) will make it easier to define the routes and zones where CCAVs can be deployed.
- **RR_34** Introduce dynamic curb side management for on-demand mobility services: CCAVs will require designated on-street locations to park, to charge and to pick up and drop off passengers. As the introduction of shared new mobility services in combination with on-demand logistics already requires local

authorities to make more efficient use of curb space, they can already take into consideration the integration of CCAVs when defining rules and processes for curb side management. Further digitisation of curb use will also allow a more dynamic and flexible use of limited urban space.

- **RR_35** Define if and under which conditions CCAV operators are allowed to make use of dedicated public transport infrastructure: public transport infrastructure in cities typically includes stops and interchanges, reserved lanes, controlled junctions and (C-)ITS equipment that enables positioning and prioritisation of vehicles as well as communication between vehicles, control centres and infrastructure. To avoid that CCAVs cause any disruption for conventional public transport services, access of CCAVs to PT infrastructure needs to be negotiated with local (road) authorities and incumbent PT operators.
- **RR_36** Avoid vendor lock-in for digital and communication infrastructure: to avoid service interruption and switching costs, local authorities should aim for an open ITS architecture and standards, that allow for CCAVs to be deployed in a multi-operator and multi-vendor environment, where digital and communication infrastructure is not only interoperable but also backward compatible.

5 Adaptation of Operational Strategies

5.1 State-of-Play

Many of the CCAM use cases that are being tested in Europe are aimed at reproducing on-demand services that are currently performed by digital platforms, taxi companies and public transport operators. In addition, there are also pilots aiming to remove the driver from depot operations. The fleet currently tested in SHOW is mainly at SAE Level 4, which implies that safe operation is limited to a predefined area requiring interventions from test drivers and remote operators.

Pilots are mainly focused on technological challenges, safe operation of the vehicles within the designated Operational Design Domain, and protection of passengers and test drivers. They must ensure that vehicles follow the desired route, are well aware of the traffic environment and other road users and respect the traffic rules.

The steps towards commercial operation remain unclear, due to the difficulty of projecting the effects of large-scale deployment. Operational strategies for shared, on-demand CCAVs in urban areas will also depend on the specific national and local context, which challenges the concept of a holistic strategy that also guarantees profitability.

5.2 Operational Gaps and Barriers

Regulation and business models for shared CCAVs are not yet mature enough to support full commercialisation by OEMs and PTOs. Further steps in technology development (e.g., remote vehicle control) are also needed to ensure safety of passengers and other road users. The CCAM services that are expected to be deployed also need to be safe from a systemic point of view, which means that not only vehicles need to be safe by design; also the services have to be performed safely. In addition, legal procedures for bringing CCAM pilots and CCAVs to public roads are complex and time-consuming, which in turn limits scalability.

Current CCAM technology in Europe is not yet able to manage the complexity of mixed traffic on urban roads. In terms of test site development, current test sites and pilot sites are mainly restricted to designated areas and corridors. This could be resolved by developing more complex living labs that allow replicating a variety of traffic scenarios that collectively represent the complications that may arise during real-life deployment.

As suggested by the EU-funded AVENUE project, the many challenges related to the operation of fully automated shared vehicles may be overcome by introducing a remote operator as an intermediate step [33]. This remote operator will also require technology to communicate with users (speakers, microphones, cameras) and control the safety (and security) outside and inside of the vehicle.

The need for further technological improvement is also underlined by the 2022 ERTRAC Roadmap for CCAM: “Further advancement in enabling technologies thus is essential for making CCAM ready for a wider market deployment, like sensor components and networks, computing systems and control architectures with high reliability, fail-operation capabilities and efficiency, embedded software and artificial intelligence at the edge providing agile upgradability and self-learning capabilities and communication infrastructures and cloud-based services for the gathering, exchange and analysis of critical data at high bandwidth, short latencies and highest levels of data security” [34]. Current efforts are mainly focused on improving CCAVs and their deployment in the real world, similar efforts should however also be applied to the further development the infrastructure on which they will operate.

Considering that current pilots with shared CCAVs are limited both in terms of fleet and duration, the required adaptation of operational strategies is mainly depending on assumptions. Only by scaling up fleet size, area of operation and availability of services, the effects of large-scale deployment on operational strategies and the profitability of business cases can be better understood. Finally, also a better visualisation of the urban transport system is needed to allow for optimisation of services.

5.3 Recommendations

5.3.1 Technology Development and Safety

- **OR_1** To ensure safety and security, technology for remote operation of shared CCAVs and communication with users' needs to be further developed and validated in the framework of large-scale pilots.
- **OR_2** Removing the driver will affect the safety perception of users. Future deployment will require a combination of remote intervention and technological solutions to guarantee safety, security and user acceptance, both inside and outside of the vehicle.
- **OR_3** Virtual models need to be developed which can be included in accurate simulations of the environment (or Digital Twins) where the vehicle will be deployed. This will allow identifying mismatches, assessing risks and safety of the system as a whole, and will also enable scaling and projection into real-life operations.
- **OR_4** Virtualisation will also support the development of operational strategies that are adapted to the local context, shifting the focus from technology development to mobility business.

5.3.2 Regulation and Standardisation

- **OR_5** A clear roadmap for CCAM regulation and policies is needed at all levels (national, regional and local) as they impact development of new business models.
- **OR_6** Harmonise the authorisation of operation sites (mentioned in 3.3.3.1)
- **OR_7** Define requirements, responsibilities and liability of remote intervention operators (mentioned in 3.3.3.2)
- **OR_8** Consider aspects to guarantee the safety of passengers (mentioned in 3.3.3.3)
- **OR_9** Define the continuous monitoring process of commercial operations (mentioned in 3.3.3.4)
- **OR_10** Further standardisation of Operational Design Domains is required, however without limiting too much the competition between different technologies and providers.

5.3.3 Infrastructure

- **OR_11** Operational deployment with a high level of safety will require infrastructure that supports CCAVs in alignment with the relevant Operational Design Domain.
- **OR_12** A common strategy for infrastructure development will enhance the uptake of shared CCAVs in urban areas.

5.3.4 Understanding Mobility Business

- **OR_13** Deployment of iterative and scaled large-scale pilots will improve understanding of how shared CCAM services will impact the business models

of operators, potentially leading to new types of mobility services that will be more efficient and more profitable.

- **OR_14** New large-scale pilots must be designed in living labs able to reproduce complex real-life scenarios as a minimum viable product (MVP) with a focus on safe implementation [35].
- **OR_15** A holistic vision of the urban transport system will help to define the role of the (public) transport operator. The focus should be on the mobility needs and the travel patterns within a given urban rather than the technological possibilities.
- **OR_16** Public and private CCAM services will have a place in the urban transport system of the future, but local authorities will need to clarify their strategies.

6 Conclusions

The purpose of D3.3 is to explore the adaptation of regulatory and operational frameworks at local and regional level to support large-scale deployment of shared CCAVs in a safe, sustainable and integrated manner. In order to define the scope for intervention, we started with an analysis of relevant regulatory frameworks at international, European and national level. The 2021 introduction of UN Regulation No. 157 for Automated Lane Keeping Systems (ALKS) constituted an important step towards international regulation of SAE L3 vehicle functions; at European level, regulation is mainly focused on developing a common type-approval framework and technical standards for CCAM, in close coordination with the United Nations Economic Commission for Europe (UNECE) and relevant standardisation bodies. The 2022 EU delegated regulation 2022/2236 and implementing regulation 2022/1426 on the type-approval of fully automated driving systems does however not address the operational dimension of CCAM: the safety of operation of fully automated vehicles in traffic and local transport services falls under the responsibility of the Member States.

With the exception of some countries like Germany and France, which in recent years developed their own regulatory frameworks for real-life operation of CCAVs, national regulation for CCAM in Europe is still mainly limited to defining approval and exemption procedures for testing on public roads. As demonstrated by the country overview, the different procedures and requirements make it challenging for OEMs and operators to deploy the same type of vehicle and service across different countries. The fact that in some cases – including for example Germany, Greece and Italy - also regional authorities have a role in the approval and exemption process increases the level of complexity.

Local competence for developing 'hard legislation' is limited and needs to be understood in its specific national context. However, as cities are in general responsible for developing and implementing sustainable urban mobility strategies, public space and road management, public procurement, (multilevel) public transport governance, access regulation, parking, etc., their potential role in defining the future deployment of shared (commercial) CCAVs in urban areas can and should not be underestimated. In recent years, the introduction of new mobility concepts like ride-hailing, micro-mobility, MaaS, drones etc. increased the experience and capacities of cities in designing and applying 'soft' regulation, including for example licencing rules, incentives, recommendations, guidelines, codes of conduct, memorandums of understanding, non-binding resolutions and standards.

The table below provides a summary of the main regulatory gaps and barriers for each level of jurisdiction, as well as recommendations for adapting regulatory strategies.

Table 2: Summary of recommendations for adapting regulatory strategies

Level of Jurisdiction	Gaps / Barriers	RR	Recommendations
EU	Limited scope of the EU CCAV type-approval regulation.	1	Go beyond small series
		2	Strengthen integration of physical and digital communication infrastructure in the approval process
		3	Ensure system liability
		4	Ensure adequate monitoring processes taking into account the possibility of having manufacturers applying different risk distribution strategies
National/ Regional	Lack of harmonised	5	Define aspects regulated at EU/national level and which aspects fall at the regional level

Level of Jurisdiction	Gaps / Barriers	RR	Recommendations	
	requirements for testing and deployment of CAVVs.	6	Clarify responsibilities with regional and local authorities for exemption procedures, traffic authorisation or operational deployment	
		7	Promote harmonised regulations and standards for EU countries	
		8	Align regulations with capacities and possibilities of newer and safe CCAV technologies	
		9	Consider standardised procedures for mutual recognition of already approved use cases	
Local	Limited legal competence to maximise the benefits of shared CCAVs	10	General	Develop vertical and horizontal working groups and structures
		11		Create an open ecosystem for transport and innovation
		12		Align CCAVs' deployment with SUMP objectives
		13		Put in place a licensing scheme for new mobility services/CCAM operators
		14	Pricing and revenues	Define maximum and minimum prices for using CCAV services
		15		Introduce smart road pricing
		16		Apply charges to adapt and upgrade infrastructure
		17		Anticipate drop in parking revenues
		18	Environment and Energy	Reduce the ecological footprint of CCAV services
		19	Accessibility, affordability and quality	Mandate accessibility of CCAV services
		20		Put in place vehicle requirements
		21		Extend CCAV Service Provision
		22		Collect public feedback on the performance of CCAVs
		23	Fair competition and access to market	Establish a 'duty to notify'
		24		Establish a licensing scheme for commercial operators
		25		Set a cap on operator licenses and number of vehicles
		26		Integrate (door-to-door) CCAV services with the local taxi market
		27	Multimodal integration	Ensure connectivity and complementarity with other operators

Level of Jurisdiction	Gaps / Barriers	RR	Recommendations	
		28		Support integration into an open MaaS ecosystem
		29		Set up joint marketing campaigns
		30	Data sharing, network and demand management	Require CCAV operators to provide anonymised (real-time) data on passenger flows and vehicle movements
		31		Define minimum occupancy rates for CCAVs
		32	Physical, digital and communication infrastructure	Apply common visual elements to CCAVs vehicles and infrastructure
		33		Develop a categorisation system for urban roads
		34		Introduce dynamic curb side management for on-demand mobility services
		35		Define if and under which conditions CCAV operators are allowed to make use of dedicated public transport infrastructure
		36		Avoid vendor lock-in for digital and communication infrastructure

The anticipated impact of CCAVs on operational strategies – i.e. strategies that will be applied by PTOs/PTAs and mobility service providers to optimise efficiency, cost-effectiveness (or profitability) and quality of CCAM services integrated with conventional public transport – remains unclear as current deployment of shared CCAVs in Europe is still in a testing phase with pilots that are limited in terms of vehicles, duration and scale of operation. Also, regulatory barriers and technological limitations do not yet allow drawing conclusions from ongoing real-life demonstrations. Developing a better understanding of how to adapt operational strategies will require a more detailed level of virtualisation of the local context, and continued efforts in scaling up real-life demonstrations.

Gaps and barriers as well as recommendations for adapting operational strategies at local and regional level can be summarised as follows:

Table 3: Summary of recommendations for adapting operational strategies at local and regional level

Gaps / Barriers	OR	Recommendation
Lack of technology to safely manage more complex operational scenarios in real-world deployment of shared CCAVs	1	Develop technology for remote operations of shared CCAVs
	2	Combine remote intervention and technological solutions
	3	Develop virtual models to be included in accurate simulation of the environment
	4	Shift the focus from technology development to mobility business

Gaps / Barriers	OR	Recommendation
Absence of a harmonised regulatory framework limits the development of operational strategies for shared CCAM services	5	Establish a clear policy roadmap at European, national, regional and local levels.
	6	Harmonise the authorisation of operation sites
	7	Define requirements, responsibilities and liability of remote intervention operators
	8	Consider aspects to guarantee the safety of passengers
	9	Define the continuous monitoring process of commercial operations
	10	Further standardisation of Operation Design Domains
Lack of adequate infrastructure	11	Infrastructure supporting CCAVs should be aligned with the relevant ODD
	12	Have a common strategy for infrastructure development
Lack of business case	13	Deploy iterative and scaled large pilots
	14	Design new large-scale pilots in living labs
	15	Develop a holistic vision of the urban transport system
	16	Local authorities to clarify their strategies for future urban transport system (public and private)

The SHOW demos are expected to run until the end of 2023 and therefore new inputs should be considered by the end of the project. To conclude, the content of this document is expected to feed into the SHOW D17.5 *'Roadmap towards CCAV* implementation in cities and policy recommendations' due by M48 of the project.

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Appendix I: Survey Results

Regulatory aspects of shared CCAM services at local level

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89
Total Responses

Complete Responses: 89

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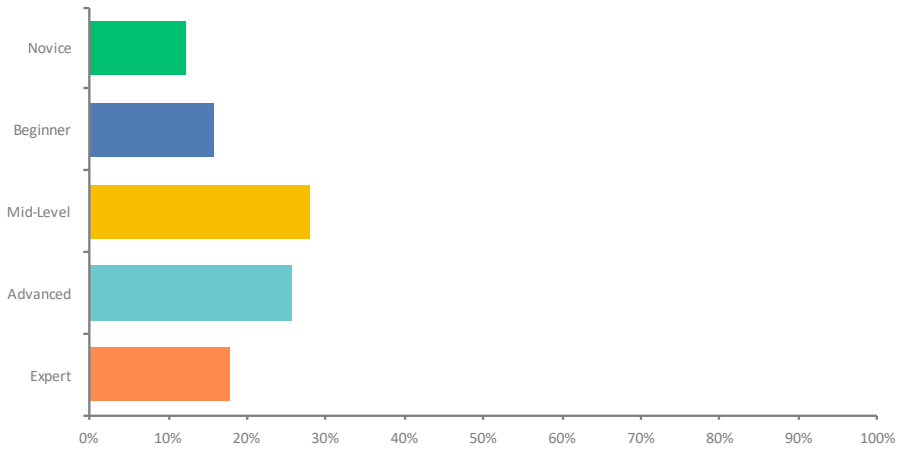
Part I: Regulatory and operational aspects of CCAVs at Local and Regional Level

GENERAL INFORMATION

Level of Expertise on the topic of CCAM



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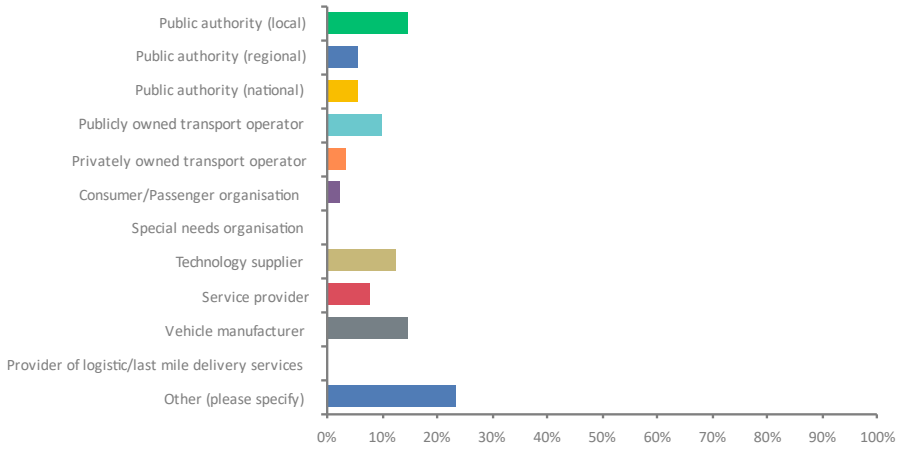
Type of organisation



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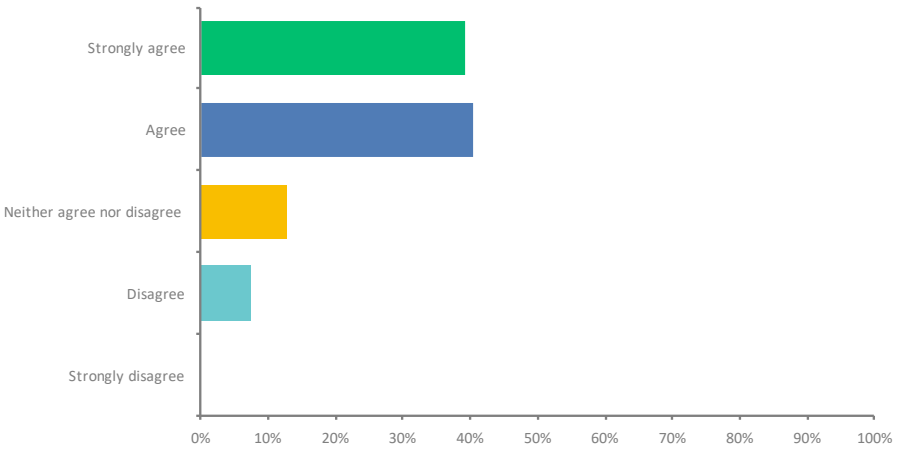
Part II: Regulatory and operational aspects of CCAVs at Local and Regional Level

REGULATION AT LOCAL LEVEL IS NEEDED TO ENSURE:

Servicesare accessible, available (ime and location-independent) and affordable for all types of users regardless of their age, physical and mental condition, level of income or digital skills



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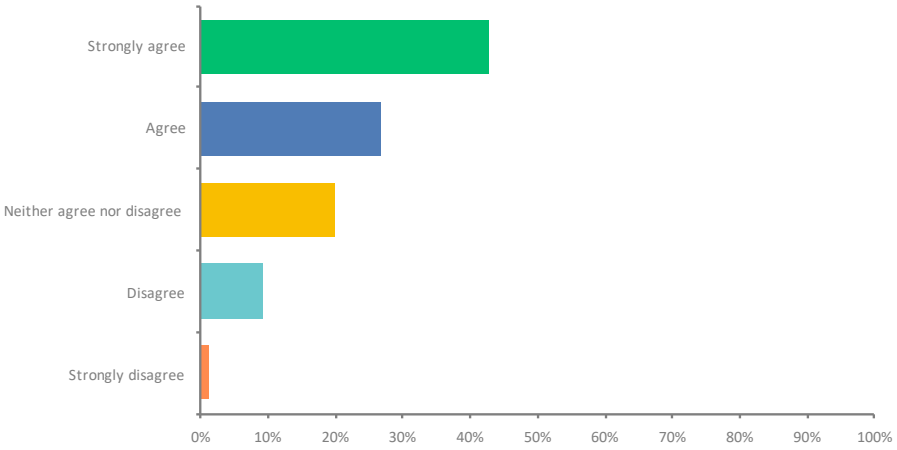
Shared CCAVs adapt their speed in case of planned or extraordinary event(e.g: road works, hazards, demonstrations…)



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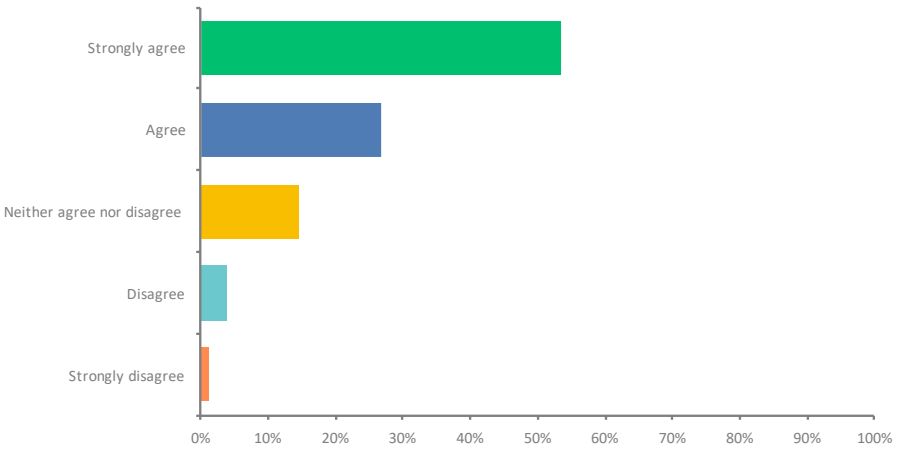
Part II: Regulatory and operational aspects of CCAVs at Local and Regional Level

REGULATION AT LOCAL LEVEL IS NEEDED TO ENSURE:

Operations are monitored to ensure the safety and security of people in and around the shared CCAVs in compliance with data protection& privacy rules



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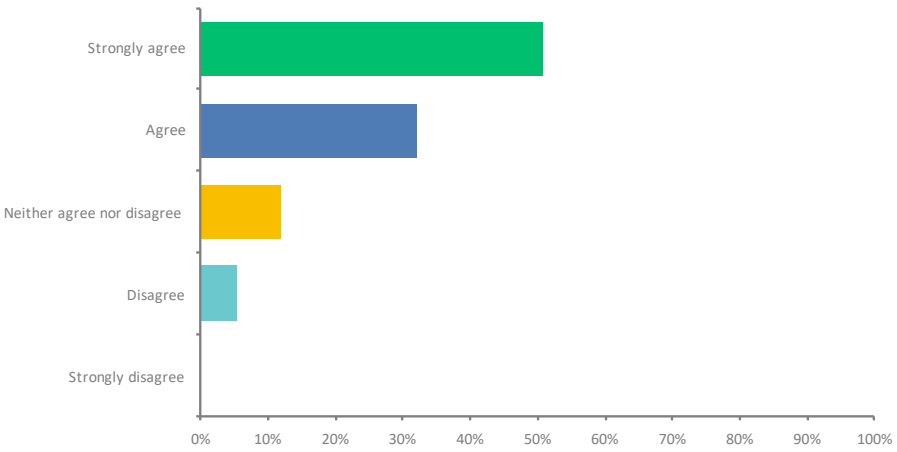
Assistanceis provided in case of emergencies, accidents and incidents



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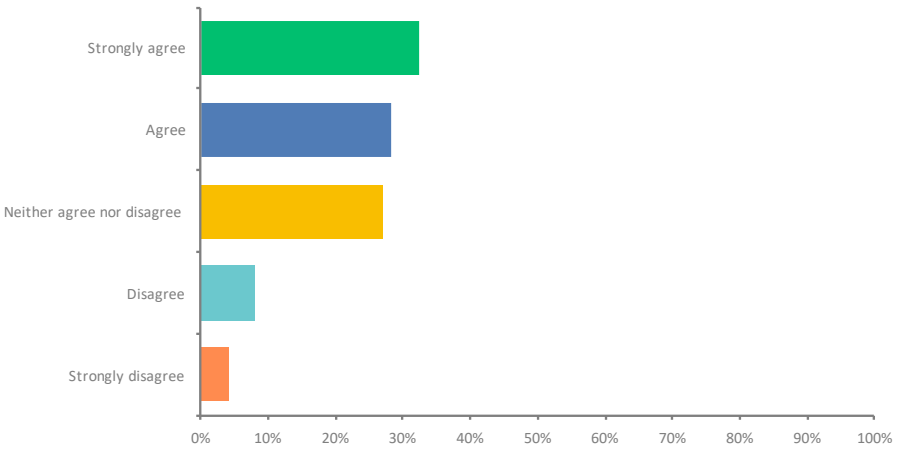
Part II: Regulatory and operational aspects of CCAVs at Local and Regional Level

REGULATION AT LOCAL LEVEL IS NEEDED TO ENSURE:

Routing and fleet management are optimised to improve energy performance of shared CCAVs and CCAM services



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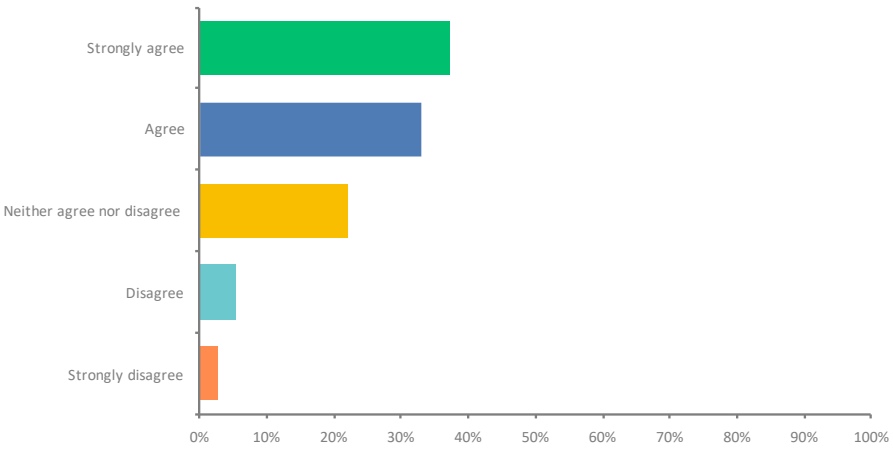
Minimum quality standards are put in place regarding service availability and service reliability



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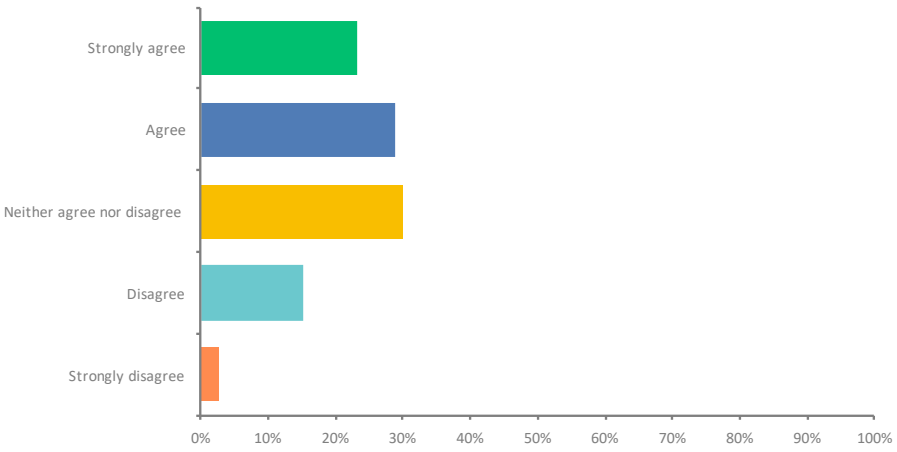
Part II: Regulatory and operational aspects of CCAVs at Local and Regional Level

REGULATION AT LOCAL LEVEL IS NEEDED TO ENSURE:

Minimum quality standards are put in place regarding comfort and cleanliness of vehicles



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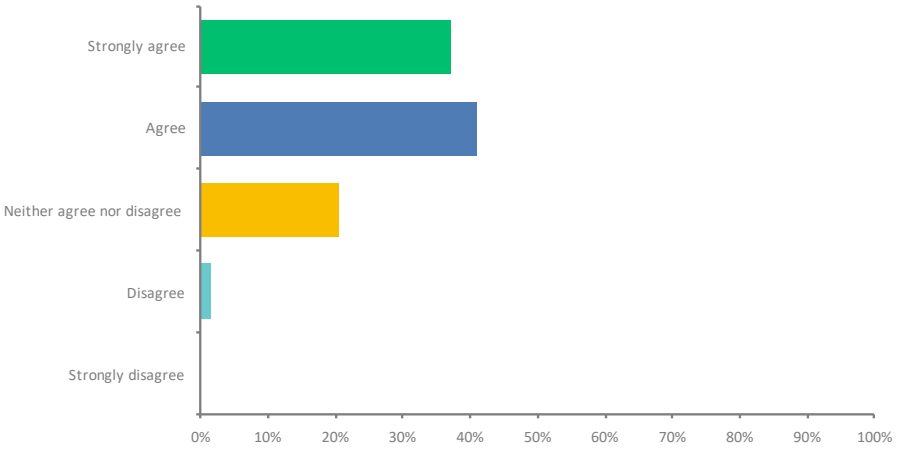
Passengershave the possibility to request assistance



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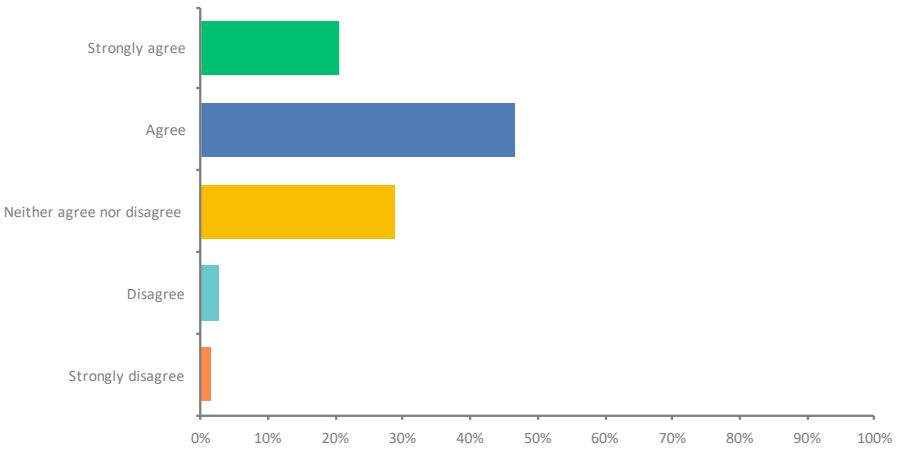
Part II: Regulatory and operational aspects of CCAVs at Local and Regional Level

REGULATION AT LOCAL LEVEL IS NEEDED TO ENSURE:

Passengersatisfaction and system performance are monitored and evaluated on a regular basis and results are shared and discussed with local authorities



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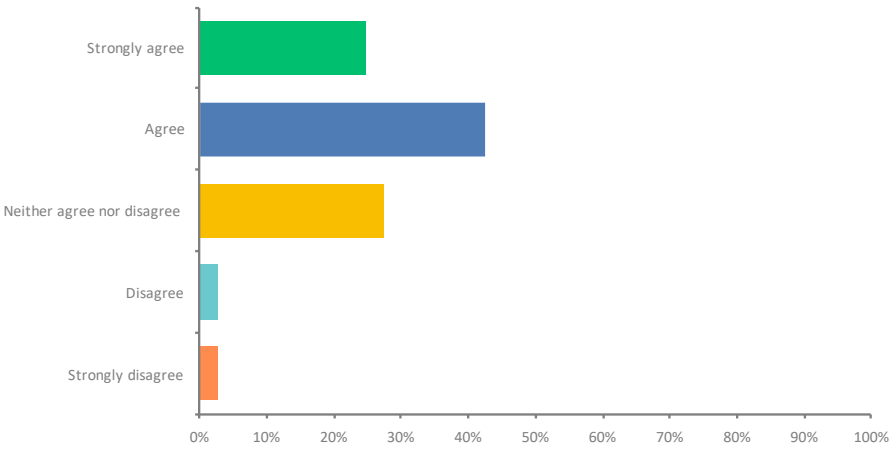
A transparent procedure for complaints handling and redress is put in place



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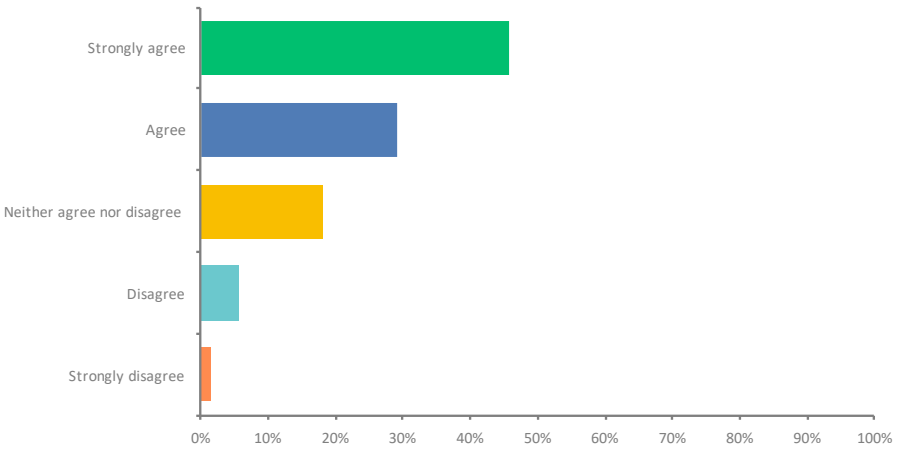
Part II: Regulatory and operational aspects of CCAVs at Local and Regional Level

REGULATION AT LOCAL LEVEL IS NEEDED TO ENSURE:

Transparent rules and requirements are applied to ensure fair competition between different means of transport and operators



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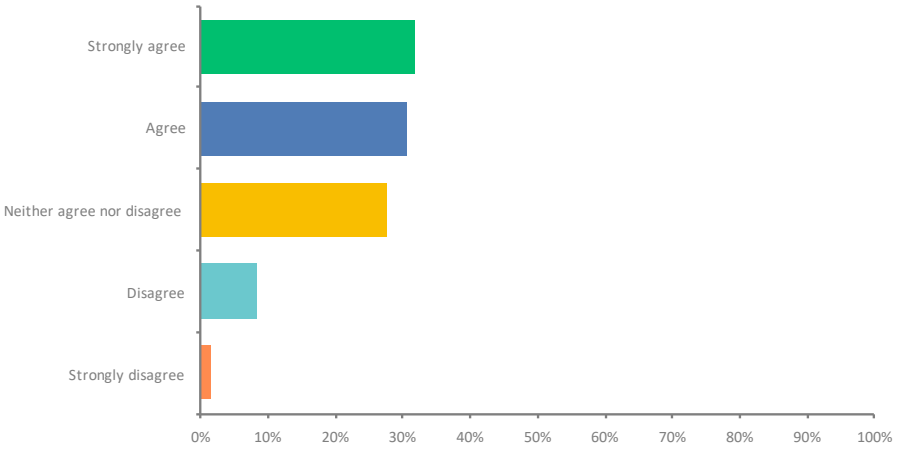
CCAM workers (e.g. on-board/on-site stewards, repair and maintenance staff, remote operators, etc.) enjoy an adequate level of social protection



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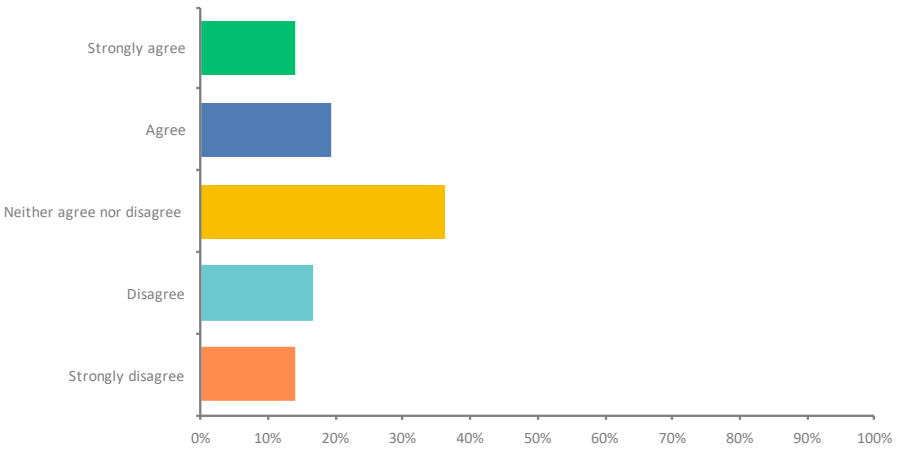
Part II: Regulatory and operational aspects of CCAVs at Local and Regional Level

REGULATION AT LOCAL LEVEL IS NEEDED TO ENSURE:

The number of shared CCAM operators and vehicles is restricted



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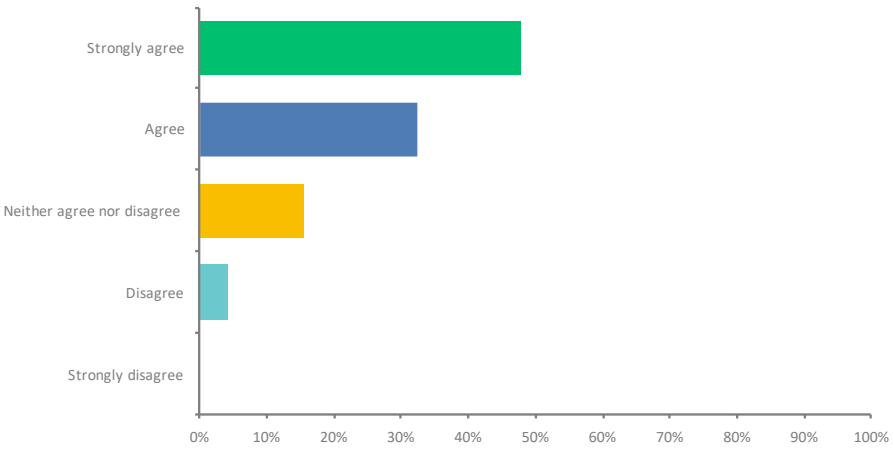
Shared CCAM services provide connections with multimodal hubs and complement high capacity public transport lines



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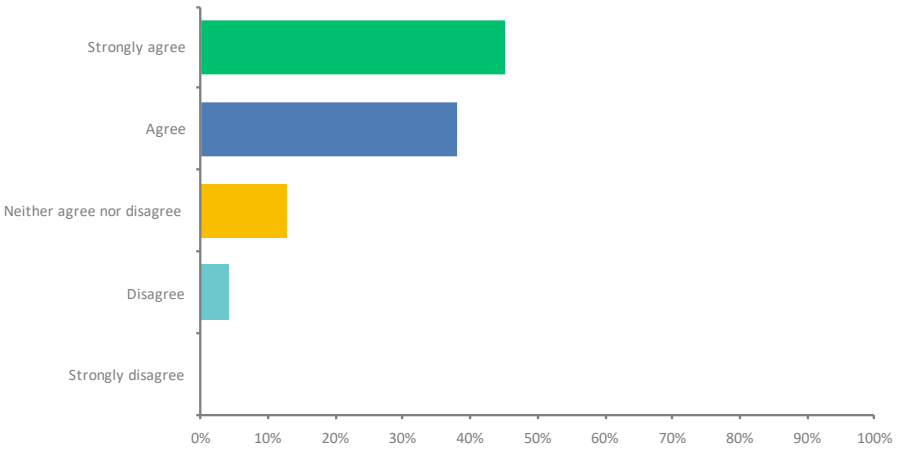
Part II: Regulatory and operational aspects of CCAVs at Local and Regional Level

REGULATION AT LOCAL LEVEL IS NEEDED TO ENSURE:

Shared CCAM services are integrated with multimodal travel information, planning, reservation and ticketing systems



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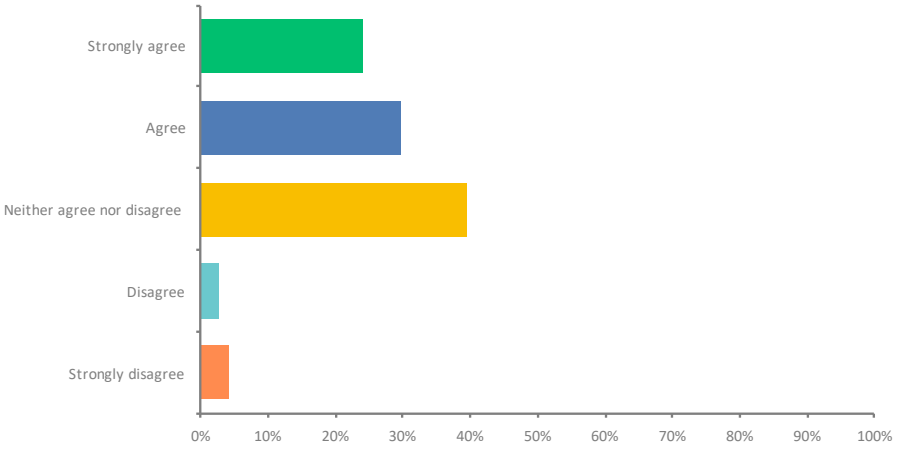
Shared CCAV fleet management including teleoperation is integrated into local Traffic Management Centres



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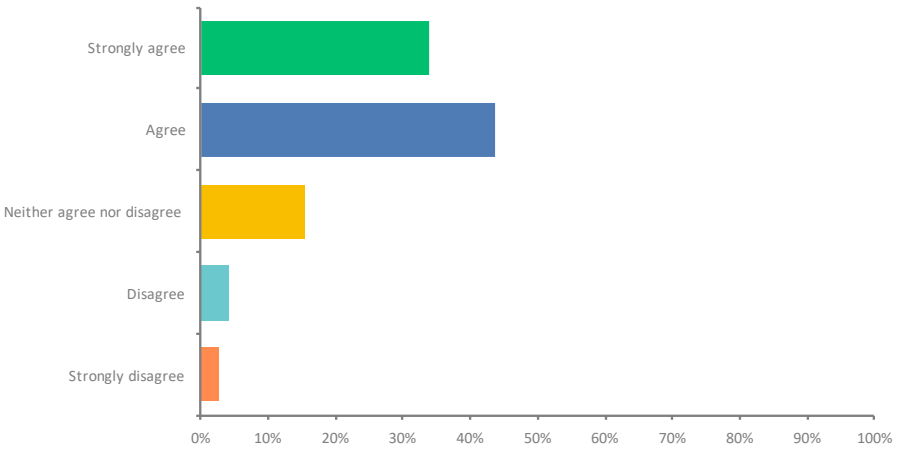
Part II: Regulatory and operational aspects of CCAVs at Local and Regional Level

REGULATION AT LOCAL LEVEL IS NEEDED TO ENSURE:

CCAM operators share relevant and anonymised data with local (transport) authorities for mobility management and sustainable mobility planning purposes (including for example data related to ticket sales, location, expected and actual trip, etc.)



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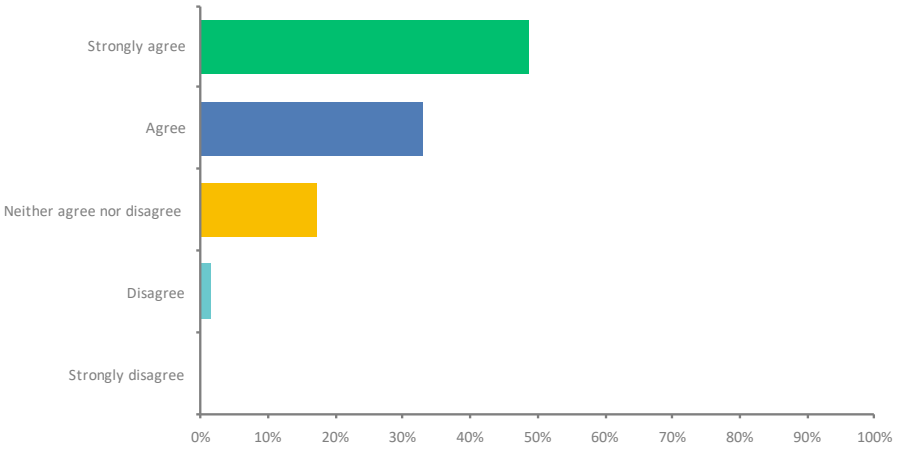
Roadside equipment, sensors and digital maps required for the operation of shared CCAM services are interoperable



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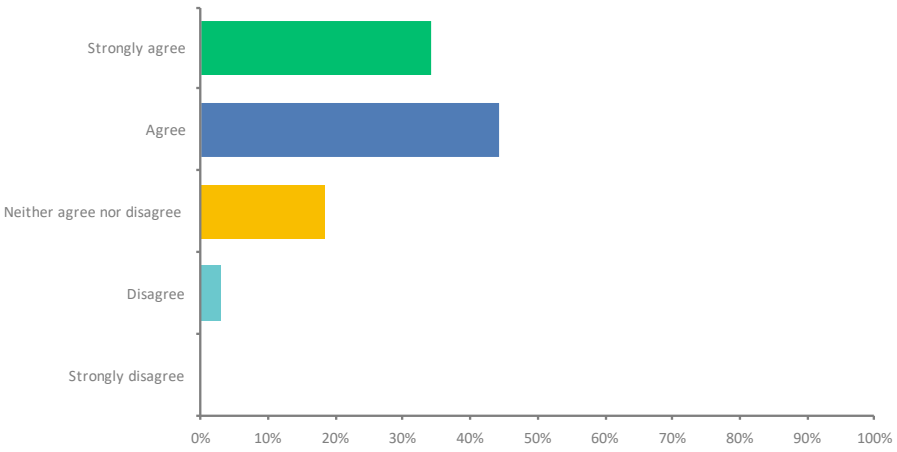
Part II: Regulatory and operational aspects of CCAVs at Local and Regional Level

REGULATION AT LOCAL LEVEL IS NEEDED TO ENSURE:

Shared CCAVs communicate with local Traffic Management Centres



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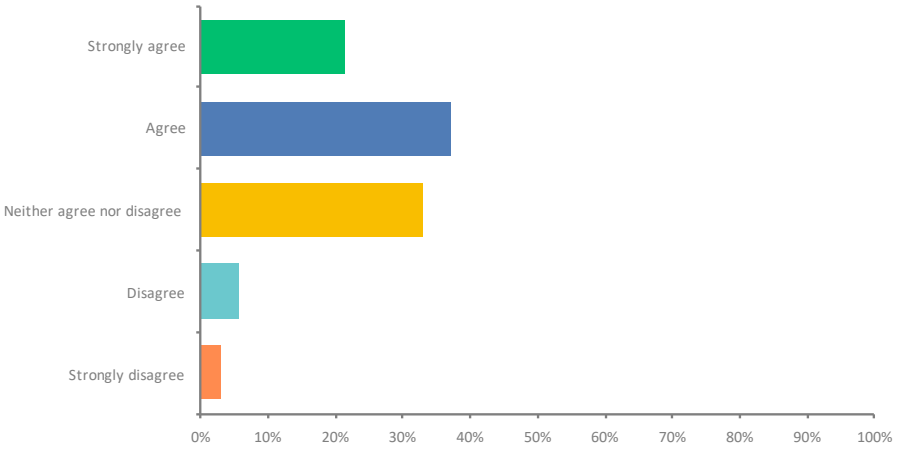
Shared CCAVs can access dedicated public transport lanes, interchanges and stops



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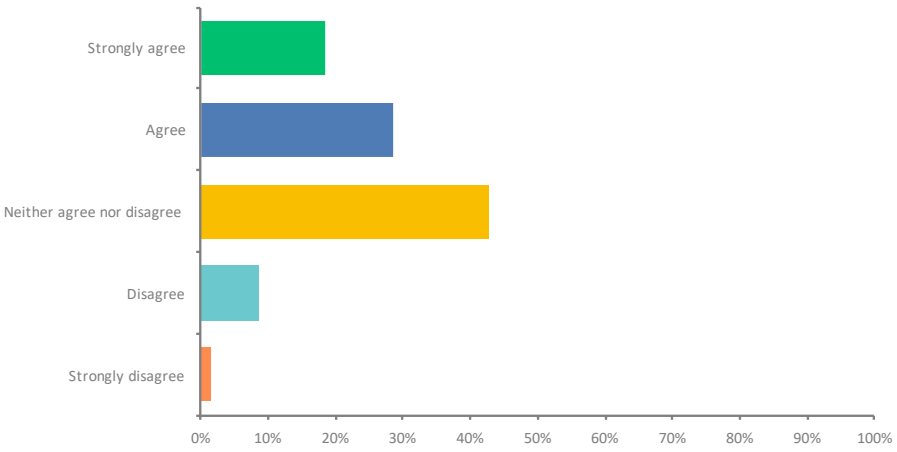
Part II: Regulatory and operational aspects of CCAVs at Local and Regional Level

REGULATION AT LOCAL LEVEL IS NEEDED TO ENSURE:

Shared on-demand door-to-door CCAM services are not required to make use of official public transport stops to pick up and drop off passengers



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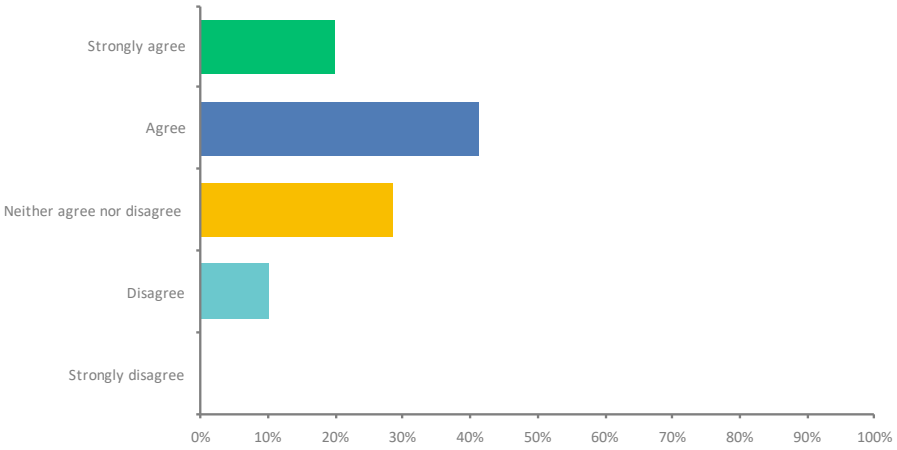
Shared CCAM services operate within a predetermined geographical scope



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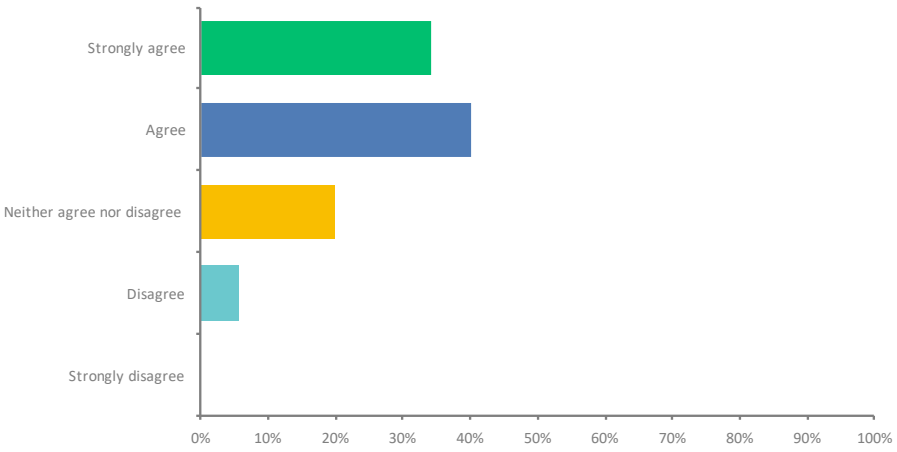
Part II: Regulatory and operational aspects of CCAVs at Local and Regional Level

REGULATION AT LOCAL LEVEL IS NEEDED TO ENSURE:

Shared CCAVs adapt their routes taking into account planned or extraordinary events



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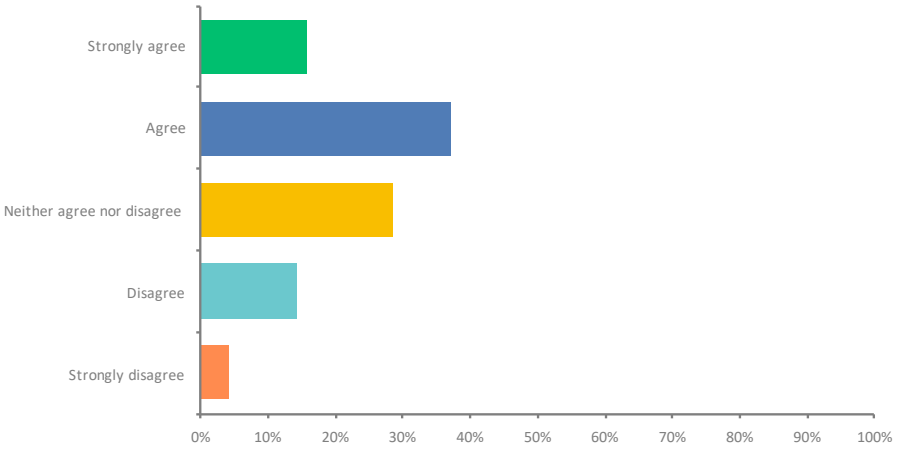
Shared CCAVs only allow onboarding and disembarking of passengers at designated pick up/drop-off points



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Annex 2: Country overview of procedures and entities involved in the approval

Country	Procedure	Level of jurisdiction
Austria	The operator or manufacturer hands in a completed application form at the Contact Point for Automated Mobility (Austriatech). The application form is reviewed by the Contact Point Automated Mobility. The BMK (Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie) issues the permission.	National
Czech Republic	The vehicle manufacturer or technical service conducting approval tests applies for permission to conduct field testing. The permission is granted by the Ministry of Transport of the Czech Republic, Road Vehicles Operation Section.	National
Denmark	The Danish road safety agency receives the application for tests with automated vehicles. An application for tests with autonomous motor vehicles is sent to the Road Directorate. Upon receipt, the Road Directorate examines whether the required documents are attached. Then the application material is forwarded to the authorities to process the application.	National
Finland	Permit issued by the Finnish Transport and Communications Agency Traficom.	National
France	Test authorisation is granted on an individual basis and several different ministries are involved. Initially, the applicant has to provide documents which explain the objectives of the test, describe the vehicles and how safety will be ensured. Authorities will raise questions that the applicant must consider. If all involved ministries agree, the Ministry of Ecological Transition will send the dossier to the local road authority to ask for an opinion, after what the Ministry will issue a permit for the specific route.	National
Germany	The law on autonomous driving defines two main steps for the nationwide approval process: • Approval of the vehicle with autonomous driving functions that is issued by the German Federal Motor Transport Authority (Kraftfahrtbundesamt – "KBA"); • Approval of the operating areas is granted by regional bodies responsible under state law.	National and regional
Greece	Operation of automated urban bus on public roads is permitted, by decision of the Municipal	National, regional and local

Country	Procedure	Level of jurisdiction
	council after the consent of the local traffic police or other bodies that perform traffic duties, for a specified period of time and a specific urban or peri-urban route, determined after a traffic study, as long as the operation of the vehicle is carried out as part of municipal transport. The operation of autonomous vehicles in the context of a pilot application or test operation is carried out in testing stages, after evaluating the results of each stage, which determine the nature and conditions for the implementation of the next one, as well as the need to receive additional measures or interventions in order to control the safe operation of the vehicle. The operation of an autonomous passenger car with a maximum weight of up to 3,500 kg is allowed without the presence of a driver on it, only in the context of a pilot application for research purposes, upon submission by the interested body of a relevant documented request. By decision of the Minister of Infrastructure and Transport, the supporting documents accompanying the relevant request, the terms, conditions and the procedure for putting the vehicle (both bus and passenger car types) into circulation, as well as any technical matter for the safe circulation of the vehicle on a specified route, are determined. Several authorities are involved: • Greek Ministry of Transport, Infrastructure and Networks; • Local stakeholders (municipality, the regional authorities, the local police and traffic regulation department); • A public research or educational institute.	
Italy	A local authority - a municipality or the authority responsible for the infrastructure - requests certification of a new transport system from the Italian Ministry of Transport, Division 5.	National, regional and local.
Netherlands	The National Road Traffic Agency grants exemption on a case-by-case basis, guaranteeing sufficient safety. Exemptions are obtained from the Netherlands Vehicle Authority (RDW) and the relevant road operator(s).	National
Spain	The Spanish government issued a law to authorise the testing of vehicles equipped with automated technologies in open road scenarios. Vehicles with automated functions are regulated under the Instruction 15/V-113 that was issued by the main Spanish body in charge of the traffic organisation, the *"Dirección General de Tráfico*	National

Country	Procedure	Level of jurisdiction
	(DGT)" (General Directorate for Traffic). IDIADA is the designated technical service entity to certify compliance with the Instruction.	
Sweden	The Swedish Transport Agency issues permits for trial operations with automated vehicles on public roads. Anyone who seeks permission must be able to prove that the operation is conducted in a traffic-safe manner.	National