SHared automation Operating models for Worldwide adoption

SHOW

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D17.4: CCAV integration in SUMP

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Executive Summary

D17.4 CCAV Integration in SUMP provides a comprehensive overview of the integration of Cooperative, Connected, and Automated Mobility (CCAM) into Sustainable Urban Mobility Plans (SUMPs) within the context of the SHOW project, funded by the European Union's Horizon 2020 research and innovation programme.

The primary goals are to assess the status of CCAM integration in various cities involved in SHOW, identify barriers, and propose methods to enhance CCAM adoption within urban mobility frameworks. Significant achievements include a comprehensive analysis of SHOW pilot sites, the identification of challenges encountered, and the development of strategic recommendations for effective CCAM implementation and CCAM integration in SUMPs.

Within this report, we provide a comprehensive overview of the ongoing CCAM pilots within the SHOW project and their implications for the integration of CCAM into SUMPs. The integration of CCAM into SUMPs is not just about adopting new technologies but also about rethinking urban mobility in a way that is more sustainable, inclusive, and resilient. Policymakers and planners need to stay informed about the latest developments in CCAM, understand the potential impacts, and be proactive in creating strategies that will leverage these technologies to improve urban mobility. By elucidating the status, challenges, and prospects, our document seeks to inform about the critical intersections between emerging technology and sustainable urban mobility.

The Advisory Board members who reviewed this Deliverable shared their positive overall comments regarding that and proposed some improvements in the titles and the phrasings to be more representative of the content and the messages it aims to convey. It was specifically asked to be more specific on the role of the private sector. Following-up on this comment, the section on the collaboration between public and private stakeholders was expanded to elaborate on how private entities can initiate CCAM systems by conducting feasibility studies, securing funding, and providing operational expertise, which helps accelerate CCAM implementation.

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Table of Contents

List of Tables

List of Figures

Abbreviation List

Abbreviation	Definition
AV	Automated vehicle
CCAM	cooperative, connected, and automated mobility
CCAV	cooperative, connected, and automated vehicles
C-ITS	Cooperative Intelligent Transport Systems
D	Deliverable
DMP	Data Management Platform
DSS	Decision support system
EU	European Union
GDPR	General Data Protection Regulation
HD	High Definition
ISO	International Organisation for Standardisation
ITS	Intelligent transport systems
MaaS	Mobility-as-a-service
NAP	National access point
PPP	Public-private partnership
PST	Policy support tool
PT	Public transport
PTA	Public transport authority
PTO	Public transport operator
SULPs	Sustainable urban logistics plans
SUMPs	Sustainable Urban Mobility Plans
TEN-T	Trans-European transport network
UNECE	United Nations Economic Commission for Europe
USA	United States of America
V2X	Vehicle-to-everything
VRU	Vulnerable Road User
VTI	Swedish National Road and Transport Research Institute
WP	Work package

1 Introduction

1.1 Purpose and structure of the document

The EU-funded project SHOW seeks to advance sustainable urban transport by piloting real-life deployment of shared, connected and electrified automated vehicles (AVs) through innovative technical solutions, considering novel business models, and impactful scenarios.

The introduction of Cooperative, Connected, and Automated Mobility (CCAM) into cities' Sustainable Urban Mobility Plans (SUMPs) heralds a transformative era in European transportation. A SUMP in Europe is a strategic plan developed by cities and urban areas to promote sustainable transportation and improve the overall quality of life. As CCAM has the potential to bring great benefits to citizens and society, by making transport more affordable, safe, inclusive and sustainable, it is important to consider how it can be integrated into cities' SUMP.

In the Methodological Approach chapter, the report details the research methods employed, which include data collection from pilot sites, interviews with key stakeholders, and an analysis of existing literature and regulations. This rigorous methodological framework ensures a comprehensive examination of the state of the art in terms of integration of CCAM into SUMPs within the European context.

The Definition of SUMPs chapter underscores the importance of SUMPs in fostering sustainable urban mobility. It highlights how SUMPs are pivotal in reducing greenhouse gas emissions, improving public health, and managing urban mobility challenges effectively. By aligning CCAM deployment with SUMPs, cities can prioritise initiatives that enhance accessibility, reduce congestion, minimise environmental impact, and improve the overall quality of life for residents.

The Integration of CCAM in SUMP chapter evaluates the current state of CCAM integration across various cities, noting the heterogeneity in approaches and challenges. It identifies several barriers to integration, including regulatory complexities, strategic coordination issues, and insufficient collaboration between public and private stakeholders.

In the Considering CCAM in SUMP Implementation chapter, the report emphasises the importance of understanding local contexts and adapting frameworks for the large-scale deployment of new mobility services. It highlights the need for innovative procurement methods to support technological advancements and discusses the integration of CCAM within public transport systems.

The Conclusions chapter summarises the key findings and provides recommendations for policymakers and urban planners to support the effective integration of CCAM into SUMPs. This report serves as a crucial resource for understanding the intersection of emerging mobility technologies and sustainable urban planning. By addressing the current challenges and proposing actionable strategies, it aims to facilitate the broader adoption of CCAM within European cities, ultimately contributing to more efficient, sustainable, and connected urban transport systems.

1.2 Intended Audience

This document intends to be public, addressing a diverse audience, including but not limited to policymakers at various levels of governance, urban planners, transportation experts, researchers, and industry stakeholders. It serves as a vital resource for those seeking insights into the integration of CCAM into sustainable urban mobility strategies, driving informed decision-making and fostering collaboration across sectors.

1.3 Interrelations

Overall: D17.4 is the main output of SHOW activity A17.2 'Automation and SUMP assessment, scenarios and DSS (Decision Support System)', which is part of WP17 "Decision support, Guidelines & Recommendations & Roadmap". The deliverable provides a basis for local authorities to work with when investigating why and how to integrate shared CCAM services into their SUMPs, either in the context of the SHOW project (WP12 'Real-life demonstrations') or beyond (SHOW follower sites and more).

Input: Certain insights related to 'Regulatory and operational aspects' (SHOW A3.3) have proven to be relevant also for D17.4 as such aspects are a prerequisite for any type of CCAM deployment on local and/or regional level. Furthermore, SHOW pilot site leaders and follower sites provided relevant input.

Output: D17.4 is aligned with the guidelines and best practices of A13.3 'Societal, employability and equity issues assessment'. D17.4 methodology was conceived in such a way as to also contribute to other work, reflected in D17.2 'Best practices for implementation and application guidelines for Industry, Operators and Cities' and D17.3 'Cities and Authorities decision-making mechanism' to tailor SHOW's Policy Support Tool (PST) according to the needs expressed by the cities. Finally, D17.4 provides a basis for D17.5 'Roadmap towards Connected and Cooperative Automated Vehicles (CCAV) implementation in cities and policy recommendations' (due M56).

External: Stakeholders who are external to the project (especially cities and public transport authorities) working on their urban mobility or logistics plans.

2 Methodological Approach

Drawing upon the expertise of Eurocities, with expert input from the city of Bremen (former EU SUMP Award Winner), this report provides a comprehensive examination of the integration of CCAM into SUMPs within the European context, based on a combination of desk research, workshops insights, and consultation with key stakeholders, we endeavour to provide a comprehensive examination of the integration of CCAM into SUMPs within the European context.

A set of **eight (8) interactive workshops** were organised offering a mix of best practices and applied methodologies, peer-to-peer exchange, scenario development and testing of decision support tools. The content, insights and feedback from the workshops were collected and are presented in **D17.4: CCAV integration in SUMP** goals and objectives and promoted for further take-up.

The first series of workshops focused mainly on the theoretical concept, process, and principles of SUMPs and highlighted examples of cities/regions – both within and outside of the consortium – that developed a comprehensive strategy for integrating CCAM in SUMP/SULPs. Two (2) workshops with the pilot sites partners in SHOW were organised by Bremen to raise awareness of the SUMPs. Workshop#1 took place on 15 June 2022 during the 9th SHOW Demo Board meeting and introduced the topic of CCAM in SUMP. The Workshop#2 took place on 18 October 2022 during the 10th SHOW Demo Board meeting in Madrid, Spain. During the workshops, Bremen collected feedback from the partners through the Mentimeter tool and the results can be found in Appendices I and II.

The second series of workshops took a more hands-on approach, focusing on the impact assessment of CAVs against SUMP goals and objectives, demonstrating for example the updated Policy Support Tool (PST) developed by NTUA and WP10 simulation and future deployment schemes and scenario developments. The PST was developed in the context of the LEVITATE project and was presented in SHOW's **D17.1: First issue of best practices and decision-making mechanisms for different stakeholder groups** [1]. A timeline for the workshops was agreed upon with the cities that are partners – as well as the follower sites emerging from WP12 activities which wished to use the workshops for their replication plans (see Table 1).

Table 1: Eurocitie's timeline of activities planned for A17.2

Meeting	Participants	Date
Presentation of upcoming workshops to participating cities in SHOW (explaining what is needed from them and why)	Eurocities, City of Bremen, City of Helmond, TMB, NTUA, City of Tampere, City of Trikala	17 October 2023
Workshop #1	City of Brno, Eurocities, NTUA	8 December 2023
Workshop #2	City of Helmond, Eurocities, NTUA	23 January 2024
Workshop #3	City of Barcelona/TMB, Eurocities, NTUA	16 February 2024
Workshop #4	City of Tampere, Eurocities, NTUA	19 February 2024
Workshop #5	City of Trikala, Eurocities, NTUA	6 March 2024
Final validation workshop with SHOW and follower cities	Eurocities, NTUA, Bax, City of Aachen, City of Kadikoy, City of Gdansk, City of Tampere	13 June 2024

During these online workshops, city representatives provided feedback on the PST and engaged in an open discussion on CCAM in their SUMP with Eurocities. The results of the workshops, which have fed into this deliverable can be found in **D17.3: Cities and Authorities Decision-making Mechanism** [2]. After this, a final workshop was organised to discuss the findings with interested city representatives (among the SHOW and follower sites).

Work in A17.2 was aligned with **A13.3: Societal, employability, and equity issues assessment** and uses the data provided to draw the wider context to SUMPs. A series of interviews were conducted with the pilot representatives to gather input from the sites on their perspective of the integration of CCAM in SUMPs to complement the city's vision from the workshops (see Table 2).

Table 2: SUMP-related questions asked during WP13 pilot site interviews

SUMP-related questions to pilot sites	Options
Pilot site	Open-ended question
Interviewee profile and organisation	Open-ended question
Can you share the local SUMP of your city here (official link):	Open-ended question
Does your local administration consider CCAM innovation as part of their local climate plans/SUMPs?	• Yes • No • Don't know
If yes; how do you expect CCAM to contribute to achieve the climate objectives? (Can select several)	• Ensure all citizens are offered transport options that enable access to key destinations and services; • Improve safety and security; • Reduce air and noise pollution, greenhouse gas emissions and energy consumption; • Improve the efficiency and cost-effectiveness of the transportation of persons and goods; • Contribute to enhancing the attractiveness and quality of the urban environment and urban design for the benefits of citizens, the economy and society as a whole
Is there any regional or national legislation on CCAM?	Open-ended question
What type of obstacles have you encountered in implementing the pilot in your city? (Regarding SUMP or city regulations)	Open-ended question
Is there a policy or a regulation currently stopping the pilot from scaling up?	Open-ended question
Does the city government have the will to implement the necessary policies to scale up CCAM deployment (implement bigger operations, bigger region…)?	Open-ended question
How and to what extent is your organisation involved in decision-making processes linked to transport & CCAM?	Open-ended question
Which stakeholders do you think should be involved in the planning/inclusion of CCAM in SUMPs (you can tick as many as you think)?	• City • Regional/National government • EU

SUMP-related questions to pilot sites	Options
	• Public Transport operators • Private Transport operators • Citizens, CCAM users • Citizens, not CCAM users • Researchers, academic community • CCAM industry manufacturers
In which form have the previous groups been involved during the planning process of your pilot?	Open-ended question

The inputs gathered via this methodology feed into the main analysis below.

3 Definition of SUMPs

3.1 Relevance of SUMP

The concept of SUMP was introduced in the 2013 Urban Mobility Package to deal with new approaches to urban mobility planning and support the transition to cleaner and more sustainable transport modes [3]. A SUMP differs from traditional transport planning in the sense that it spotlights the involvement of citizens and stakeholders, coordination of policies between sectors, and broad cooperation across different layers of government and private players [4]. For the moment, implementing a SUMP is not a strictly defined process that requires ticking boxes but could be defined as a long-term comprehensive mobility strategy to reach climate objectives.

The Trans-European Network for Transport (TEN-T) Regulation was revised in 2023 and included an obligation for 424 cities on the network to adopt a SUMP and collect the relevant data [5]. These plans hold paramount importance for city administrations across Europe today for several compelling reasons:

In the face of escalating climate change concerns and air pollution challenges, SUMPs offer a strategic framework for **reducing greenhouse gas emissions** and promoting cleaner forms of transportation [6]. By prioritizing sustainable modes such as walking, cycling, and public transit, SUMPs contribute to mitigating environmental degradation and fostering healthier urban environments.

SUMPs play a pivotal role in **promoting public health and well-being** by facilitating active transportation options and reducing reliance on private vehicles [7]. By creating pedestrian-friendly streets, enhancing cycling infrastructure, and improving access to public transit, SUMPs encourage physical activity, reduce traffic congestion, and mitigate the adverse health effects associated with sedentary lifestyles and air pollution.

With urbanization trends leading to increased vehicular traffic and congestion, SUMPs offer a strategic approach to **managing mobility challenges effectively** [8]. By prioritizing sustainable modes of transportation and implementing measures such as congestion pricing, car-sharing schemes, and efficient public transit networks, SUMPs alleviate traffic congestion, enhance mobility, and improve the overall quality of life for urban residents.

SUMPs contribute to **enhancing the economic viability of cities** by promoting efficient and cost-effective transportation solutions [8]. By reducing the reliance on private vehicles and encouraging modal shifts towards public transit, walking, and cycling, SUMPs help optimise infrastructure investments, minimise transport-related expenditures, and enhance overall economic competitiveness.

SUMPs **foster social equity and inclusivity** by ensuring equitable access to transportation options for all segments of society, including vulnerable populations such as the elderly, disabled individuals, and low-income communities [8]. By prioritizing accessibility, affordability, and

inclusivity in transportation planning, SUMPs promote social cohesion, enhance mobility options, and reduce disparities in access to essential services and opportunities.

SUMPs provide a coherent and integrated framework for **aligning transportation policies** with broader urban planning objectives, including land use, economic development, and environmental sustainability [9]. By fostering collaboration across diverse stakeholders and sectors, SUMPs enable synergies between transportation planning, urban design, and environmental management, promoting holistic and sustainable urban development.

3.2 Why include CCAM in local planning

As highlighted in SHOW *D3.3: Recommendations for Adapting Regulatory and Operational Strategies for CCAV deployment at Local and Regional Level*, the local CCAM vision needs to consider the long-term goals and indicators outlined in the SUMPs [10]. By aligning CCAM deployment with SUMPs, cities can prioritise initiatives that enhance accessibility, reduce congestion, minimise environmental impact, and improve the overall quality of life for residents. Additionally, coordinating CCAM deployment with SUMPs enables cities to leverage existing infrastructure, resources, and policy frameworks effectively, fostering a more cohesive and integrated approach to urban transportation planning and implementation.

3.2.1 Bremen's take on the SUMP methodology

During the first workshop described in Section 2 above, the City of Bremen presented the various elements that city authorities need to consider to effectively include CCAM in their SUMP. By following the SUMP methodology from the cycle, Bremen developed a mobility plan that is forward-looking, sustainable and well-integrated with the city's overall vision for urban development. This approach has positioned Bremen as a leader in sustainable urban mobility, with a strong focus on innovation and community involvement.

Not only can local authorities increase urban sprawl if they do not prepare and plan accordingly (with the development of new technologies), but there can also be a modal shift away from public transport (PT) and increased congestion [11]. To avoid this, 12 steps could be taken into account – ranging from setting up working structures to reviewing and drawing learning lessons from the implementation – to avoid these risks (see Figure 1).

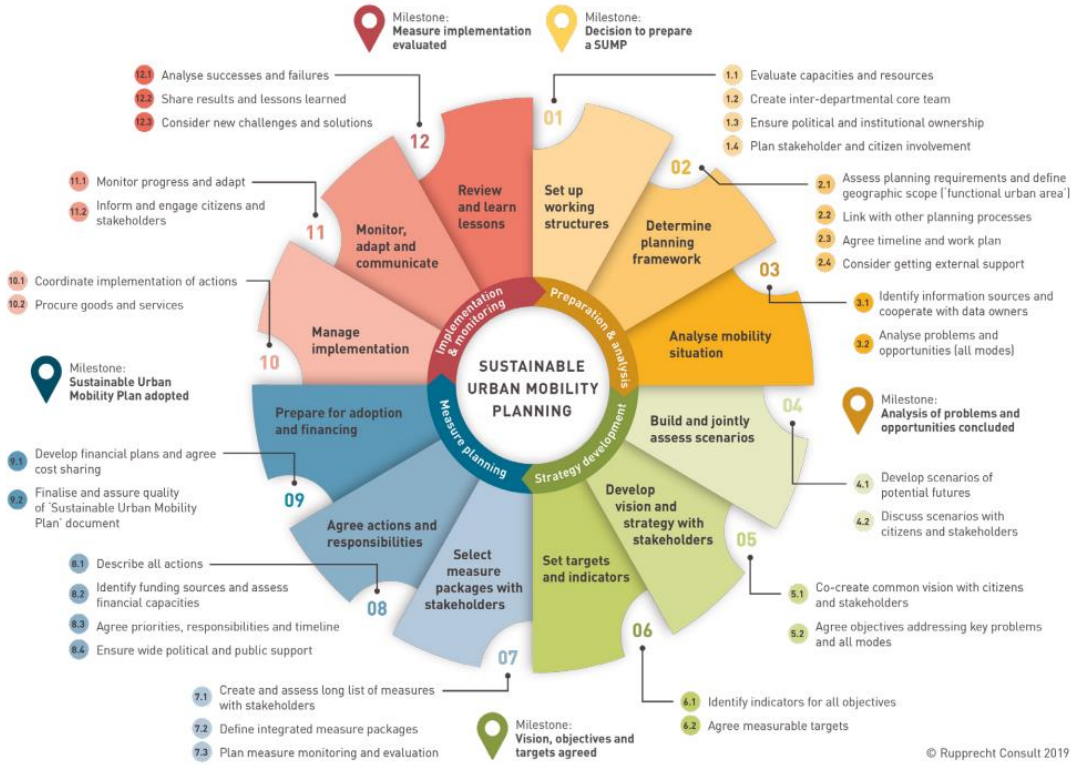

Figure 1: The Sump 2.0 Cycle ©Rupprecht Consult

Nevertheless, it is worth noting that there is no 'one-size-fits-all' for preparing and implementing SUMP and this cycle represents merely a guidance for local authorities and has to take into account local contexts. This report builds on the existing work of SUMP to add lessons learned and new considerations for sustainable urban mobility planning from the experiences of the pilots in SHOW.

3.2.2 Tampere's integration of automated mobility into their mobility plan

The aspect of integrating automation in SUMP is also the first application guideline for cities originating from D17.2, which is based on the model adopted in Tampere (Finland) [1]. The city developed a set of actions to address different focus areas including the development of an automated feeder service as part of the PT network. By including this, the city recognises that automation could help the city address the goal of low-carbon mobility by 2030. The plan also lays down the basis of equality of mobility in Tampere and represents guidance for any deployment of new mobility services (Figure 2).

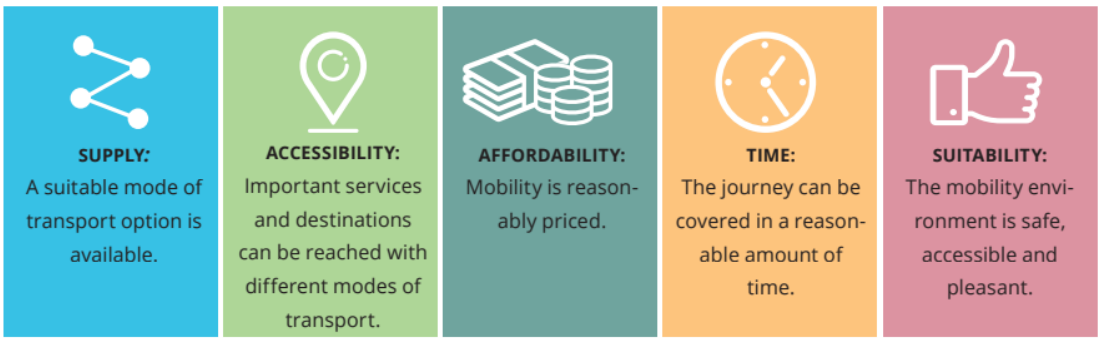

Figure 2: Equality of mobility in Tampere's SUMP [12]

The implementation of automated mobility services integrated with the existing PT system in Tampere took place in the context of the SHOW project. The pilot addresses, among other things, the equality of mobility factors in the SUMP as its goal is to provide proper automated feeder transport services to the light rail/tram for all citizens, including users with special needs, and to promote the use of PT. A few recommendations from SHOW to the local authority are to:

- Strengthen the integrated PT services with fluent feeder services;
- Provide attractive services that will attract car users to voluntarily start using PT and reduce the number of vehicles in the city centre;
- Establish economically and technologically viable services that will create a market boost for AVs;
- Develop strategic and fruitful public-private-partnerships (PPPs);
- Reduce pollution and congestion by deploying only electric vehicles for shared automated mobility.

Not only does this aim to help the city reach its climate objectives, but it is also able to provide continuity to the CCAM pilot beyond the SHOW project. Indeed, the city administration is ready to deploy the current service wider, once the pilot proves to be technically and economically viable; however, this will be done in different and often challenging conditions.

By delineating the key components and objectives of SUMPs, SHOW establishes a framework for understanding their relevance and significance in the context of CCAM integration.

4 Integration of CCAM in SUMP

4.1 Status of CCAM in SUMP

During the second workshop organised by the City of Bremen, the SHOW pilot site representatives strongly agreed with planning for sustainable mobility in the functional city and assessing current and future performance as reasons that explain how the SUMP principles are considered in their pilot sites (see Appendix II). While all cities from the pilot sites in SHOW have a sustainable mobility plan in place, very few already considered CCAM (see Table 3).

Table 3: Status of CCAM in SUMP of SHOW pilot sites

Country	Pilot Site in SHOW	City has a SUMP	CCAM integrated in SUMP
Sweden	Linkoping	Yes	Yes[1]
Sweden	Gothenburg	Yes	Yes[2]
Germany	Frankfurt	Yes	Yes[3]
Germany	Monheim	Yes	Yes[4]
Germany	Karlsruhe	Yes	No
Austria	Graz	Yes	No
Austria	Salzburg	Yes	No
Austria	Carinthia	Yes	No
Spain	Madrid	Yes	Yes[5]
France	Les Mureaux	Yes	No
France	Crest-Val-de-Drôme	Yes	No
Finland	Tampere	Yes	Yes[6]
Italy	Turin	Yes	No
Greece	Trikala	Yes	No
Czech Republic	Brno	Yes	No

Only Linkoping, Gothenburg, Frankfurt, Monheim, Madrid, and Tampere have integrated automated mobility solutions into their SUMP or local climate objectives. For instance, the regional authority of Frankfurt (FrankfurtRheinMain) includes CCAM in its SUMP to ensure that the benefits of digitalisation are fully harnessed to create a more efficient, safe, and sustainable transportation system. Some of the SUMPs, such as in Trikala, do not have automated mobility integrated into their plans but do

[1] City of Linköping (2024). Ride the Future [webpage]. Retrieved online from: https://www.linkoping.se/kommun-och-politik/hallbara-linkoping/ekologisk-hallbarhet/mobilitet-och-hallbara-transporter/hallbart-resande/ride-the-future/

[2] City of Gothenburg. Urban Mobility, transport and infrastructure [webpage]. Retrieved online from: https://goteborg.se/wps/portal/enhetssida/gothenburg-european-office/focus-areas/geourban-mobility-transport-and-infrastructure

[3] Regional Authority FrankfurtRheinMain (2020). A Sustainable Urban Mobility Plan (SUMP) for the Region. Retrieved online from: https://www.region-frankfurt.de/media/custom/3255_1406_1.PDF?1618303533

[4] Monheim Am Rhein. Local public transport [webpage]. Retrieved online from: https://www.monheim.de/stadtleben-aktuelles/stadtprofil/oeffentlicher-personennahverkehr

[5] City of Madrid (2022). Plan de Movilidad Sostenible Madrid 360: Boletin Oficial del Ayuntamiento de Madrid. Retrieved online from: https://sede.madrid.es/csvfiles/UnidadesDescentralizadas/UDCBOAM/Contenidos/Boletin/2022/Anexos%202022/3.1.%20Anexo%20Madrid%20360%20BOAM_.pdf

[6] City of Tampere (2021). Sustainable Urban Mobility Plan SUMP, available at: https://www.tampere.fi/sites/default/files/2022-05/SUMP_taitto2021_englanti.p%C3%A4ivitetty.pdf

incorporate digitalisation and other parts of CCAM – including Mobility as a Service (MaaS), on-demand mobility, or smart infrastructure.

The partners leading the pilots are different types of stakeholders and have had different roles regarding their involvement in their local or regional SUMPs. CCAM can contribute to achieving climate objectives in various ways [13]. The main objectives of SUMPs were presented to the 12 pilot site leaders, and they were asked how they expected CCAM to contribute to achieving the climate objectives of their cities. Some factors were more commonly noted by pilot representatives than others in the following figure.

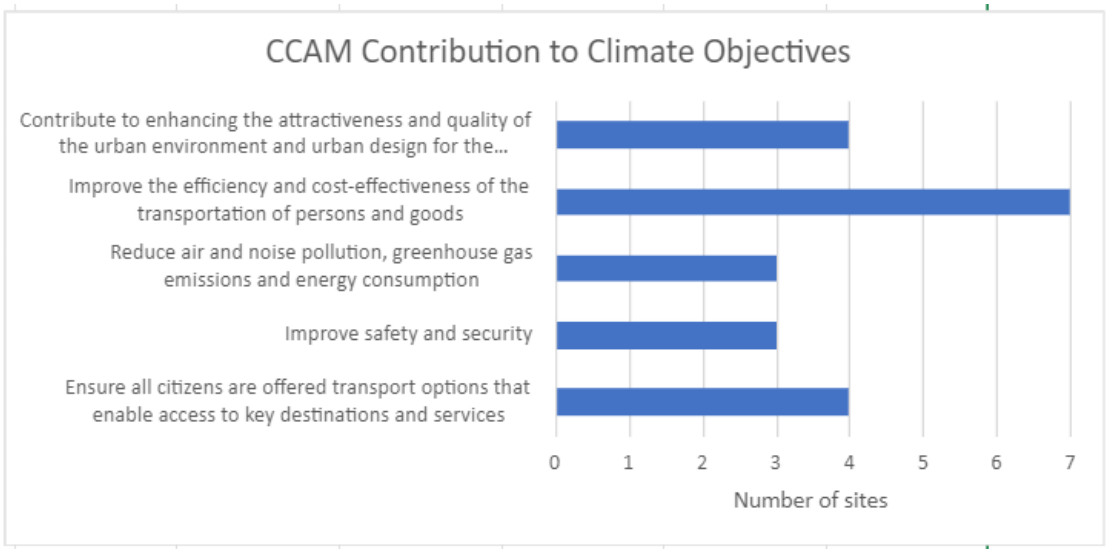

Figure 3: CCAM contribution to SUMP objectives

SHOW partners generally agreed that CCAM contributes most to SUMP objectives by improving the efficiency and cost-effectiveness of passenger and freight transport.

There was less consensus on the other four objectives, as the specific impact of CCAM on these aspects is not always clear. For example, a reduction in air pollution could be achieved because CAVs are usually electric, not because it is automated. However, others argue that by improving transport efficiency, air pollution will be reduced too.

Similarly, the offer of transport options, such as the introduction of new routes will improve the offer of PT and its accessibility, regardless the service is automated or not. However, in the future, as technology becomes more affordable, it could potentially address this issue on a broader scale.

Impact on safety and security will depend on the development of the technology, but as it stands today, it is not considered to be one of the main factors that CCAM is addressing.

4.2 Why is CCAM not included in SUMP

Generally speaking, the partners involved in SHOW responded that continuity and availability of AV technology are the main challenges when moving from the initial demonstration of CCAM to their integration in SUMP (see Appendix II). Automated mobility in Europe faces hurdles due to inconsistent regulatory frameworks, inadequate infrastructure, and complex urban environments.

4.2.1 Strategic Coordination

Strategic coordination involves bringing together various stakeholders, including governmental agencies, public transit operators, private sector partners, community organizations, and residents, to collaborate effectively in addressing complex urban challenges and optimising outcomes [14]. Drawing from SHOW, it is apparent that several coordination issues commonly contribute to the lack of integration of CCAM into SUMPs.

Lack/low investments from local authorities in strategic infrastructures: Electric AVs require a robust network of charging stations, but many local authorities have not invested enough in this infrastructure, leading to gaps in coverage. High-definition maps, essential for safe and efficient navigation, also require significant investment and constant updates. Many cities lack the resources or strategic foresight to create and maintain these maps. Consequently, the seamless operation of CCAM is hindered by insufficient infrastructure investment.

Pilots in cities are not taking place on a larger scale: Many pilot programs for CCAM are conducted on a very small scale, often limited to a few vehicles and a small geographic area (i.e., automated shuttles on a fixed route in a single neighbourhood). While these small-scale pilots are valuable for initial testing, cities cannot assess the full impact of CCAM on traffic flow, parking, public transit integration, and urban planning. For instance, how AVs interact with existing PT systems, cyclists, and pedestrians can only be adequately understood through extensive real-world testing.

Future traffic priorities are not considered in the way cities build the infrastructure: Cities often plan and build infrastructure without considering how new mobility services, such as CCAM, might interact with it. This includes traditional projects like road widening, which may overlook the efficiency of provisional dedicated lanes and the need for additional/more elaborate road markings and signals. CCAM can require smart infrastructure, including connected traffic lights, smart signage, and dedicated lanes. Investing solely in conventional infrastructure can hinder the integration of these advanced technologies, creating barriers to future mobility solutions.

The stage of assessing the needs of the city before adopting automated solutions is frequently omitted: Before adopting any kind of new mobility services, conducting a thorough needs assessment is crucial to understand the city's unique challenges and requirements. Skipping this step can result in solutions that are inefficient and face public pushback. Without a detailed assessment, cities may implement one-size-fits-all solutions that don't address specific local issues. For instance, deploying AVs in areas with low demand or a preference for biking or walking can waste resources and have a limited impact on urban mobility goals.

Lack of specific goals and difficulties in committing to them: Clear, specific goals are essential for successfully integrating autonomous vehicles into urban mobility plans. Many cities lack these goals, making it

hard to measure progress and allocate resources effectively. Even when goals are set, cities often struggle to commit to them due to political changes, budget constraints, or competing priorities. For example, a new administration might deprioritise or defund CCAM initiatives, leading to inconsistent progress and missed opportunities for integration.

4.2.2 Regulatory and Funding Landscape

Having a regulatory overview plays a critical role in ensuring that various actors, including public agencies, private sector entities, and individuals, adhere to prescribed rules and requirements aimed at promoting safety, equity, sustainability, and efficiency in urban mobility. Based on the workshops and desk research, common regulatory and funding oversights can explain why CCAM is not integrated into SUMPs at the moment.

Bureaucracy in public administrations slows down decision-making processes and creates regulatory barriers to CCAM deployment [4]. In general, very bureaucratic structures tend to lack flexibility and responsiveness to emerging technologies – further delaying the integration of CCAM into SUMP. Many pilots in SHOW have suffered from delays concerning permit granting and found themselves unable to start their testing in real life (i.e. Turin).

Despite the availability of funding for innovation in automated transport, **many cities struggle to invest in the necessary expertise and resources** to support the integration of CCAM into their SUMP [6]. This struggle can be explained, among other things, by cities being overlooked in EU-funded projects and they cannot invest in experts, application processes being too complex and time-consuming for city authorities, limited awareness in the administration about SUMP, etc.

The **heterogeneity of frameworks for testing AVs** in Europe, along with unclear delineation of responsibilities among different authorities, can contribute to the exclusion of CCAM from SUMPs [15]. Some of the regulations that are holding cities back from scaling up include the prohibition of teleoperation on public roads, additional/lower speed limits for vehicles used in pilots (beyond the speed limits in urban areas) on certain roads, lack of approval processes for retrofitted AV vehicles, or infrastructure barriers such as a lack of electric charging stations. Although local governments generally support shared AVs, budget constraints, lack of resources due to unforeseen events (i.e., COVID, war, energy crisis, etc.), and slow technological progress remain major obstacles. Some cities, particularly in France, have reduced their AV projects due to unmet legal and technological expectations, while others, like those in Germany and Norway, continue to advance.

4.2.3 Collaboration between public and private stakeholders

Deploying successful pilots for CCAM is not only about following rules and procedures coming from the EU and national levels, but also about fostering relationships with other regions and cities, private parties, and public stakeholders.

A SUMP creates better conditions to promote the use of innovative public procurement methods for new mobility solutions [4]. **Current tenders often miss the opportunity to foster innovation and adapt to technological changes** – to address complex urban challenges and support sustainability goals. SHOW partners have been sharing the need to have innovative procurements since the beginning of the project and this desire has been shared during the workshops (see Appendix II).

Without strong relationships and effective collaboration, **cities struggle to pool resources, share knowledge and expertise, and implement CCAM initiatives efficiently and cost-effectively**. Establishing relevant ties with private stakeholders plays a pivotal role in developing and implementing relevant SUMPs by sharing best practices and lessons learned from private organisations [16]. The private sector not only can provide the technology and operational expertise but can also initiate pilots by conducting feasibility studies or securing funding. This can help local administrations avoid pitfalls and accelerate the development and implementation of CCAM solutions.

An exploration of the status of CCAM integration within SUMPs provides valuable insights into the progress, challenges, and opportunities associated with this endeavour. Through an analysis of ongoing initiatives and pilot projects, SHOW sheds light on the pathways toward achieving seamless integration and sustainable urban mobility.

5 Including CCAM in SUMP Implementation

Exploring the status of CCAM integration within SUMPs has provided valuable insights into challenges inherent in real-world urban mobility contexts, as described in the previous chapter. Based on the results of the second SHOW workshop on SUMP, whereby cities identified which experiences they considered implementable (see Appendix II), we propose the following pathways forward toward achieving seamless integration of CCAM in sustainable urban mobility planning:

Understanding local needs

Adapting testing framework for large-scale deployment

Integration of CCAM in public transport

This approach was chosen as aspects of CCAM should be gradually integrated into local planning. Cities need to first provide an environment that can host AVs before addressing the deployment of new mobility services. The following subsection discusses the vision of these three stages to consider integrating into a SUMP, picked up from the workshop.

5.1 Understanding local needs

5.1.1 Prioritise a collaborative governance

End-user and stakeholder engagement is crucial for cities integrating CCAM into their SUMP because it leads to more inclusive and effective solutions. By engaging citizens, businesses, and policymakers in the planning process, cities can tap into local knowledge and ensure that CCAM strategies meet the specific needs of their communities. This approach fosters ownership and collaboration, driving greater acceptance and long-term engagement in implementing CCAM initiatives for urban mobility. In the context of SHOW, local demo boards were systematically established in each pilot site to facilitate the pre-demo and public phases of the trials. Furthermore, A9.3: Users engagement and co-creation initiatives as a horizontal task within SHOW focused specifically on aspects related to user and stakeholder engagement and co-creation, whereby all SHOW pilot sites were called upon to create their customised engagement strategies and activities [17].

For instance, the stakeholders involved in the local ecosystem in Linkoping (Sweden) met weekly during the preparation phase to raise day-to-day questions and make decisions [18]. The participants in the local ecosystem can be found in Table 4.

Table 4: Local ecosystem in Linkoping pilot site in SHOW [18]

Participating Entity	Role
VTI	Site leader and responsible for the evaluation. Financial support of the shuttles, acting as a depot, providing the workshop for service and installations. Owner of 1 shuttle.

Participating Entity	Role
Transdev Sweden	PT operator. Responsible for the daily operation of 8 shuttle safety operators. Financial support of the shuttles. Management and support for the daily operation. Owner of 2 shuttles.
Östgöta trafiken AB	PT provider. Responsible for the connection to PT. Financial support of the shuttles.
RISE	Responsible for the digital infrastructure and solution including Dashboards, stream of data to DMP, visualisation of maps, rider information, etc.
LiU	Hosting students, one of the key traveller groups also involved in land use issues. Financial support of the shuttles.
Linköping municipality	Owner of the ground in Vallastaden, responsible for communication issues, and infrastructure solutions like bus stops etc. Responsible for the maintenance and service at Vallastaden, Owner of the school and the retirement home with one of the key travelling groups. Financial support of shuttles.
Akademiska hus	Owner of the ground, responsible for maintenance and service at Campus.
Combitech	Responsible for the dashboard and the preparations toward a remote solution.
Linköpings Science park	Responsible for connection to the companies at the technology village.
Veridict AB	Subcontractor to VTI, developing the connection to user applications for booking and visualisation.
EDEVA	Provider of system for accelerations in three dimensions with high sampling frequency.
Webropol AB	Provider of the customer rating of satisfaction and its dashboard.

Moreover, VTI engaged with a broader audience to gather feedback from the local stakeholders and end-users through various events (e.g., children, students, and politicians), as can be seen in Figure 4.

Figure 4: Stakeholder and end-user engagement in Linkoping

Through this collaborative governance, Linkoping successfully launched pilot projects for automated shuttle services in select areas, gradually expanding to cover more

neighbourhoods based on user feedback and performance evaluations. This approach allowed the city to tailor CCAM services to the specific needs of its residents while fostering innovation and collaboration among stakeholders in urban mobility planning and implementation.

5.1.2 Centralise data to measure the impact of CCAM

By centralising public data, local administrations can access comprehensive and accurate information about service usage, travel patterns, and user preferences, enabling them to assess the effectiveness and impact of different mobility interventions and prioritise resources accordingly. This point is highly relevant in a European context where public and private mobility stakeholders are increasingly asked to provide data to the national access points (NAPs) – responding to the requirements of the Intelligent Transport Systems (ITS) Directive and its delegated regulations [19]. Each NAP is put in place to facilitate access, easy exchange, and reuse of transport-related data (see Figure 5).

Figure 5: Overview of National Access Points in Europe [20]

Centralising data necessitates breaking down silos and integrating information from various sources, including transportation departments, urban planning agencies, public transit operators, and private mobility service providers. This requires coordination and collaboration between different local authorities responsible for managing and overseeing different aspects of urban mobility. By fostering a culture of data sharing and collaboration, city administrations can overcome organisational barriers and create a unified data ecosystem that supports evidence-based decision-making and holistic urban planning.

5.1.3 Invest in the right expertise

Skilled professionals are essential for designing, deploying, and maintaining CCAM infrastructure and systems effectively. They play a crucial role in ensuring the safety, reliability, and regulatory compliance of CCAM technologies, navigating complex technical challenges, and fostering innovation and adaptation in the rapidly evolving field of urban mobility. By investing in technical expertise, cities can enhance the integration, interoperability, and sustainability of CCAM initiatives, driving forward the goals of sustainable urban mobility and improving the overall quality of life for residents. For instance, Helmond's investment in hiring technical experts within the administration demonstrates its commitment to building institutional capacity, fostering innovation, and ensuring the long-term success of its sustainable urban mobility initiatives.

In addition to hiring experts, cities should use their SUMP to promote capacity-building tools to ensure that this knowledge is not restrained to one single person in the organisation. Several courses related to CCAM or any new mobility services can be found online and are freely accessible, while others more specific and personalised would be made available for a certain fee. SHOW has developed a series of online trainings targeting different audiences and fit for different levels of CCAM knowledge (see Figure 6).

Figure 6: Promotion of SHOW online training course on automated mobility for the general public @CERTH/HIT

By nurturing a skilled and knowledgeable workforce, the city is better positioned to address complex urban mobility challenges and achieve its vision of creating a more liveable, inclusive, and sustainable urban environment.

5.2 Adapting testing framework for large-scale deployments of new mobility services

5.2.1 Clarify and adjust testing procedures at national, regional, and local levels

Decision-makers should advocate in their SUMP for clear testing procedures of new mobility services at national, regional, and local levels in Europe to ensure safety,

regulatory compliance, and quality assurance. Standardised testing protocols promote interoperability, mitigate risks, and build stakeholder confidence, fostering public acceptance and smoother deployment of innovative mobility solutions. By clarifying and providing transparent testing frameworks, SUMPs create a conducive environment for innovation, investment, and integration of new mobility services such as CCAM within the European regulatory landscape, advancing sustainable urban mobility goals and enhancing the overall quality of transportation systems. Therefore, local authorities must be prepared to leverage national frameworks for the real-life deployment of new mobility services when the opportunity arises. For example, several European cities are currently working on the development and approval of regulatory sandboxes specifically designed to test innovative mobility solutions, such as the Madrid. And others have already used them to explore new ways of making urban transport more efficient, sustainable and adapted to citizens' needs – such as Amsterdam, Helsinki, Hamburg or Vienna – encompassing the entire city and enabling the controlled deployment of CCAM services with real populations [21].

Even if most European countries have a dedicated framework for AVs in regular service, the roles of authorities involved in the approval process at the national level are very different – making it very difficult for service providers to understand what they need to do before testing new solutions [15]. To address this issue, local stakeholders in the Tampere pilot are members of the automated road legislation working group of the Finnish Ministry of Transport and Communications to address the need to harmonise legislation – guiding automated vehicle operations and services. Subsequently, this led to a set of detailed measures (for urban transport and development, data availability, service models and trust, and cooperation and information exchange) intended for stakeholders interested in developing automation in road traffic to serve cities. Addressing this in SUMPs is relevant as unclear regulatory pathways to follow do not only concern CCAM but the wider new mobility services ecosystem.

5.2.2 Provide training to public servants on data usage and GDPR

The public sector must keep pace with rapid technological advancements. Training on data usage and the General Data Protection Regulation (GDPR) helps employees stay informed about the latest developments, ensuring that they can leverage new technologies while remaining compliant with European data protection laws. Educating public servants in city administrations about data usage and GDPR is particularly valuable in supporting local pilot sites for shared CCAM deployment. For instance, cities are increasingly interested in digital twins due to their potential to optimise traffic management in densely populated areas. Training can enhance public servants' ability to contribute to the creation and maintenance of high-definition (HD) maps, which are crucial for the effective implementation of both digital twins and CCAM. Combined with other technologies, such as sensors and satellite data, HD maps deliver precise real-world performance and reliability [22]. These maps need constant updates to include dynamic information that only the city can access, such as roadworks, traffic light data, and congestion data, to provide the best representation of the environment. By understanding data protection and management principles, public servants can ensure the accuracy, security, and privacy of the data used in these HD maps, facilitating smoother and more efficient deployment of innovative mobility services.

5.3 Integration of CCAM in public transport

5.3.1 Adjust/develop the appropriate infrastructure

In navigating the complexities of urban development, cities should adopt a multifaceted approach that meticulously considers both their existing physical and digital infrastructure while simultaneously weighing the necessity for additional development. Urban planners and policymakers must place a premium on the utilisation of current infrastructure assets, including dedicated bus lanes, recognising them as foundational components of a sustainable transportation network [23]. Building upon existing digitalisation initiatives, cities can seamlessly integrate cutting-edge CCAM services, capitalising on previous investments made in Cooperative Intelligent Transport Systems (C-ITS). Even in the absence of complete automation, the functionalities provided by ITS infrastructure have showcased tangible positive impacts across various domains, spanning from enhanced road safety to heightened energy efficiency and more effective traffic management.

Within the realm of digital infrastructure, an abundance of opportunities for automation exists, particularly in the context of shared on-demand CCAM services. For instance, the C-ITS infrastructure used in the SHOW pilot of Carinthia – which was used to enhance the safety of vulnerable road users (VRUs) with V2X technology – will be used afterwards by KMG (PT provider) for public bus prioritisation (see Figure 7).

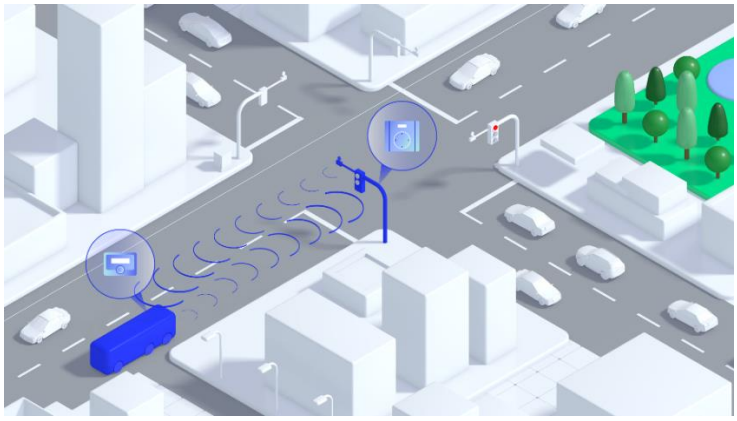

Figure 7: C-ITS solution for public transport prioritisation from YUNEX Traffic for the SHOW pilot in Carinthia

By ensuring that synergies between digital and physical infrastructure are fully taken into account in the SUMPs, cities can not only mitigate risks but also drive efficiency gains, ultimately forging a path toward more sustainable and resilient urban mobility ecosystems.

5.3.2 Implement relevant use cases

On 26 June 2024, the Commission’s subgroup on public transport of the Expert Group for Urban Mobility (EGUM) recognised the role CCAM could have in complementing PT in urban and rural/peri-urban areas [24]. Cities aiming for long-term sustainability should carefully select relevant use cases to incorporate into their SUMPs. CCAM emerges as a potential solution for cities, offering the capability to contribute to achieving climate neutrality. However, it's essential to note that CCAM should not be seen as a substitute for mass transit systems but rather as a complementary feature. Shared CCAM services, particularly those designed to complement PT networks and

utilise existing infrastructure, show promise in this regard. Examples of such integration can be observed in initiatives like the MaaS one in Frankfurt (see Figure 8).

Figure 8: Frankfurt's link of automated shuttles and on-demand software in SHOW © RMV/Christof Mattes

As part of *D17.3: Cities and Authorities decision-making mechanisms*, NTUA updated the Policy Support Tool (PST) developed in the context of the LEVITATE project to provide decision support for CCAM-related interventions [2]. This tool should support city authorities in assessing which use case could help them in achieving their SUMPs. By strategically integrating CCAM into their SUMPs, cities can enhance their overall mobility ecosystem while addressing sustainability goals effectively.

6 Conclusions

The integration of CCAM into SUMPs across Europe, as explored through the SHOW project, reveals a landscape both promising and challenging. While all pilot sites have SUMPs, the degree to which CCAM is incorporated varies significantly. Cities like Linkoping, Gothenburg, Frankfurt, Monheim, and Tampere have successfully embedded CCAM within their mobility strategies, demonstrating the potential benefits of such integration.

One of the primary obstacles to broader CCAM adoption is the lack of strategic infrastructure investments. For CCAM to be effectively integrated into SUMPs, cities need to prioritise and secure investments that support the development and maintenance of advanced mobility systems. This includes not only physical infrastructure, such as roadways and public transport networks, but also digital infrastructure that can support the seamless operation of connected and automated vehicles.

Regulatory complexities also pose a significant challenge. The current regulatory landscape often lacks the flexibility needed to accommodate the rapid pace of technological advancements in CCAM. Cities must navigate a complex web of local, national, and European regulations, which can delay the deployment of CCAM technologies and create uncertainty for stakeholders. To address these challenges, cities need to advocate for clearer and more adaptive regulatory frameworks that can keep pace with innovation.

Furthermore, the integration of CCAM into SUMPs requires robust collaboration between public and private stakeholders. Successful implementation of CCAM technologies hinges on the ability of cities to foster partnerships across sectors. Public authorities, private companies, and research institutions must work together to share knowledge, pool resources, and drive innovation. Without strong partnerships, cities risk missing out on the benefits of CCAM, such as improved safety, reduced congestion, and enhanced accessibility.

To overcome these challenges, cities should adopt a collaborative governance model that prioritises the involvement of all relevant stakeholders. Centralising data for informed decision-making is also crucial. By harnessing data on mobility patterns, infrastructure usage, and environmental impacts, cities can make more informed decisions about where and how to deploy CCAM technologies. Investing in specialised expertise is another key factor in ensuring the successful integration of CCAM into SUMPs. Cities need to build internal capacities or partner with external experts who can guide them through the complex process of CCAM deployment.

Finally, the recommendations provided in this report should be viewed not as generic solutions but as strategic guidelines that can be tailored to the specific needs and contexts of individual cities. Each city’s approach to integrating CCAM into its SUMP will vary based on local conditions, priorities, and capacities. By gradually incorporating elements of CCAM into their mobility plans, cities can create more resilient and sustainable urban transport systems that meet the needs of their residents now and in the future.

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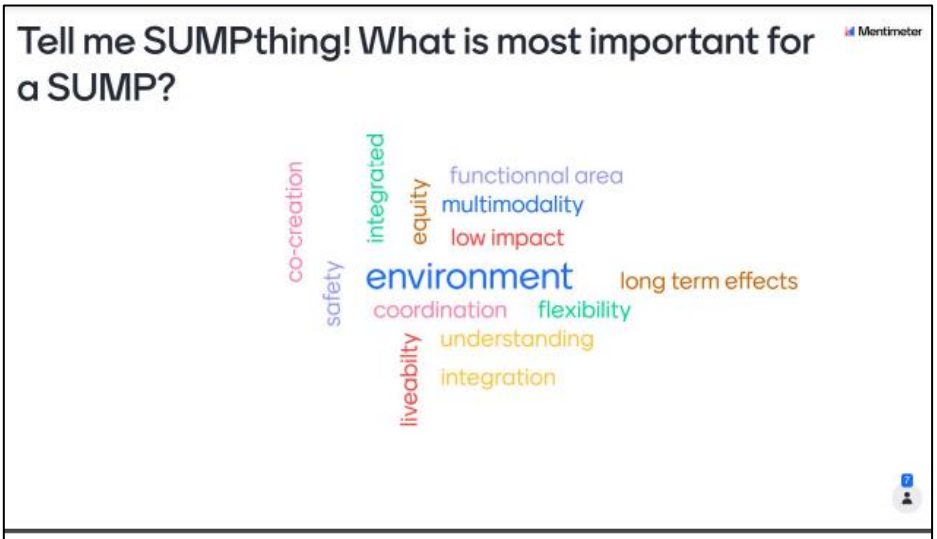
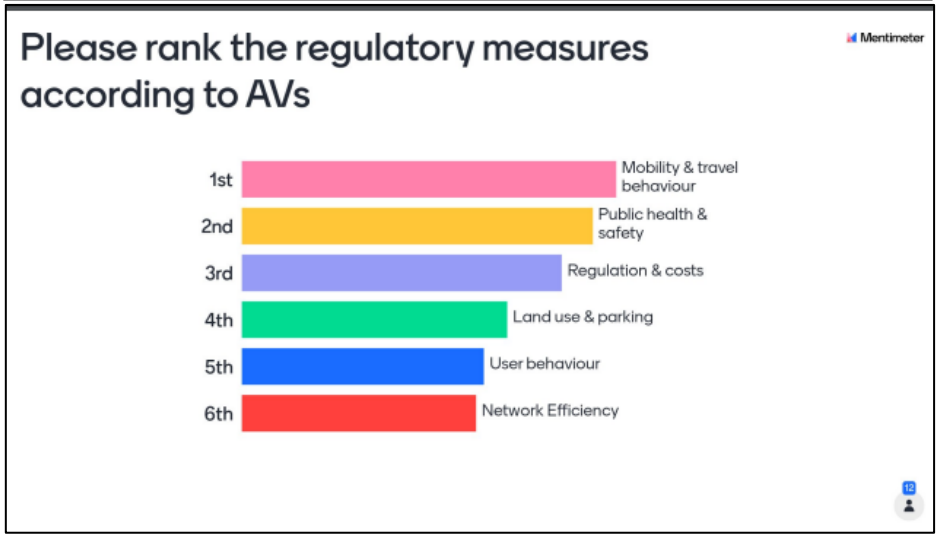
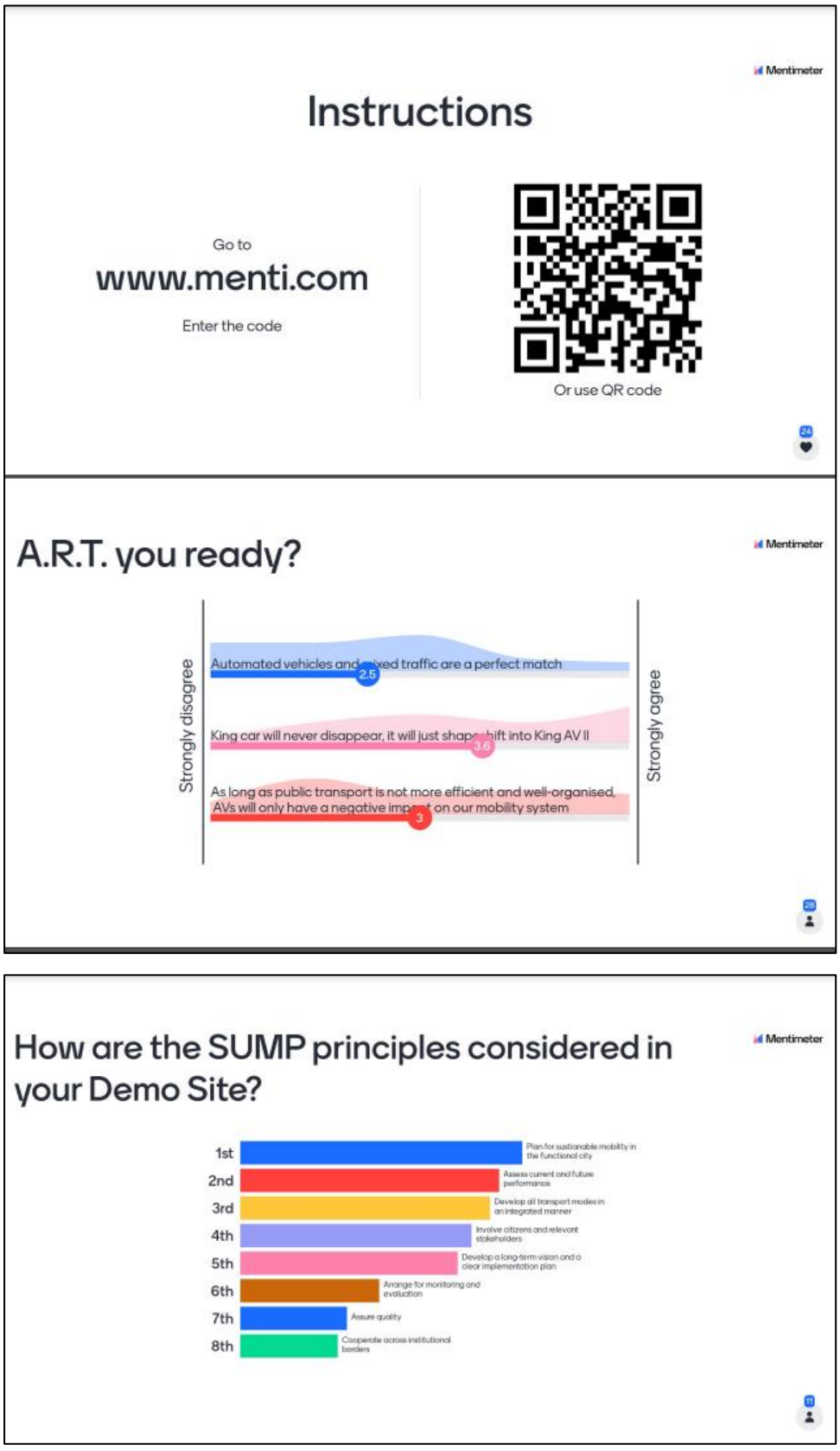
Appendix I: Workshop#1 results



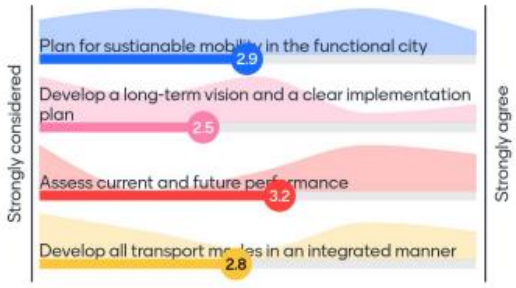


Appendix II: Workshop#2 results



How are the SUMP principles considered in your Demo Site?

Mentimeter



19

How are the SUMP principles considered in your Demo Site?

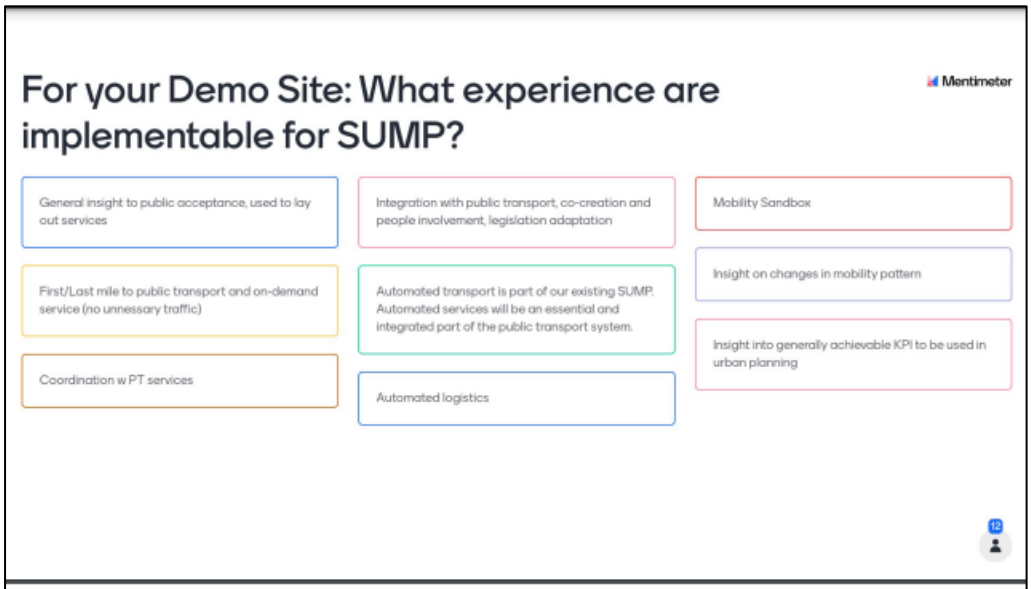
Mentimeter

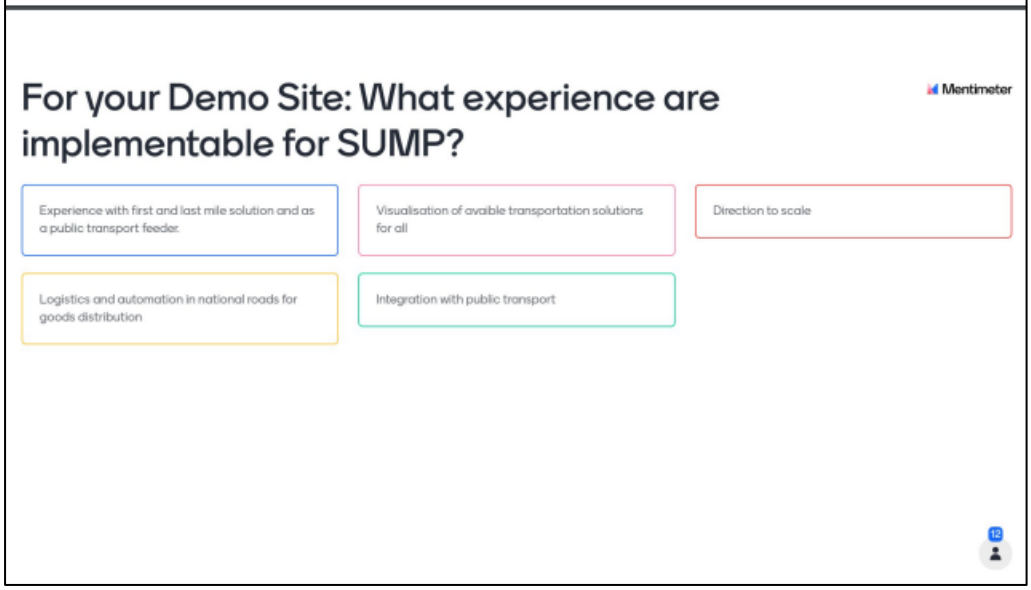
16

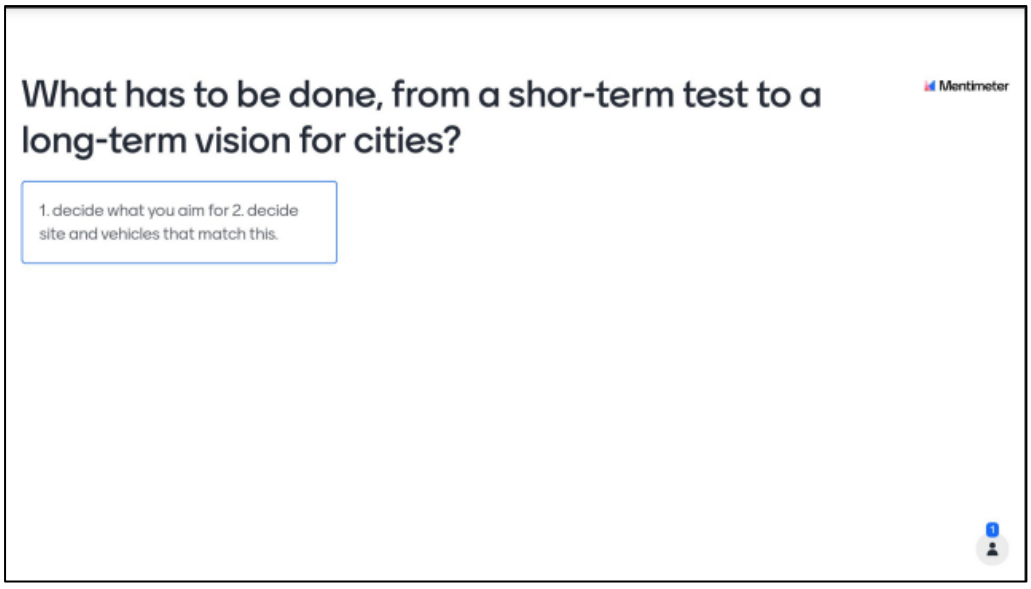
One word: What are the main challenges from Demonstrations to SUMP?

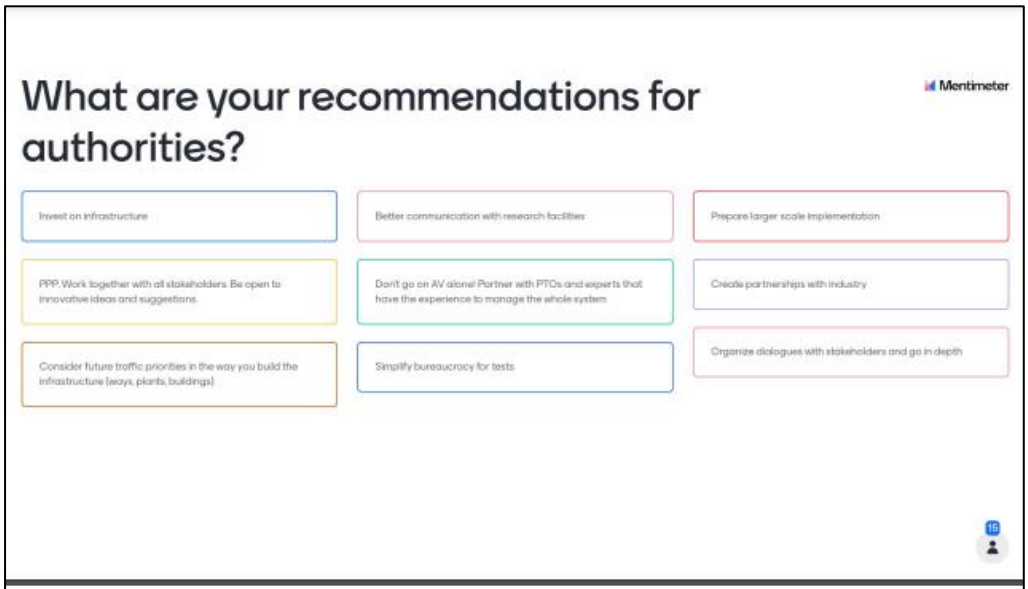
Mentimeter

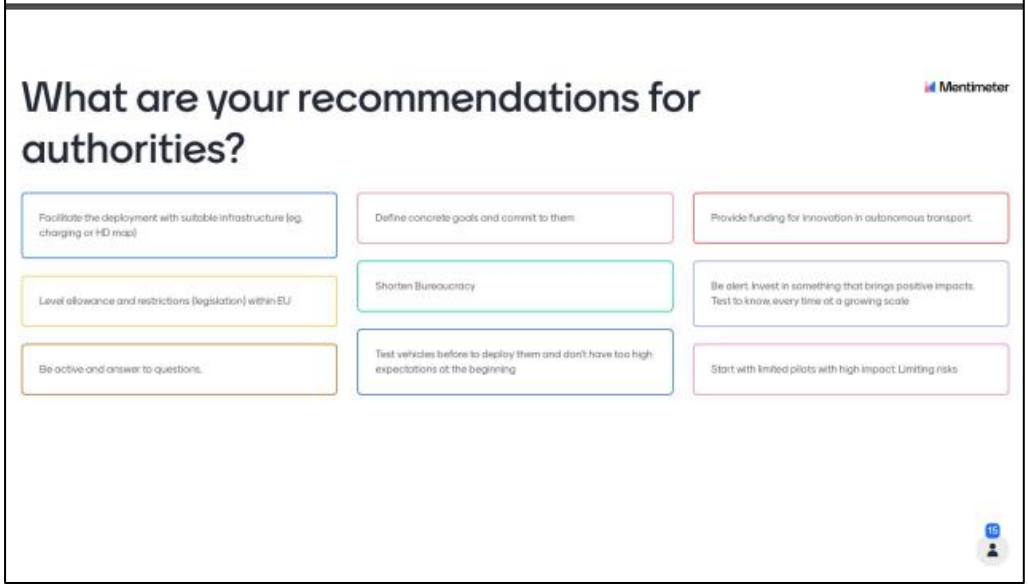
22

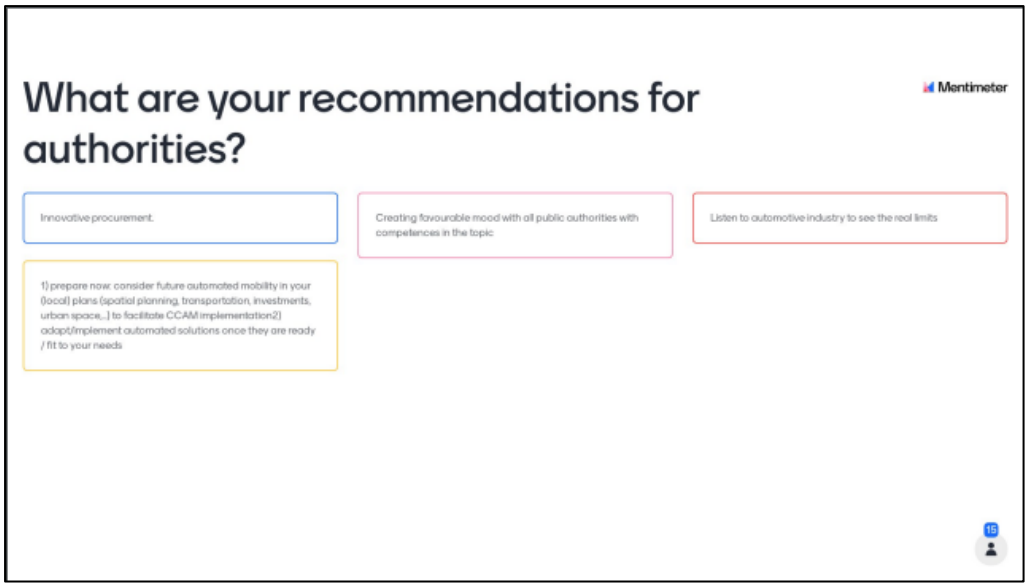

For your Demo Site: What experience are implementable for SUMP?
Mentimeter
General insight to public acceptance, used to lay out services
Integration with public transport, co-creation and people involvement, legislation adaptation
Mobility Sandbox
First/Last mile to public transport and on-demand service (no unnessary traffic)
Automated transport is part of our existing SUMP. Automated services will be an essential and integrated part of the public transport system.
Insight on changes in mobility pattern
Coordination w PT services
Automated logistics
Insight into generally achievable KPI to be used in urban planning
12

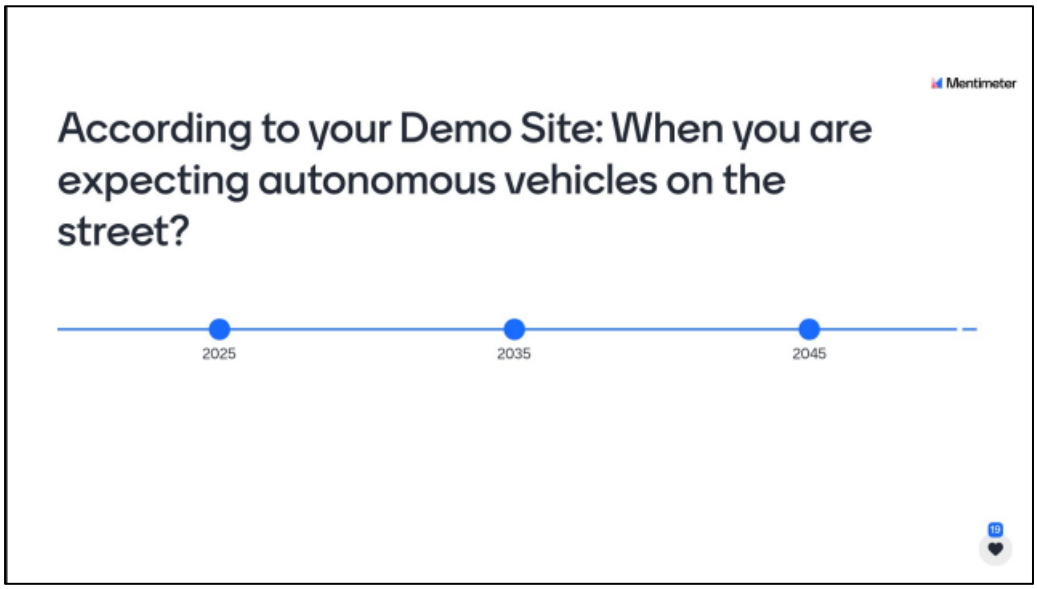

For your Demo Site: What experience are implementable for SUMP?
Mentimeter
Experience with first and last mile solution and as a public transport feeder.
Visualisation of avaible transportation solutions for all
Direction to scale
Logistics and automation in national roads for goods distribution
Integration with public transport
12


What has to be done, from a shor-term test to a long-term vision for cities?
Mentimeter
1. decide what you aim for 2. decide site and vehicles that match this.
1


What are your recommendations for authorities?
Mentimeter
Invest on infrastructure
Better communication with research facilities
Prepare larger scale implementation
PPP. Work together with all stakeholders. Be open to innovative ideas and suggestions.
Don't go on AV alone! Partner with PTOs and experts that have the experience to manage the whole system
Create partnerships with industry
Consider future traffic priorities in the way you build the infrastructure (ways, plants, buildings)
Simplify bureaucracy for tests
Organize dialogues with stakeholders and go in depth
16


What are your recommendations for authorities?
Mentimeter
Facilitate the deployment with suitable infrastructure (eg. charging or HD map)
Define concrete goals and commit to them
Provide funding for innovation in autonomous transport
Level allowance and restrictions (legislation) within EU
Shorten Bureaucracy
Be alert. Invest in something that brings positive impacts. Test to know, every time at a growing scale
Be active and answer to questions.
Test vehicles before to deploy them and don't have too high expectations at the beginning
Start with limited pilots with high impact. Limiting risks
16


What are your recommendations for authorities?
Mentimeter
Innovative procurement.
Creating favourable mood with all public authorities with competences in the topic
Listen to automotive industry to see the real limits
1) prepare now: consider future automated mobility in your (local) plans (spatial planning, transportation, investments, urban space,...) to facilitate CCAM implementation2) adopt/implement automated solutions once they are ready / fit to your needs
16


Mentimeter
According to your Demo Site: When you are expecting autonomous vehicles on the street?
2025
2035
2045
19