CoEXist

D1.2

Automation-ready Framework

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Introduction

1.1 The CoEXist project

The mission of the CoEXist project is to systematically increase the capacity of local authorities and other urban mobility stakeholders to get ready for the transition towards a shared road network with increasing levels of connected and automated vehicles (CAVs), both in terms of vehicle penetration rates and levels of automation (SAE International, 2016) using the same road network as conventional vehicles (CVs).

The overall outcome of the project is to enable local authorities to confidently proclaim that they are "automation-ready". Yet, the concept of "automation-readiness" should not be misunderstood as an endorsement of the disruptive technologies surrounding CAVs and their impacts, but rather an empowerment of local authorities to critically review the anticipated technological changes and shape the future according to their expectations. Hence the concept of "automation-readiness" is defined as:

"*The capability of making structured and informed decisions about the comprehensive deployment of CAVs in a mixed road environment. This capability requires*:

- *A clear awareness of the technology underpinning CAVs, the different functional uses and business models for CAVs and a high-level understanding of the impacts different deployment scenarios can have on traffic, quality of life and stakeholders involved in local transport planning.*
- *The institutional capacity to plan for a future with CAVs by using tools that accurately represent CAV behaviour in order to identify the impacts of different CAV deployment scenarios.*
- *A strategic approach in planning a wide range of measures that will ensure a deployment of CAVs, which supports higher level mobility goals."*

The promises of CAVs to improve traffic and space efficiency, enhance safety and improve mobility for all will only be fulfilled when local authorities have the capability to shape the deployment of CAVs to their needs. Without this capability, CAVs will certainly worsen the urban mobility problems that local authorities are currently facing.

CoEXist has three main outputs that will increase the capability of local authorities to become "automation-ready":

1. Automation-ready transport modelling: A validated extension of existing microscopic traffic flow simulation and macroscopic transport modelling tools that can represent various types of CAV driving logics.
2. Automation-ready road infrastructure: An impact assessment methodology that can assess the impact of CAVs on traffic efficiency, safety and space efficiency and support the development of design recommendations for automation-ready infrastructure.
3. Automation-ready road authorities: The demonstration of the above tools in four European local authorities to develop concrete automation-ready infrastructure and policy actions plans.

The automation-ready framework is the core project deliverable that combines all the different project activities in one comprehensive report.

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1.2 Certainty in uncertain times – the need for an automation-ready framework

After the initial technological euphoria that predicted the deployment of CAVs by the end of the decade, most vehicle manufacturers and transportation network companies had to readjust the dates they are planning to introduce fully automated vehicles that can operate in all or most operational design domains. Some vehicle manufactures have even started questioning whether fully automated vehicles are actually possible and it became widely accepted that automated vehicles will be relying on extensive connected services to even operate in lower levels of automation. The ERTRAC Automated Driving Roadmap[1] provides a comprehensive overview of the different automated functionalities of CAVs and their expected market introduction. The ARCADE project provides an extensive library[2] and knowledge base[3], with the latest developments in the fast-changing field of connected and automated driving. Even though the deployment of CAVs is not as fast as some anticipated, it is clear that more and more vehicles with automated functionalities are being deployment and that enabling technologies, such as 5G and ITS G5, will significantly increase the ability of CAVs to handle more complex operational design domains. The initial fear that cities will be overrun by this technology (luckily) has not materialised, yet, but this is not a justification for local authorities to continue with a "wait and see approach". The time should be wisely used to better prepare for the deployment of CAVs – which will certainly come.

The deployment of CAVs will have significant impacts on most transport and urban planning related activities of a city. The Polis policy paper on "Road Vehicle Automation and Cities and Regions"[4] provides a structured overview of the most pressing potential impacts resulting from the deployment of CAVs. The paper focuses on the potential impacts on road safety, traffic efficiency, infrastructure, socio-economic aspects, travel behaviour and spatial planning. There is a high degree of uncertainty surrounding the exact impacts as nobody, at this stage, can really predict how the technology will be used and whether the positive aspects will outweigh the negative ones. Many local authorities stated not to be prepared to handle CCAM (see Figure 1), lacking capacities and a knowledge base to make informed decisions about its deployment, which results in a dangerous form of inertia. Local authorities need to take a leading role in dealing with the uncertainties in a structured way to break out of this inertia.

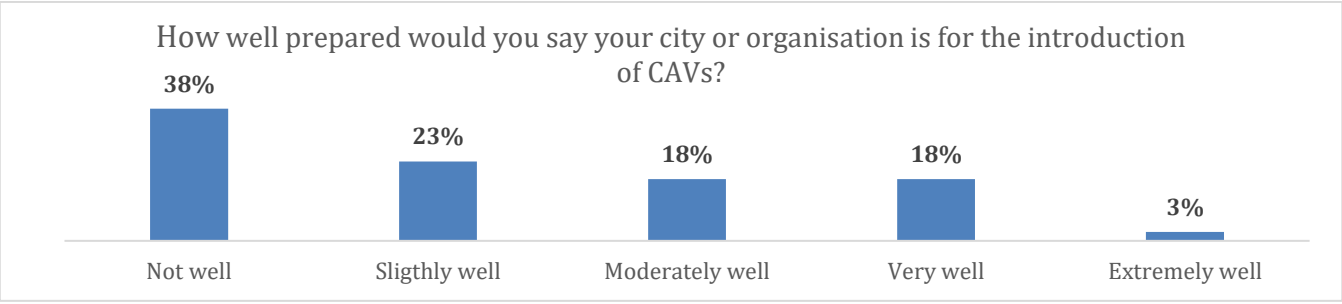

Figure 1: CoEXist Online Automation-Ready Survey (CoEXist, 2019)

[1] ERTRAC (2019) Automated Driving Roadmap
[2] https://connectedautomateddriving.eu/library/
[3] https://knowledge-base.connectedautomateddriving.eu/
[4] Polis (2018) Road Vehicle Automation and Cities and Regions.

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To ensure the roll out of CAVs is in line with sustainable urban mobility goals, local authorities should take the lead with proactive planning approaches. This begins with preparing to address CCAM as early as possible, to minimise the potential negative impacts and more importantly make the most of the opportunity to influence the paradigm shift into a more sustainable urban mobility vision. The UITP Policy Brief on 'Autonomous vehicles: a potential game changer'[5] clearly sets out that cities need to now foster a culture of sharing to avoid single occupancy or empty CAVs in city centres in the future. An uncontrolled deployment of CAVs in cities could lead to conflicts between CAV users and non-users due to opposing transport planning needs of liveable versus CAV-friendly cities.

1.2.1 Mapping out uncertainties

Through a European-wide stakeholder process the CoEXist project conducted an exercise to map out the most common uncertainties that European local authorities currently are facing. The uncertainties can be structured along three main headings:

How to create awareness about CAVs?

- What is a CAV? How does it behave? What functionalities can it offer?
- What do my citizens feel about the technology?
- Which stakeholders need to be consulted?
- How to create awareness within the transport authority?
- How to develop scenarios that represent the potential impacts of CAVs?

How to plan for CAVs?

- How to integrate CAVs into an overall mobility vision?
- How do CAVs align with mobility goals in a city?
- How to integrate CAVs into a strategic transport plan?
- What tools to use to test the scenarios and assess the impact of CAVs?

Implementing automation-ready measures?

- When and how should the organisational structure of my organisation be adjusted?
- When and how to change public transport operations?
- When and how to change the digital and physical infrastructure?

The automation-ready framework aims to reduce these uncertainties through a structured and comprehensive approach.

1.2.2 Planning principles that don't change - even in uncertain times

Even with a lot of uncertainties, the core planning principles should not be changed:

- Good Planning is key: the success of the transition towards higher penetration levels of CAVs will largely be determined by integrating them into existing sustainable urban mobility planning processes (i.e. SUMPs). However, today there are hardly any strategic transport plans in Europe that properly address the technology and the resulting impacts.

[5] UITP (2017) Autonomous vehicles: a potential game changer

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- A participatory approach is key to ensure that CAVs are being deployed to the benefit of all and not the few. Not one single actor is able to find the answers to all these complex issues.
- Shared vehicles are key. High capacity public transport still needs to be the backbone of a functioning transport system. Since privately owned CAVs are expected to lead to an increase in vehicle kilometres travelled, the role of public, collective and shared transport needs to be secured in the advent of automation connected MaaS services. Local authorities are in the position to establish a culture of sharing early.

By reducing uncertainties and sticking to the core planning principles, local authorities can take a leading role again rather than merely being observers of the technological developments. In the frame of the European SUMP Guidelines updating process, CoEXist developed a practitioner briefing on *Road-Vehicle Automation in sustainable urban mobility planning*, specifically looking into the challenges of planning for automated vehicles.

1.3 Objectives of the Automation-ready framework

“The first step is always the hardest” – this widely used proverb illustrates well the situation many local authorities find themselves in. They are unsure about what the first step towards automation-readiness could be and are careful about not making any mistakes. The result is that that many local authorities are doing very little or nothing and are therefore losing precious time to prepare.

Against this background and in view of the stated uncertainties, the objective of the automation-ready framework is as follows:

“*To support local authorities in reducing uncertainties and building up the capability to make structured and informed decisions about the comprehensive deployment of Cooperative Connected and Automated Mobility (CCAM).*”

This will be achieved by presenting a set of measures implemented in three phases, which can guide local authorities in becoming automation-ready.

1.4 Three Phases of Automation-Readiness

The automation-ready framework is organised in three phases, which represent strategic focus areas for urban mobility planning processes. Still, the different stages do not correspond to a time period as different cities may be in a different phase depending on local circumstances. They can be overlapping, parallel and interlinked. The automation-ready framework aims to reduce uncertainty as cities go through each of the phases.

For each phase, a set of measures are recommended to facilitate the reduction of uncertainties and to ensure a smooth transition into the sustainable deployment of CAVs in cities. Also, the technological scope of the framework aims to provide recommendations that are applicable to different European cities, which will experience a wide range of CAV deployment due to unique local circumstances with regard to the mode share between privately, shared or collective CAVs.

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1.4.1 Automation awareness creation

The first phase involves becoming aware of the technological advancements and capabilities of connected and automated vehicles (and the associated features) and understanding the opinions, needs and concerns of the citizens at an early stage. The key here is to develop an awareness of what the deployment of automated vehicles and resulting impacts means from a local authority perspective.

Automation awareness measures are not expensive and do not depend on the technological development. The aim is to be able to make city authorities as well as the citizens aware of the possible changes that can take place within their transport systems and forms of mobility. Measures at this stage are the most certain, as they can already be implemented regardless of the situation a city is facing now. Awareness also gives a hint about the type of policies that need to be developed to protect and ensure the continued support for currently existing sustainable modes (i.e. public transport and active modes) and potential changes in organisational structures.

1.4.2 Planning for automation-readiness

After developing a sense of awareness about the technology, gathering the opinion of citizens and building the required skills for a structured deployment of CAVs, the next stage is for the city to include CAVs in their planning processes. Among others this includes: setting a vision and identifying goals through stakeholder engagement processes and applying a set of tools to assess deployment scenarios. This stage initiates the path to proactive planning by identifying measures that support the integration of new forms of mobility and technology to improve the overall transport planning processes in a city. The city should be able to develop a flexible planning strategy for automation-readiness in order to allow necessary modifications along the process.

1.4.3 Preparing for the implementation of Automation-Ready measures

With a clear strategy defined for CCAM in the city and a good level of knowledge acquired, it is important to consider key steps to prepare for the implementation of concrete measures towards the deployment of CCAM services. The measures introduced within this stage bring many uncertainties as these will highly depend on many complex developments that will take place over the coming years. Hence, it is not recommended to implement measures too prematurely; not before completing the actions of the previous stages. Measures in this stage can only be implemented after conducting detailed planning processes, incl. modelling and impact assessment and conducting several pilots with CAVs.

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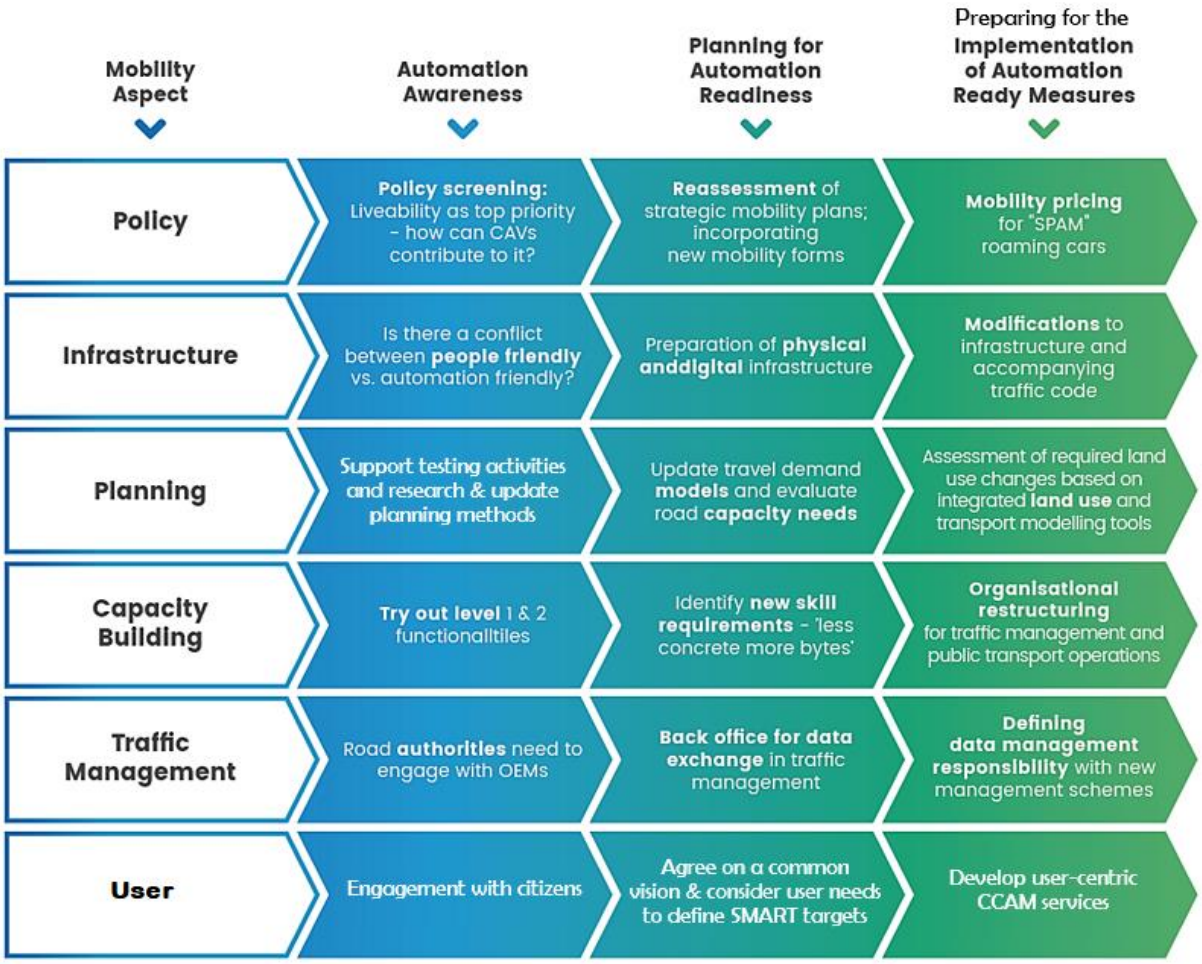

Figure 2: Overview of three phases towards automation-readiness with examples of measures

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2 Automation awareness creation

2.1 Try it out and gain experience

2.1.1 Experience automated driver assistance systems - Rent a Level 2 AV and try out the different ADAS systems that exist today.

Today, automation already exists in some vehicles up to a certain level. Some of these functionalities or advanced driver assistance systems (ADAS) include: adaptive cruise control (ACC), lane keep assist or a congestion chauffeur which automates the driving function during a stop-and-go situation. When new features are launched in a vehicle or any technology, it is difficult to get a grasp of its benefits unless the users try them out first hand. However, often city employees have limited practical experience with modern ADAS systems that are more and more common in mid-range vehicles. They should try it out to learn about these level 1 and 2 functionalities. Thus, renting a Level 2 AV will help understand the potential benefits the technology has to offer to the user in terms of comfort and safety.

For higher levels, pilot site visits could be organised. For example, testing of AV shuttles is taking place in many locations around the globe. Bloomberg Philanthropies provides on their 'AVs in Cities' website[6] an overview of most of the initiatives that are being carried out worldwide. Visiting the pilot sites will give you a feel of the different types of service or a modified version of it that could potentially also work in your city.

Benefits: To better understand and appreciate the benefits brought by the technology and its potential benefits. Engaging in dialogues with cities and organisations that have already conducted pilots is a great way of learning from them and understanding the potential of AV in an urban mobility context, e.g. for transit or first and last mile services.

Challenges: Raising or getting funding for renting AVs and site visits. AVs with higher levels of automation normally require special authorisation before testing.

2.1.2 The dress rehearsal - start your own pilot that you think will fit best into your transport system.

Many cities worldwide who have an edge in mobility look into conducting pilots of different technologies in their cities, e.g. cooperative intelligent transport systems (C-ITS), autonomous shuttles/last mile services such as in the CityMobil2 project[7] as part of the public transport system. Initiatives are increasing globally as most cities see the benefit in upscaling AV technology, which opens up other innovation opportunities.

However, before conducting a pilot, other measures from this early stage should be considered in advance as well. Pilots should be the result of a scenario building process including stakeholder engagement and assessing benefits of pilots. Furthermore, training is needed to ensure safe operations. Among the various lessons learned, CityMobil2 recommends adequate training of the operators of the system. The involvement of the automated road transport system (ARTS) manufacturer is essential to train the

[6] https://avsincities.bloomberg.org/
[7] https://connectedautomateddriving.eu/project/citymobil-2/

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operators and providing maintenance services. Service operations also concern the physical and digital infrastructure, and therefore include road-side sensors, communication networks, management centres, etc. A city should designate a project coordinator who can in turn provide all these systems or subcontract them to specialised providers. However, the designated project coordinator should be responsible to the city for the system operation and its performance.

Benefits: Pilots can demonstrate the practicality of a certain technology within the context of urban mobility. If a pilot project seems to be projecting benefits to the users, it increases the acceptability to integrate AVs into the (public) transport system.

Challenges: Securing funding for the pilots could be a difficult task depending on the economic conditions of the city. Ensure adequate training and maintenance work to avoid lengthy downtimes of the pilot and risk a poor image of the pilot technology.

CityMobil2 Pilot

Pilots in Sardinia, Italy, led by the CityMobil2 project, tested automated vehicles in real-life urban environments. Two driverless buses, carrying up to 12 passengers each, have been piloted on a busy pedestrianised seafront promenade in Oristano. The route was about 1.3 km long and had seven stops. Passengers were allowed to travel for free but had to register first; minors were allowed on board, but only if the registration was signed by an adult. The pilot was organised in partnership with the Municipality of Oristano, the Regional public transport operator ARST, and the transport planning consultancy Company MLAb.

Figure 3: citymobil2.eu

Further Details: *http://www.eltis.org/discover/news/europes-first-driverless-bus-trial-begins-sardinia-italy*

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2.2 Raise awareness and create dialogue

2.2.1 Understanding public perspectives

This is essential to understand the needs of the citizens and to develop plans by involving them in the process. Citizen participation helps to understand the needs of the future users of the system and to cater to them, as this also gives an opportunity for the municipality to understand how mobility services can be improved. And in particular, how can connected and automated vehicles be of help in the future transport systems by improving accessibility and equity of services. Having provided a platform for citizens to be heard increases acceptability and furthermore, the perception of users gives an insight on understanding the possible threats (e.g. reduction in the value of travel time, since it can actually be a productive time and increase comfort of CAV usage) and enhances proactive mitigation strategies (e.g. pricing schemes) by engaging citizens as part of developing a common solution. An example of this is the participatory approach followed by Milton Keynes, through the national public attitude survey conducted by the UK Autodrive project and the Automation-ready Fora held within CoEXist (see case study below).

Benefits: Democratic legitimation of planning for the introduction of AVs. Early warning procedure to integrate both user needs and threats in automation-ready planning.

Challenges: Formulation of a survey and communication of results in a comprehensible manner in order to bring such a complex and technological topic across to the general public.

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Involving Citizens

A key to developing novel solutions to tackle mobility challenges in cities is to gain the acceptance of the general public. Hence, involvement of citizens is vital to enhance take up. A good practice example is the UK Autodrive project's public attitudes survey. As part of the project, the University of Cambridge carried out a national survey of public attitudes towards self-driving vehicles (SDVs). The survey was conducted in October-November 2016, comprising 49 questions, and gathered 3000 responses. The results of this survey were used as basis for a deeper exploration of public attitudes through local focus groups.

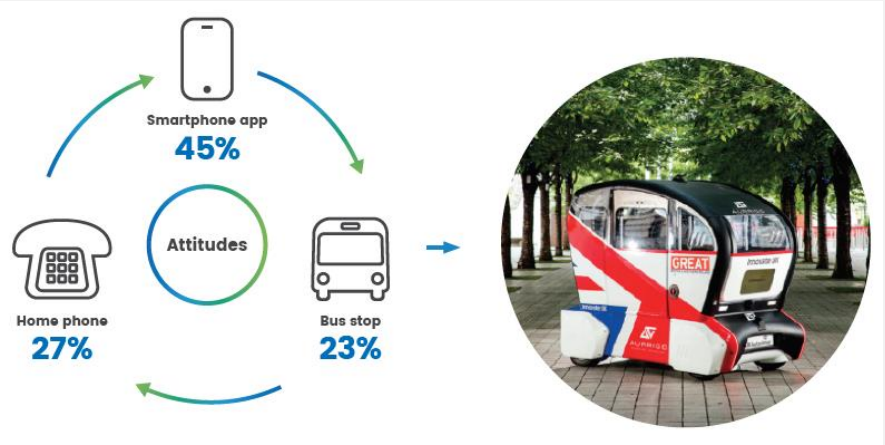

Figure 4: Preferred means of booking to access shared public transport systems

CoEXist Automation-ready Fora in Milton Keynes

Reflecting on the excellent work produced by the UK Autodrive project, and recognising the potential shortcomings helped define the approach, Milton Keynes took to engaging with stakeholder for the CoExist programme. The city identified opportunity to further inform citizens, providing targeted information and clearer explanations on the potential benefits and risks from this innovative technology. A series of workshops were designed to target specific groups who would be critical to the development of future CCAM initiatives, especially for the transition phase. This meant working with: younger people – those approaching adulthood and to using independently, transport systems; and older and disabled group - with specific transport and mobility needs.

Three events were undertaken, using different formats designed to maximise meaningful engagement and interaction with the very different target audiences.

- Elderly and disabled citizens participated in a storytelling workshop aimed to develop their response to the information provided and demonstrations, where they had the opportunity to ride an AV (POD operating in Milton Keynes). The workshop focused on developing a narrative based on a 'quest' which sought to unpick people's feelings, before, during and after their trial journey, guided by a professional facilitator to engage the topic in a non-technical way.
- Aiming to evaluate the changes in perspectives, school students and the MK Youth Parliament were surveyed both at the beginning of the event and after hearing from the potential benefits and challenges of CCAM and participating in a facilitated discussion.

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Figure 5: Automation-ready Forum - Milton Keynes' Youth Parliament

Through these workshops, the city could confirm the importance of understanding the needs and views of all local stakeholders, to facilitate informed decision making about the introduction of such a disruptive technology, which may indeed have short term negative impact during the transition phase. Besides, it showed how bespoke methods can be adopted to engage with key stakeholder groups, and the meaningful outputs that can be achieved by using effective communication techniques.

Further Details: *http://www.ukautodrive.com/survey-finds-uk-public-still-open-minded-about-self-driving-vehicles/*

D4.4 Report on four 'Automation-Ready Fora' (https://www.h2020-coexist.eu/resources)

2.2.2 Engage new stakeholders

Planning for AVs and reducing uncertainties requires the involvement of actors that are not traditionally part of mobility planning. Municipalities alone cannot solve mobility challenges and thus need to collaborate with mobility service and technology providers from the private sector. Engaging with OEMs, technology companies, and new mobility service providers is an important aspect in co-creating solutions that benefit all stakeholders: businesses, government, operators, and people. This also helps in developing a common vision between often conflicting objectives of different organisations in planning for the future of mobility in cities. A good example of this is the Automation-ready forum hosted by the city of Helmond within CoEXist, engaging with internal stakeholders of the municipality to evaluate the challenges and opportunities of CCAM (see example below).

Cities and authorities will get a chance to have a better understanding for the implementation of the right policies and regulations to support innovation and restrict unfair competition. Examples for platforms bringing together stakeholders from different areas are Antwerp's Marketplace for Mobility[8], Gothenburg's DriveME[9] or – on a higher level - the German platform for urban mobility[10] which involves cities and OEMs for developing jointly mobility solutions for the future. However, besides the involvement of cities and industry partners, the participation of civil society groups is important to increase acceptability and help co-create solutions that are user-centric. In addition, bringing together different stakeholders' knowledge will foster innovation development in terms of application of new technologies and opening up new markets for building win-win-situations for the involved stakeholders.

[8] http://www.eltis.org/discover/case-studies/antwerps-marketplace-mobility-partnering-private-mobility-service-providers#field_study_usr_contact_ref

[9] http://international.goteborg.se/smart-cities-and-sustainable-solutions/driveme-self-driving-cars-sustainable-mobility

[10] https://www.plattform-urbane-mobilitaet.de/ (in German)

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Benefits: Associating new actors means that the prospects of the successful implementation of new mobility services with connected and automated vehicles will increase and uncertainties will be reduced by bringing in knowledge and needs from different perspectives. This dialogue can also be a good basis for innovation development and for the formulation of the right policies and regulations to foster innovation (see also below measure 1.8) and reach positive impacts of urban mobility solutions with AVs.

Challenges: Getting the right mix of people and stakeholders to have a balanced discussion and solution development process. Creating a dialogue with new actors and getting useful results may be a long-term process.

Steering cooperative innovation in Helmond

The leading role in dynamic traffic management and its active approach as a Living lab for ITS pilots and showcases, has given Helmond the name "City of Smart Mobility". The city believes in the principle of learning by doing and is convinced that innovative developments can be taken one step further by actually testing them together with the business community and educational institutions. Helmond participates in several national and European projects that are wholly or partly related to self-driving vehicles and CCAM, with a clear focus on cooperative traffic systems and connected vehicles.

Within CoEXist, Helmond organised an Automation-ready Forum aiming to engage with all internal stakeholders of the municipality of Helmond, from policymakers to implementers, and evaluate the challenges and opportunities of CCAM, and setting objectives and measures for the future.

Figure 6: Automation-ready Forum in Helmond

Representatives from the various research projects related to CCAM Helmond is involved in (including MAVEN, Autopilot, CoEXist, Fabulos and ISA) came together in an effort to create a common understanding and holistic coordination of efforts in this field. The workshop resulted on a joint assessment of the city's automation-readiness and the identification of strategic measures going forward.

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Engaging with stakeholders

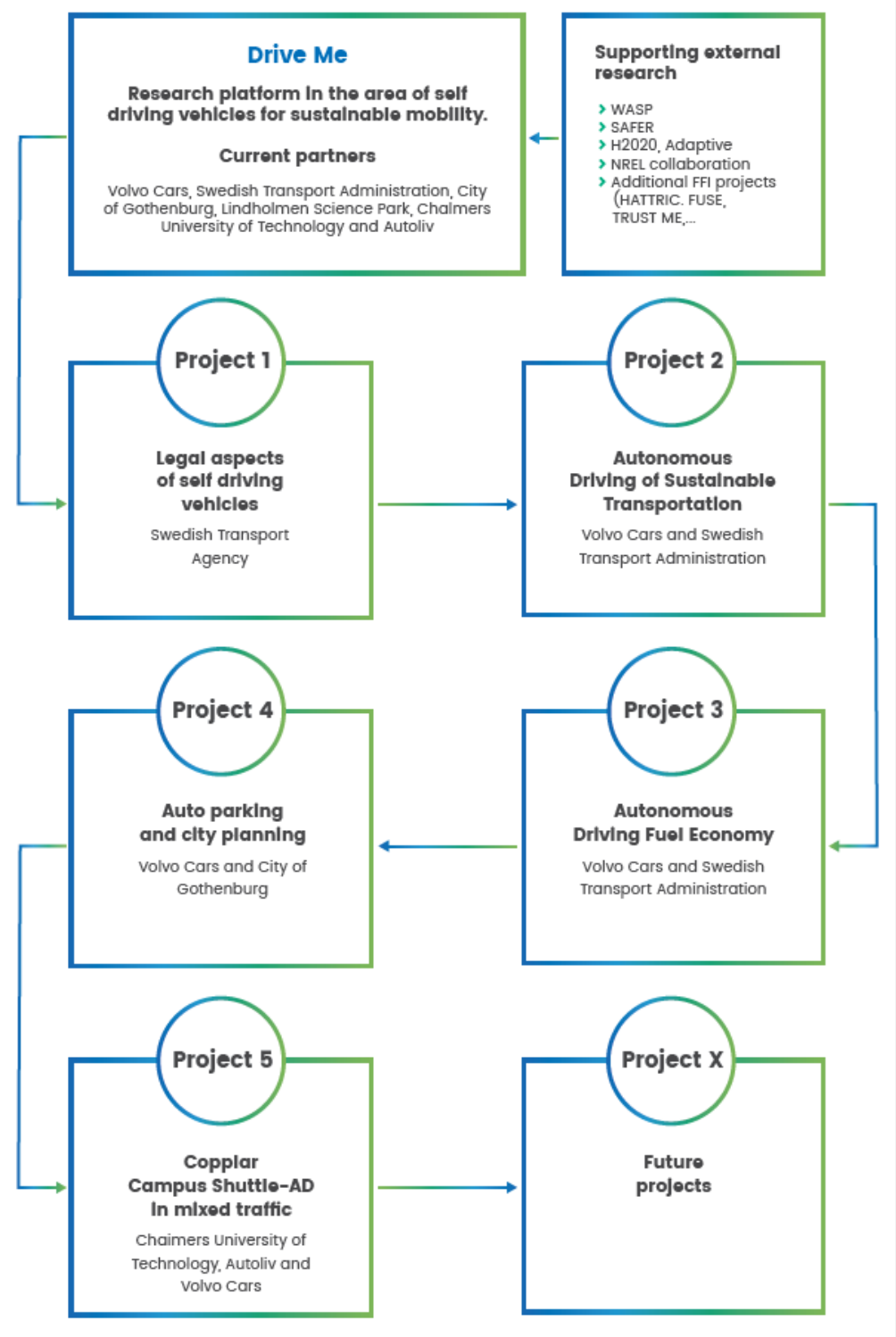

Figure 7: Framework of Drive Me innovation platform for Gothenburg

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CoEXist Automation-ready forum in Gothenburg

The main objective of the forum was to raise awareness of CAVs amongst stakeholders such as national, regional and local authorities as well as other urban mobility stakeholders.

A full seminar day on the topic of societal development and automated transports was jointly organised by CoExist and Drive Sweden. Drive Sweden is a cross-functional collaboration and innovation platform that drives the development of efficient, connected and automated transport systems that are sustainable, safe and accessible for all.

Figure 8: Automation-ready Forum in Gothenburg

One of the core questions raised at the seminar was: how can cities plan for a future where CAVs constitute a natural and integrated part of the urban transport system? Objective was to receive key input and feedback to evaluate the perspectives of stakeholders on the strategy/measures towards the deployment of CAVs.

2.3 Initiate innovation

2.3.1 Foster innovation through open innovation and data approaches including policies that support and encourage open data exchange and sharing

Today, innovations for sustainable urban mobility solutions are more often based on data (and linked information and knowledge) than on concrete or physical infrastructure. Planning of sustainable urban mobility, in particular in a data-heavy environment of AV-based solutions, needs to be aligned and should keep up with technological advancements to be able to effectively and proactively plan for future technological changes that impact mobility in cities. In this era of data and digitization, there are many innovative solutions that help in optimizing the usage of infrastructure and decrease the need for investments in physical infrastructure.

A precondition for such (open) data-based innovations around MAAS concepts with CAVs is the strategy for data exchange and sharing to exploit the full innovation potential, also by third parties or independent developers. Strategies should provide policies and rules to a have standards and regulations regarding sharable formats for open data and publicizing the availability of data.

An example for an open-data based innovation process are hackathons which become more and more popular for developing innovations based on data by third parties. A hackathon is an event in which computer programmers and others involved in software development, including graphic designers, interface designers, project managers, and others collaborate intensively on software projects, in this context for mobility solutions.

Benefits: Fostering joint innovations around sustainable urban mobility solutions with CAVs. Creating new markets and an open innovation culture in your city.

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Challenges: Agreeing on open data strategy with all involved stakeholders. Cost-benefit analysis of data-based or digital mobility solutions compared to physical infrastructure investments.

Open innovation with hackathons

DESCRIPTION

Transportation hackers in Germany! Berliner Verkehrsbetriebe (BVG) invites you to participate in the BVG HACKATHON - Urban Mobility. You'll be challenged to come up with an innovative solution that will make Berlin even more mobile with new offers, improved services, and combined data sources. You can choose your project from one of the following challenge categories:

» Supply, Traffic & Simulations

» Access to Mobility

» Passenger Information & New Services

» Open Category

Figure 9: Advert for the BVG (Berliner Verkehrsbetriebe / Berlin Public Transport Company) Urban Mobility Hackathon 2018; Hackathon.com © 2018

2.3.2 Conduct staff training on C-ITS and connectivity, e.g. ITS Capital training.

Staff for planning and managing mobility in cities will have to develop new skills and competencies regarding data handling and analysis, modelling and impact assessment of automated road transport. More and more new technologies available for deployment in supporting traffic management, e.g. C-ITS, will become available and authorities and cities need to ensure that technical capacities are up to the level to be capable to use new tools and deploy state-of-the-art measures.

Benefits: Skills and competencies development for sustainable deployment of new AV-related mobility solutions.

Challenges: Lack of further training offers and structured competence development plans.

CAPITAL ITS and C-ITS e-learning

The main aim of the CAPITAL project is to create a collaborative capacity building community and deployment programme to support public and private stakeholders implementing cooperative and Intelligent Transport Systems (ITS & C-ITS) with training and educational resources, while also raising awareness of the services and benefits available. Over nine e-learning courses are available on www.its-elearning.eu.

Figure 11: Extract from the CAPITAL project website (www.it-elearning.eu)

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2.4 Develop high level scenarios

2.4.1 Lay out the different potential futures of the mobility in your city with AVs.

Drawing up the potential future mobility conditions in your cities considering different dimensions (e.g. in the Sweden example, the two dimensions are proactive planning and sharing) and comparing the benefits and threats against each other. Developing and illustrating possible future scenarios is a step towards understanding the potential benefits and drawbacks of introducing a certain technology into the transport system. Prioritising certain future scenarios can also be a guide on how to develop policies and pilots to reach that scenario.

Benefits: Create a common basis for impact assessments and develop further from 'gut feelings' towards an improved understanding of benefits based on connected and automated vehicle mobility solutions.

Challenges: Gathering input from various stakeholders on potential future scenarios and develop a holistic view of the potential impacts that could be brought by each scenario.

Automation-readiness Self-assessment

CoEXist automation-ready framework, and its guiding questions for the consideration of each mobility aspect along its three phases, has served to analyse cities' current conditions. This exercise has been implemented by CoEXist partner cities as internal diagnosis of their baseline scenario towards automation-readiness, and has been employed to guide discussions during Automation-ready Fora.

During the event in Gothenburg, for instance, for each mobility aspect of the Automation Ready Framework, several potential actions and measures were ideated by the participants, but also a lot of discussion points, both recommendations and question marks.

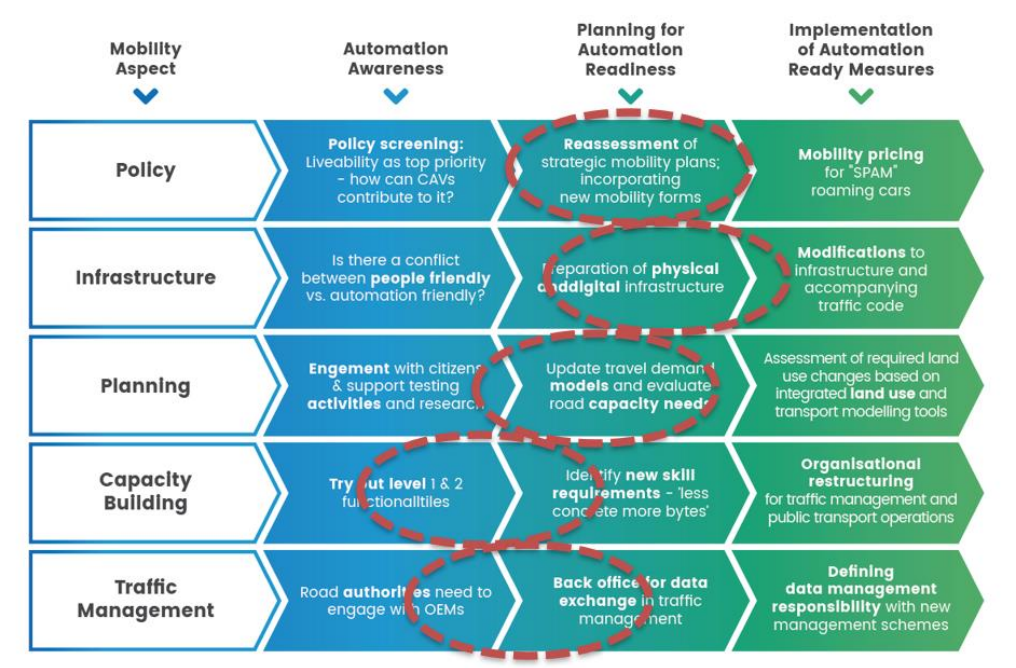

Figure 12: Automation-readiness self-assessment exercise for Gothenburg

Further details *https://www.milton-keynes.gov.uk/highways-and-transport-hub/policy-and-strategy-hub/transport-policy*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 723201

Mission Publiques Citizen´s Debate on Automated Mobility

With a team of partners, Missions Publiques ran the first of two phases of an international and local citizens' dialogue processes in 2018 and 2019, where cities from Europe, North America, and Asia hosted deliberations focused on scenario building, trust, and policy.

Automated mobility was one of the key topics of interest. As part of the international consortium of the citizen's debate on driverless mobility, the City of Aachen joined up with RWTH Aachen University to host a debate with 100 of its citizens. Similarly, automated mobility was the topic of a citizen's dialogue in five Austrian cities, led by AustriaTech. Almost 170 people attended the events in Vienna, Linz, Graz, Pörtschach and Salzburg to discuss the potential of this new technology.

Representatives from AustriaTech and the City of Aachen, participated in the CoEXist coordinated session at the CIVITAS Forum 2019. The presented approach included a strategic focus on potential future scenarios to engage in an informed analysis with citizens.

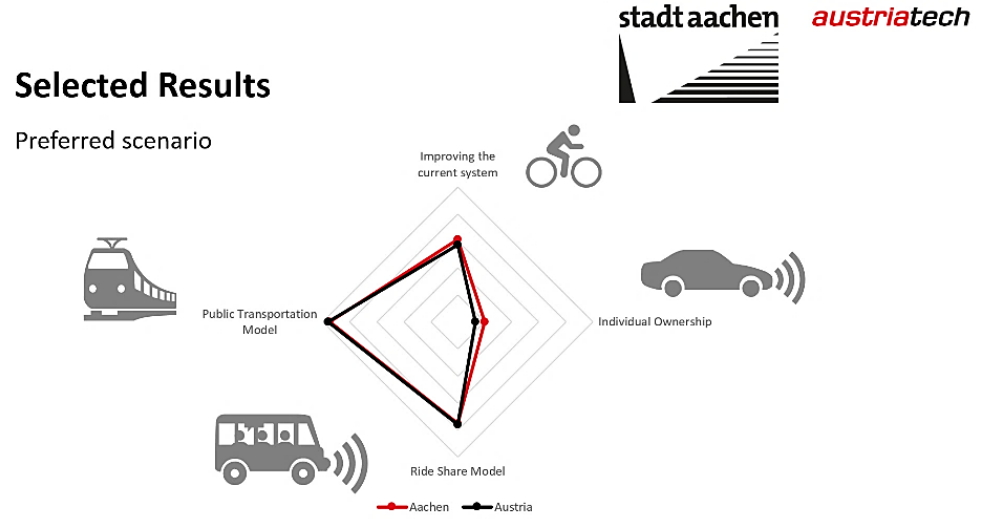

Figure 13: Scenario preferences from citizen's debate on driverless mobility in Aachen and Austrian cities (Stadt Aachen & AustriaTech, 2019)

Further details *https://www.milton-keynes.gov.uk/highways-and-transport-hub/policy-and-strategy-hub/transport-policy*

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 723201

3 Planning for Automation-readiness

3.1 Develop a vision and ensure commitment

3.1.1 Set a vision for your mobility ambitions with CAVs and ensure commitment for realising this vision.

Setting a vision clarifies the priorities that you will have as a city. Clearly addressing new mobility solutions based on CAVs does not just set a path to exploring new solutions in tackling current and future challenges in mobility. Having a vision also makes the ambitions of a city clearer to other stakeholders and potential independent developers interested in becoming part of the solution. Examples for identifying different potential governing scenarios of CAV rollout and prioritising scenarios that are desirable in relation to the sustainable mobility goals of a country are documented – inter alia – for Austria[11], Sweden[12] and Germany[13].

An example of a city developing a vision for the future with CAVs is Milton Keynes, UK.[14] Milton Keynes developed a Mobility Strategy as a reference point for how the town wishes to maintain, improve and develop its transport system up to 2036. It also shows how Milton Keynes wishes to begin investing in the short term in the development of the town's long-term future transport system to 2050 to ensure connectivity to new infrastructure projects. The strategy includes the ambition to "develop and promote a 'First Last Mile' culture for future technologies such as autonomous and connected vehicles and sustainable connectivity".

Vision for mobility with CAVs in cities – Mobility Strategy for Milton Keynes 2018 - 2036

Autonomous 'last mile' deliveries: Collaborative approach between the Council, Freight Quality Partnership, Transport Systems Catapult and the Open University to follow and possibly trial emerging autonomous delivery opportunities for the 'last mile' delivery. In liaison with industry partners consider the establishment of a Protocol for Personal Direct Delivery (PDD) trials to establish Milton Keynes as the centre for innovation and testing of new transport concepts on its local transport network.

Further details *https://www.milton-keynes.gov.uk/highways-and-transport-hub/policy-and-strategy-hub/transport-policy*

In addition, different initiatives are happening across Europe to pave the way for sustainable urban mobility. To strengthen the impact, major initiatives that call for widespread coordination have been launched such

[11] www.smart-mobility.at/fileadmin/media_data/services/Thematisches/Actionplan_automated_driving.pdf
[12] www.itrl.kth.se/research/projects/future-scenarios-for/future-scenarios-for-the-development-of-self-driving-vehicles-in-sweden-1.735820
[13] www.bmvi.de/SharedDocs/EN/publications/strategy-for-automated-and-connected-driving.pdf?__blob=publicationFile
[14] www.milton-keynes.gov.uk/highways-and-transport-hub/policy-and-strategy-hub/transport-policy

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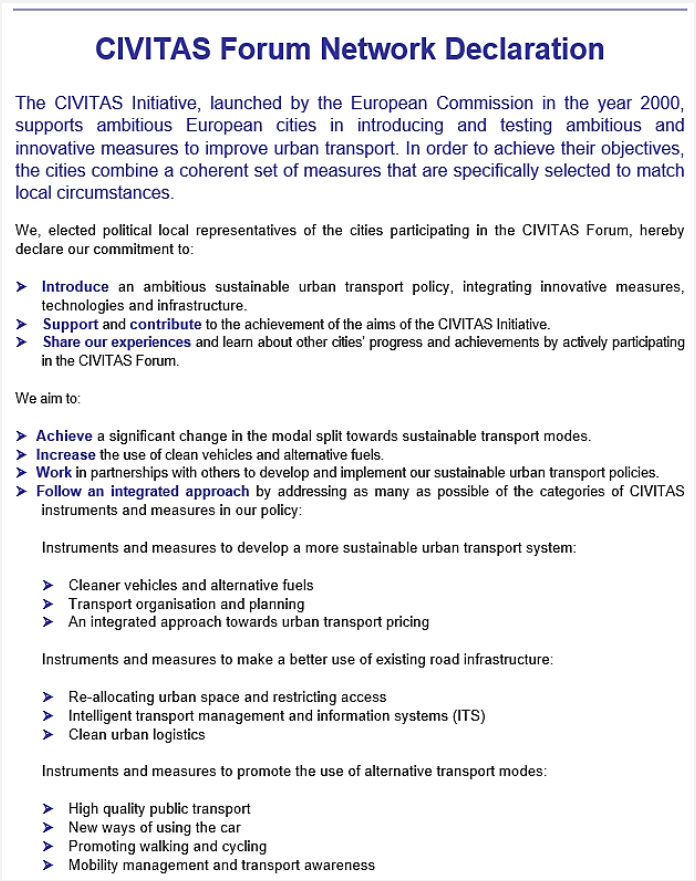
as the CIVITAS Declaration (supports ambitious European cities in introducing and testing ambitious and innovative measures to improve urban transport) and the Declaration of Amsterdam[15] to work towards a more coordinated approach enabling the introduction of connected and automated driving. The goal here is to harvest the great potential offered by connected and automated vehicle technologies in improving road safety, traffic flows and the overall efficiency and environmental performance of the transport system. Such declarations of commitment are strong direction-setting documents and agreements that develop an agenda for cooperation between the signatory countries or organisations.

Benefits: Setting a direction for involved stakeholders and showing commitment is important to understand the long-term mobility ambitions of a city.

Challenges: Agreeing on a common vision that is beneficial for all stakeholders involved.

Declaration of Commitment – The CIVITAS Forum Network Declaration

After conducting a stakeholder engagement at the CIVITAS Forum 2017, it is suggested to update the CIVITAS FORUM Declaration and include new forms of mobility including connected and automated driving and shared mobility, in relation to achieving more sustainable mobility in cities.



CIVITAS Forum Network Declaration

The CIVITAS Initiative, launched by the European Commission in the year 2000, supports ambitious European cities in introducing and testing ambitious and innovative measures to improve urban transport. In order to achieve their objectives, the cities combine a coherent set of measures that are specifically selected to match local circumstances.

We, elected political local representatives of the cities participating in the CIVITAS Forum, hereby declare our commitment to:

- **Introduce** an ambitious sustainable urban transport policy, integrating innovative measures, technologies and infrastructure.
- **Support** and **contribute** to the achievement of the aims of the CIVITAS Initiative.
- **Share our experiences** and learn about other cities' progress and achievements by actively participating in the CIVITAS Forum.

We aim to:

- **Achieve** a significant change in the modal split towards sustainable transport modes.
- **Increase** the use of clean vehicles and alternative fuels.
- **Work** in partnerships with others to develop and implement our sustainable urban transport policies.
- **Follow an integrated approach** by addressing as many as possible of the categories of CIVITAS instruments and measures in our policy:

Instruments and measures to develop a more sustainable urban transport system:

- Cleaner vehicles and alternative fuels
- Transport organisation and planning
- An integrated approach towards urban transport pricing

Instruments and measures to make a better use of existing road infrastructure:

- Re-allocating urban space and restricting access
- Intelligent transport management and information systems (ITS)
- Clean urban logistics

Instruments and measures to promote the use of alternative transport modes:

- High quality public transport
- New ways of using the car
- Promoting walking and cycling
- Mobility management and transport awareness

Further details *CIVITAS:* http://civitas.eu/cities

[15] On 14 April 2016 at the Informal Transport and Environment Council in Amsterdam, 28 EU Ministers of Transport endorsed the Declaration of Amsterdam - *Amsterdam:* https://www.regjeringen.no/contentassets/ba7ab6e2a0e14e39baa77f5b76f59d14/2016-04-08-declaration-of-amsterdam---final1400661.pdf

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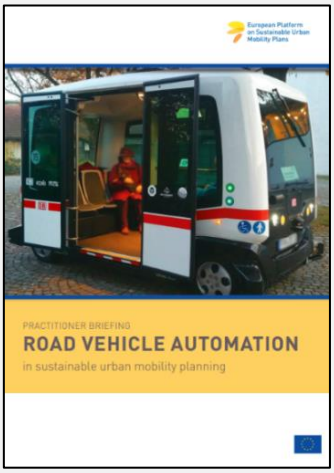
3.2 Integrate mobility solutions with CAVs in SUMP/ strategic transport plan

3.2.1 Integrate the lessons from the automation awareness measures, the set vision, and goals, into a sustainable urban mobility plan (SUMP) or strategic transport plan.

The plan represents a blueprint for the measures that are to be deployed in the coming years. The plan needs to be flexible to accommodate potential technological changes. However, planning for sustainable urban mobility solutions should follow the main SUMP elements, e.g. setting an overall strategy in relation to the city's priorities, stakeholder engagement, integration of all modes and monitoring and evaluation. In this era of disruptive technologies, it is important that cities are sufficiently prepared to deal with ever-changing mobility challenges and concurrently be able to gain the benefits brought by new technologies. Plans including CAV-based mobility solutions are – of course – not explicit at this early stage, but good examples of city plans include one from Seattle, documented in Driverless Seattle (2017), and the London case in the London Assembly (2018) document. These examples provide a general overview of how these cities intend to tackle the coming challenges brought by connected and automated vehicles.

To embed sustainable mobility goals based on CAVs (before the actual CAV rollout), cities should re-evaluate existing urban mobility goals. In the advent of ever-changing technologies, it is important to have mobility goals that are not conflicting with the ideas to integrate disruptive technologies. Integrating CAV-related mobility goals into existing mobility goals for your city helps to have tangible objectives to achieve higher mobility ambitions. Such goals can often serve as performance indicators about the progress of mobility development if they are objective, tangible, and measurable.

SUMP Guidance: Road-Vehicle Automation in Sustainable Urban Mobility Planning



As part of the SUMP EU Guidelines update process, CoEXist has lead the development of a Practitioner Briefing on planning for road vehicle automation, which provided an initial basis of support for authorities to undertake the challenge of addressing CCAM in SUMP processes.

The document provides guidance on key tasks and factors to be considered within the SUMP methodology, mapping for the main uncertainties and discussion guiding principles on how to mitigate them. Furthermore, it delivers recommendations on how the eight SUMP principles can be applied in the context of CCAM, and shares useful tools and good practice examples.

Further Details
http://www.rupprecht-consult.eu/uploads/tx_rupprecht/CoEXist_road_vehicle_automation_in_sustainable_urban_mobility_planning_0.pdf

Benefits: Following the SUMP elements and processes guides cities for implementing sound measures to support sustainable mobility solutions with CAVs in their cities.

Challenges: Developing a comprehensive plan that addresses all critical issues and lays out potential impacts of the planned mobility solutions with CAVs.

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City Plans

Further Details *http://techpolicylab.org/wp-content/uploads/2017/02/TPL_Driverless-Seattle_2017.pdf*

https://www.london.gov.uk/sites/default/files/future_transport_report_-_final.pdf

3.3 Update transport models

3.3.1 Update the baseline transport models and analyse use cases.

Many transport planning decisions affecting urban mobility and road infrastructure are based on the results of traffic flow and transport demand modelling. For this purpose, the availability of adapted simulation software is necessary, including new features and functionalities to allow for more accurate modelling of CAVs.

Updating your transport model helps better understand the benefits or disbenefits of potential measures that are being considered for implementation. Transport modelling and traffic simulation enables assessment based on forecasting possible changes in the future and helps streamline by removing undesirable measures. Models can be used to estimate changes in demand and capacity, and results can be extracted from the models to assess impacts on traffic performance, space efficiency, and safety.

In CoEXist, eight strategically selected use cases have been analysed with the developed automation-ready modelling tools, including: capacity requirements during construction and the reorganisation of shared space in Gothenburg; evaluating impacts on intersection capacity In Helmond; waiting (pick-up) and drop off zones in Milton Keynes and new shared services in Stuttgart. On the CoEXist website several deliverables are available that explain how transport models can be updated to include CAVs.

Finally, sustainable mobility measures based on CAVs could be selected that have been tested in models and simulations and agreed upon during stakeholder consultations.

Benefits: Better forecasting based on simulations allowing cities to have an enhanced understanding of the impacts of alternative future scenarios with CAVs.

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Challenges: Updating transport models is a time-intensive activity becoming more and more complex and detailed. If there is no base model in place, the biggest challenge would then be, to develop such a model first.

Automation-ready Modelling Tools

Within CoEXist, significant progress has been made on the macro- and microscopic simulation capabilities to model CAVs and their interactions with conventional vehicles and other road users.

The microscopic traffic flow simulator PTV Vissim was further developed to enable the simulation of CAV-behaviour, considering the differences in car-following distances, simple communication aspects (V2V and V2I) and acceleration behaviour, among other aspects.

Figure 14: PTV Vissim Simulation Environment - AV Shuttle Pods example ©PTV Group

Empirical data collected from real AV's on DICTM test track in Helmond (NL) and co-simulations integrating CAV driving logics (VEDECOM), vehicle dynamics (PreScan) and traffic simulator (PTV Vissim), were used to derive, calibrate and validate behavioural parameters of CAVs.

CAV will influence not only traffic flow but also travel demand. If cars become more comfortable and use the road space more efficiently, car travel demand is likely to increase. Travel demand models replicating interactions between transport supply and travel demand permit estimations how CAV may influence demand.

Starting point are the results of the validated CAV-ready microscopic traffic flow model. They are used to create assumptions for the supply-side of macroscopic travel demand models. Volume-Delay functions are adapted to replicate the impacts of CAV on capacity, which depend on vehicle class, on road type and on the share of CAV. In addition, existing travel demand models can be extended to include changes in the perception of car travel time, as drivers may use some of this time for non-driving activities.

CoEXist's macroscopic modelling tools provide extensions to PTV Visum by adding functionalities to the software in form of Visum compatible scripts, Visum procedure files and Visum Add-Ins. The tools can be integrated into the software to replicate the impacts of CAVs on capacity and demand. They allow the model developer or model user to test various assumptions, extending the capabilities of Visum to enable the consideration of CAVs in travel demand simulations.

Further Details https://www.h2020-coexist.eu/resources/

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4 Preparing for the implementation of automation-ready measures

4.1 Automation-ready measure planning

Automation-ready planning also requires a high-level understanding on the uncertainties and variations of the impacts of CAVs on key metrics, such as traffic efficiency, space demand and safety. And consequently, its implications to stakeholders involved in local transport planning. It is essential to enhance institutional capability to plan for a future with CAVs, by using tools that accurately represent CAV behaviour and identify the impacts of different deployment scenarios, and enable the selection of optimal measures to be implemented.

CoEXist has delivered tools for a structured approach of assessing future scenarios and handling uncertainties, including automation-ready modelling tools for both microscopic traffic flow simulation and macroscopic travel demand modelling (see section 3.3). In addition, the project developed a comprehensive modelling and impact assessment approach.

CoEXist driving logics and analysis framework

Since there are many uncertainties about how future CAVs will behave, CoEXist general modelling approach aims at describing a range of possible behaviours of these vehicles.

The behaviours of the automated vehicles are specified by driving logics which are functionally defined, that is, in terms of how and where they can operate safely, disregarding which technologies make this possible.

Since CAV will likely behave differently in different environments, the driving logics are combined to AV-classes (basic, intermediate or advanced) by determining which driving logic each vehicle should follow, in different road environments.

Rail-Safe	Stops if anything is on collision course. The vehicle follows a pre-defined path for the whole trajectory.
Cautious	Calculates gaps accurately and only merges when gaps are acceptable, and it slows down every time its sensors can have blind angles to have no surprises.
Normal	Behaves as an average driver but with the augmented (or diminished) capacities of the sensors for the perception of the surroundings.
All-Knowing	Perfect perception and prediction of the surroundings and the behaviour of the other road users. It is capable of forcing its way on other drivers whenever is needed without however ever causing accidents.

Figure 15: CoEXist Driving Logics

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In addition to accurate and robust modelling tools, it is necessary to define relevant indicators to be measured and to develop tools and methods to process modelling results and determine the impacts of CAV deployment on urban mobility and road infrastructure. CoEXist has focused on evaluating the effects of CAVs on: traffic performance, space efficiency and safety.

CoEXist's automation-ready road infrastructure assessment tools consists of a set of scripts and spreadsheet-based tools for the calculation of the above specified metrics and the use case specific impacts on traffic performance and space efficiency based on the micro- and macroscopic simulation outputs, as well as a qualitative estimation of traffic safety effects of different AV-functions for a specific use-case. For a detailed explanation of the tool's functionalities and guidance for its usage, please see D3.3 AV-ready hybrid road infrastructure assessment tool. The scripts and the spreadsheet-based tools are also available for download at www.h2020-coexist.eu

4.2 Institutional adjustments

4.2.1 Implementation of institutional changes that have been planned for its feasibility in the development of the automation-ready strategic transport plan.

Institutional adjustments are expected to happen in the future due to the changes that are likely to happen in relation to the increased deployment of intelligent transport systems, CCAM and MaaS services within the transport network of cities. This can be within institutions or agencies or maybe an entirely new department, and will heavily depend on the nature of the policies and regulations and the measures that are adopted in relation to connected and automated vehicles.

For example, if CAVs are to operate as fleets controlled by operators, perhaps a new setup for traffic management units would be required. Government agencies could also be needing internal information and technology departments to deal with technical communications necessary with such traffic management or control units. Furthermore, issues of privacy and cyber/security should not be neglected when planning such institutional adjustments.

Governance and organisational adjustments: Automation-ready Forum Stuttgart

Planning for CCAM concerns many different aspects of a municipality. Due to the multitude of different questions that have to be asked and answered in connection with this new form of mobility and the (new) tasks that have to be mastered, it is essential that the different organisational units concerned with their different responsibilities, work hand in hand.

In order to ensure the most constructive and effective cooperation between different authorities and responsibilities, the City of Stuttgart has long established a dedicated working group, called the "AG Mobilität" (Mobility Working Group), which aims for a holistic and competent design of mobility, and its contribution to a sustainable urban development strategy.

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During CoEXist, the organisational units in Stuttgart have extended their level of expertise concerning automated driving. Therefore, the framework of the Automation-ready Forum was used to reflect the working methods of this expert group, critically assessing the city's automation-readiness. The main aim of the Automation-ready Forum was to create a uniform, knowledge-based understanding of the chances, possibilities and risks of CCAM deployment. This included defining, and raising awareness on, the roles and responsibilities of every affected internal organisational unit.

Figure 16: Automation-ready forum in Stuttgart

The Automation-ready Forum confirmed that the complexity of achieving automation-readiness, and how various competences and responsibilities in a municipal administration need to be addressed. Therefore, the activities of the specific units have to be linked and coordinated. A continuous exchange of expertise and activities has to be established. In addition, human and financial resources must be provided to guarantee a continuous work – concerning strategic, planning, administrative and technical aspects.

Further Details *D4.4 Report on four Automation-ready fora (https://www.h2020-coexist.eu/resources)*

4.3 Automation-ready road infrastructure

4.3.1 Define infrastructure adjustments that are necessary to make mobility equitable and safer for all modes.

Infrastructure adjustments, whether physical or digital, may be necessary at higher penetration rates of CAVs in order to improve traffic efficiency and safety for all modes in the transport network. Specific infrastructure adjustments need to be made in accordance with the mobility requirements in the different heterogeneous sections of the network.

For instance, there might be changes needed for transition zones, where vehicles have to shift from an automated to manual mode. Transport models can test the necessary infrastructure adjustments that are needed to make transport networks more efficient and, in many cases, to make mobility safer for all modes. An AV-ready modelling environment will support sound decision-making (see also measure 2.3.1.).

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Infrastructure classification Scheme for Automated Driving (ISAD)

Understanding road infrastructure automation-readiness and its relation to CAV's Operational Design Domains, is of vital importance to steer CCAM deployment and plan for the transition phase. Shifting the focus from vehicle functionalities to infrastructure characteristics, can facilitate authorities' understanding of the challenges and limitations of automated driving. The H2020 project INFRAMIX has developed an Infrastructure classification Scheme for Automated Driving (ISAD), which categorises roads according to the amount of support they provide for CCAM, from class E to A, as seen in Figure 17. Enhanced capabilities of road infrastructure will be instrumental to enable coexistence of vehicles with different automation levels, and exploit the expected benefits of CCAM.

The ISAD presents a valuable tool to further evaluate deployment scenarios, coupling the infrastructure requirements with the potential CCAM services to be implemented, to deliver concrete guidance for cities. For instance, CoEXist's results have showed how traffic performance can be negatively affected by the introduction of CAVs during the initial transition period. It is up to cities to define the CCAM services, the type of mobility system and solutions that wants to implement, and finding the right mix of infrastructure development, regulations and business models to achieve that vision.

	Level	Name	Description	Digital information provided to AVs			
				Digital map with static road signs	VMS, warnings, incidents, weather	Microscopic traffic situation	Guidance: speed, gap, lane advice
Digital infrastructure	A	Cooperative driving	Based on the real-time information on vehicles movements, he infrastructure is able to guide AVs (groups of vehicles or single vehicles) in order to optimize the overall traffic flow	X	X	X	X
	B	Cooperative perception	Infrastructure is capable of perceiving microscopic traffic situations and providing this data to AVs in real-time	X	X	X	
	C	Dynamic digital information	All dynamic and static infrastructure information is available in digital form and can be provided to AVs	X	X		
Conventional infrastructure	D	Static digital information / Map support	Digital map data is available with static road signs. Map data could be complemented by physical reference points (landmarks signs). Traffic lights, short term road works and VMS need to be recognized by AVs	X			
	E	Conventional infrastructure / no AV support	Conventional infrastructure without digital information. AVs need to recognise road geometry and road signs				

Figure 17: Infrastructure Support for Automated Driving - ISAD classes (©INFRAMIX, 2019)

Further Details https://www.inframix.eu/infrastructure-categorization/

4.4 Developing collective mobility

4.4.1 Encourage collective mobility services and integrate it with public transit and other shared services, including bikes and scooters.

Although new technologies and new services enabled by CCAM have the potential to positively contribute to current societal challenges, there is still uncertainty about how the deployment of CAVs will unfold and what its impact will be. The possible various scenarios strongly depend on how CAVs are to be used and regulated. The implemented business models, normative, and resultant user-behaviour, could lead to more

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traffic, urban sprawl and congestion, or could “contribute to shaping sustainable and liveable cities, the regaining of urban space, less vehicles on the road and a higher quality of life” (UITP, 2017).

Public transport remains the only available solution to respond to the high-levels of transport demand that arise in dense urban environments, in an efficient and space efficient manner. Which is why, as stated in UITP’s Policy Brief on automated vehicles, “the arrival of driverless autonomous vehicles represents a unique opportunity for a fundamental change in urban mobility and could lead to healthier, more competitive and greener cities – but only if public authorities and public transport companies take an active role now and integrate AVs into an effective public transport network” (UITP, 2017).

UITP SPACE Toolkit

SPACE (Shared Personalised Automated vEhicles) is the flagship project from UITP, with the goal of establishing public transport at the centre of CCAM deployment. The project is developing a toolkit which integrates all required knowledge on shared automated vehicles (AVs), guiding authorities and mobility stakeholders to successfully integrate AVs with public transport.

The SPACE Toolkit focuses on four aspects of CCAM:

1. Practical scenarios and how to get there: guidance scenario development where fleets of shared AVs are integrated into public transport, for urban, suburban or rural settings.
2. Technical specifications of AVs: technical requirements for the deployment of scenarios identified.
3. AV pilots and initiatives around the world: interactive map shows the progress of shared AV initiatives around the world.
4. Impact assessment: of AV’s integration with public transport, on matters such as customer experience, human resources, business models, operations, digital infrastructure, urban space and legislative framework.

Figure 18: SPACE Project – AV progress map (©UITP)

Further Details https://space.uitp.org/toolkit

CAVs could dramatically enhance public transport, through car-sharing schemes and innovative services, such as shared ‘robo-taxis’ and mini-buses, by complementing rather than directly competing with it. Moreover, adopting AV technology in public transport services, e.g. autonomous buses and shuttles, could result in a significant reduction of operational costs, through effective PPPs (Thomopoulos & Nikitas, Editorial, 2019), and enable an extended supply of mobility services.

Nonetheless, as stated earlier, there is an essential need for structured coordination and information exchange among cities, at the national, European and global levels, in order to define consolidated needs, allow for market harmonization, markets, and enable the creation of economies of scale that ensure the optimal development of these new mobility services.

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4.5 Addressing individual mobility

4.5.1 CCAM & Travel demand

Highly automated vehicles allow their drivers to spend some of the driving time on other activities. This leads to the assumption that the perception of travel time in CAV differs from that in conventional cars. The daily commute time including delay from congestion can then be used more efficiently turning a car gradually into a limousine service or a private door-to-door vehicle. Besides, potential enhancement of traffic performance at high-automation levels, can result in significant changes in modal choice.

CCAM should be included into an integral mobility strategy, which recognises these risks and proposed effective solutions to manage changes in travel behaviour. Based on a balanced and coordinated multimodal offer, CCAM can support excellent options for sustainable door-to-door mobility.

Impacts of CAV on travel time and mode choice on a network level in Stuttgart

With the interest in evaluating the potential impacts of CAV on the traffic situation in and around the City of Stuttgart, CoEXist assessed the effects of automated vehicles on travel time, mode choice and route choice, resulting from changes in traffic performance and changes in comfort of car usage. An extended version of the existing travel demand model of the Stuttgart Region was used to examine the impacts of highly, but not fully automated vehicles.

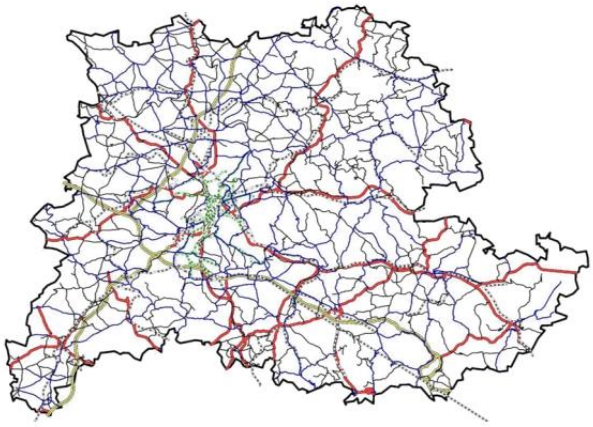

Figure 19: Stuttgart Region Transport Network

This use case aimed to find out if and at what penetration rate CAV can improve road capacity, and whether CAV will make cars more attractive thus leading to a modal shift from public transport to car. Results showed that, as first-generation CAV are assumed to be rather cautious and thus performing worse than conventional vehicles, increase in travel times are expected for all road participants. However, as soon as CAV improve traffic performance, traveling by car, either conventional or automated, becomes more attractive, causing a modal shift towards car. Additionally, people are willing to spend more time in their CAV, allowing them to travel further. Both circumstances lead to an increase in the distance travelled and the time spent. The impact on the modal split and the distance travelled correlates to the CAV-share. The results indicate that road traffic may increase by up to 24% solely because of the advanced capabilities of highly automated vehicles.

Further Details *D4.3 Technical report on the application of the tools for assessing traffic impacts of automated vehicles at https://www.h2020-coexist.eu/resources/*

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4.6 Policy measures

4.6.1 In line with the infrastructure adjustments and new mobility services deployed, specific policy measures for automated services are needed.

Authorities need to develop new regulatory frameworks to lead the transition to the new mobility era of sustainable and interconnected mobility with CAVs. New policies need to be adaptive and anticipatory, and based on a balanced governance. These could include pricing of empty runs, occupancy-based pricing of services, etc. Authorities need to (re)assess and monitor the necessary characteristics and requirements of regulatory schemes and policies to accommodate new mobility services with CAVs while meeting cities' economic, political and social ambitions These policies will highly depend on the technological maturity in the next 15-20 years (or even more) and also on the economic conditions of the city and country. The H2020 project GECKO will investigate these challenges.

Benefits: Help to encourage sustainable modes of transport through consideration of new forms of mobility and to control undesired mobility developments in cities.

Challenges: Involvement of the necessary stakeholders and compromising of the different needs of the stakeholders in the development of mobility policies that are primarily for the benefit of the mobility of people in cities.

GECKO Regulatory Framework Dashboard

GECKO is an Horizon2020 project which aims to support authorities in developing the most appropriate regulatory framework and governance model, through guidance, recommendations and case studies, for the transition to a new mobility era of cooperative, inclusive, competitive, sustainable and interconnected mobility.

The project is developing a Regulatory Framework Dashboard to support users in their search for information in the regulation database. So far, more than 135 regulations for disruptive mobility innovations have been collected. The Dashboard is intended to become a tool for policy-makers, helping them measure the level of compliance of business models and innovations with the regulatory schemes and governance models. To this extent, it will support their decisions on regulatory obligations, filtering the latest news of regulation changes and on upcoming directives.

Further Details http://h2020-gecko.eu/tools/dashboard

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The recommendations provided in this framework are based on a series of stakeholder engagement events with representatives and experts from local authorities, regional authorities, research institutes, consultancies, car manufacturers, and other urban transport stakeholders. All elements of the automation-ready framework have been tested with the four CoEXist partner cities and with an extensive list of urban transport stakeholders in order to make it as practical and applicable as possible within the urban mobility sector.

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6 Partners