Defining the future of urban transport

Deliverable D5.1 – WP5 –PU

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Table of contents

Table of figures

Table of tables

Executive summary

The aim of the LEVITATE project is to prepare a new impact assessment framework to enable policymakers to manage the introduction of connected and automated transport systems, maximise the benefits and utilise the technologies to achieve societal objectives. As part of this work the LEVITATE project seeks to forecast societal level impacts of connected and automated transport systems (CATS). These include impacts on safety, environment, economy and society.

This report specifically focuses on urban transport. The aim of this report is to provide a framework under which the future of automated urban transport and resulting impacts can be defined as relevant for the future work of the LEVITATE project. This includes defining expected penetration rates as influenced by market forces and technology adoption. This initial information on forecasted market penetration rates will inform the subsequent work (tasks 5.2, 5.3 and 5.4) to analyze short-, medium- and long-term impacts of CATS on urban transport, respectively. The findings presented in this report were obtained in two ways, through a preliminary literature review on the impacts of autonomous shuttles on urban transport and a dedicated stakeholder workshop. An extensive literature review of the impacts on urban transport for the short, medium and long-term future will be provided as an outcome of the corresponding subsequent tasks 5.2, 5.3 and 5.4.

Literature review on Advanced Driver Assistance Systems (ADAS), which are considered SAE level 2 technologies, indicated clear impacts on traffic, safety, environment, mobility and society, albeit small percentage. It is expected that level 3-5 technologies will have major impacts on traffic, safety, environment, economy and mobility. However, it is probable that current estimations of technology adoption may be overestimates, similarly to, forecasts of ADAS penetration made in 2005 compared to actual penetration of ADAS technologies clearly showed overestimation. In general, the literature suggests the future of CATS to be positive in terms of their impacts on traffic, safety, environment, economy and mobility. However, their uptake is most likely to be influenced by trust and user's acceptance.

A stakeholder reference group workshop was conducted to gather views on future of CATS and possible use cases of urban transport, named, sub-use cases from city administrators and industry. A pre-workshop survey was also conducted to shape the workshop activities in a manner most applicable for the attending stakeholders. It emerged that while planning processes extend to 2040 for level 5 technology, there is no agreement on what to expect. Overall, workshop participants stated that CATS were mainly expected to supplement public transport functions. According to the participants, there are many opportunities that would be available through this new technologies and cities would need to prepare to take full advantage of it.

A list of sub-use cases of possible interest for use cases of urban transport from CATS perspective has been developed, informed by the literature and stakeholder workshop. This list will be prioritised and refined within subsequent tasks in the project to inform

the interventions and scenarios related to urban transport which will be included in the LEVITATE Policy Support Tool (PST).

1 Introduction

1.1 LEVITATE

Societal **Lev**el **I**mpacts of Connec**t**ed and **A**utoma**t**ed Vehicl**e**s (LEVITATE) is a European Commission supported Horizon 2020 project with the objective to prepare a new impact assessment framework to enable policymakers to manage the introduction of connected and automated transport systems, maximise the benefits and utilise the technologies to achieve societal objectives.

Specifically LEVITATE has four key objectives:

1. To incorporate the methods within a **new web-based policy support tool** to enable city and other authorities to forecast impacts of CATS on urban areas. The methods developed within LEVITATE will be available within a tool box allowing the impact of measures to be assessed individually. A Decision Support System will enable users to apply backcasting methods to identify the sequences of CATS measures that will result in their desired policy objectives.
2. To develop a range of **forecasting and backcasting** scenarios and baseline conditions relating to the deployment of one or more mobility technologies that will be used as the basis of impact assessments and forecasts. These will cover three primary use cases – automated urban shuttle, passenger cars and freight services.
3. To establish **a multi-disciplinary methodology** to assess the short, medium and long-term impacts of CATS on mobility, safety, environment, society and other impact areas. Several quantitative indicators will be identified for each impact type
4. To apply the methods and **forecast the impact of CATS** over the short, medium and long term for a range of use cases, operational design domains and environments and an **extensive range of mobility, environmental, safety, economic and societal indicators**. A series of case studies will be conducted to validate the methodologies and to demonstrate the system.

1.2 Work package 5 and Deliverable 5.1 within LEVITATE

This WP focuses on the impacts that the deployment of cooperative, connected and autonomous vehicles may have on urban transport operations, through advanced city shuttles and other micro-transit vehicles. Forecasting of impact will consider four main components: (i) Type of transport: road vs. rail, motorised vs. non-motorised, personal vs. shared; (ii) Modes of transport: passenger cars, micro-transit shuttles, public transport (buses), pedestrians, cyclists; (iii) Actors: drivers / operators, passengers, transit companies / authorities, cities authorities; (iv) The SAE levels : urban shuttle modes are directly considered at SAE 4. It will be based on the methodology developed in WP3 and the scenarios developed in WP4 to identify and test specific scenarios regarding the impacts of CATS on urban transport. More specifically, the objectives of work package 5 are:

- To identify how each area of impact (safety, mobility, environment, economy, and society) will be affected by Connected and automated transport systems (CATS) in

urban transport operations, with focus on the transition towards higher levels of automation. Impacts on traffic will be considered cross-cutting the other dimensions.
- To assess the short, medium and long term impacts, benefits and costs of CATS for urban transport.
- To test interactions of the examined impacts in urban transport scenarios and
- To prioritise considerations for a public policy support tool to help authority decisions.

Key transport types that are of particular interest in this case concern shared passenger transport (i.e. passenger cars, micro-transit), non-motorized transport and road public transport (buses) and the related infrastructure arrangements.

The purpose of Deliverable 5.1 is to summarise the literature and workshop findings in relation to the expected short, medium and long term future of urban transport and the impacts of automated vehicles on urban transport regarding society, economy, environment and safety. This will pave the way for choosing the suitable and more realistic sub-use cases to forecasting the impacts of CATS. The document will be informed by work conducted in work packages 3,4 and 8 and will complement the corresponding reports of 6.1 on passenger cars and 7.1 on freight transport.

2 Methods

Before assessing impacts, benefits and costs of CATS it is necessary to define what is meant by the short, medium and long-term future. This document identifies aspects relevant to this specific use cases by employing:

a) A preliminary review of recent literature on the impacts of autonomous shuttles on urban transport. This work also builds on the knowledge gained through existing research at European level, for instance the CityMobil and CityMobil2 projects.

b) A dedicated stakeholder consultation, through the organisation of a workshop to which relevant stakeholders (related to urban transport operations) and LEVITATE partners were invited. The workshop has gathered expert opinions about what is coming for connected and automated urban transport, and has provided related evidence. The workshop has been conducted using a 'Future Enquiry' in which a group-process builds on existing methods to produce insights that are grounded in the experience of stakeholders, reflecting the reality of everyday life, and identifying existing strengths as well as needs. Structured discussions have considered the situation/problem from the current standpoint (what is currently being done well/badly), described an ideal future and identified the major steps to be achieved and hurdles to be overcome in order to reach the desired future.

These activities result in a comprehensive set of circumstances which may be expected for urban transport in the short, medium and long-term future, thus providing the context for subsequent WP5 tasks and deliverables.

2.1 Literature review strategy

Literature informing about the future of urban transport, including forecasts, within CATS domain was considered. In terms of level of automation, the definitions provided by SAE were adopted as they are widely used.

Literature on Advanced Driver Assistance Systems (ADAS) was considered because it is closely related to autonomous driving or self-driving. There are some parallels between ADAS and automated cars that can be drawn to inform work on impact assessment of automated cars. A focused research on ADAS technologies was carried out. Relevant systems were determined before investigating predicted and actual impacts of each system. Previous European projects, such as CityMobil and eSafety, provided information that was further complemented with journal papers and government reports. Multiple international libraries were consulted, including:

- The ITS Library: https://ertico.assetbank-server.com/assetbank-ertico/action/viewHome
- RASAP (Repository & Open Science Access Portal): https://rosap.ntl.bts.gov/welcome

2.2 Workshop details and planning

2.2.1 Background

The project is supported by a reference group of core stakeholders consisting of international / twinning partners, key international organisations, road user groups (i.e. pedestrians, cyclists, professional drivers), industry, insurances and health sector representing the more influential organisations that can affect mobility, environment, road safety and help accomplish casualty reduction among travellers. The main role of the Stakeholder Reference Group (SRG) is to support the project team in ensuring the research continues to address the key issues as well as providing a major route to implementation of the results and consequent impact on mobility and road safety of all travellers. The group will meet to support and give feedback on the project's activities, as well as contribute to the exploitation plans and draft policy recommendations. All SRG members were invited to the workshop. The experts who have confirmed their involvement are (Letters of Support signed, partner) among others:

- **Cities and Regions:** City of Vienna (partner), Transport for Greater Manchester (partner), Transport for London (LoS), Madrid (LoS), Aarhus (LoS), Stuttgart region (LoS), KiM Dutch Ministry of Transport (LoS), ETSC (LoS), Rijkswaterstaat (LoS), Provincie Gelderland (LoS), City of Paris (LoS), Berlin (LoS), Catalonia (LoS), Amsterdam (LoS), Gothenberg, (LoS), City of Wels (LoS)
- **OEMs, Tiers and Infrastructure Providers & Operators:** DigiTrans consortium incl. associated partners: ASFINAG (Austrian infrastructure operator), BOSCH, Blue Danube Airport, AVL, DB Schenker, Magna, Rotax, MAN, etc. (LoS)
- Civil Society Organisations: contact to interest groups will be sought during project life-time, e.g. Bicycle Lobby Vienna (claimed interest)

2.2.2 Date of workshop and Desired outcomes

The first SRG workshop was held in Gothenburg on 28th of May and the intended outcomes were:

- The future of CATS with respect to the short, medium and long term (WP5,6,7)
- Goal dimensions and indicators of the desired future city (WP4)
- Which sub-use cases are of most interest; are there any missing? (WP5,6,7)
- Initial feedback on the Policy Support Tool (PST), (WP8)

2.2.3 Workshop participants

Members from the Stakeholder Reference Group (SRG) that were relevant to Task 4.1, 5.1, 6.1 and 7.1 were invited to the workshop, belonging to the following types of organisations:

- Representatives of European cities
- Representatives of the European Commission, European decision makers
- Local/regional and national authorities and policy makers
- Automobile manufacturers
- Researchers in automotive industry or CATS sector in general, and Consultants
- Researchers from previous European projects about CATS

In overall, there were **40 participants** at the workshop. In Figure 2.1 the distribution of participants by organisation type is presented. The majority of workshop participants (53%) were from local and national authority organisations. Other participants were from specialist groups (association related to car, cycles, pedestrian), research organisations and, R&D departments within commercial organisations.

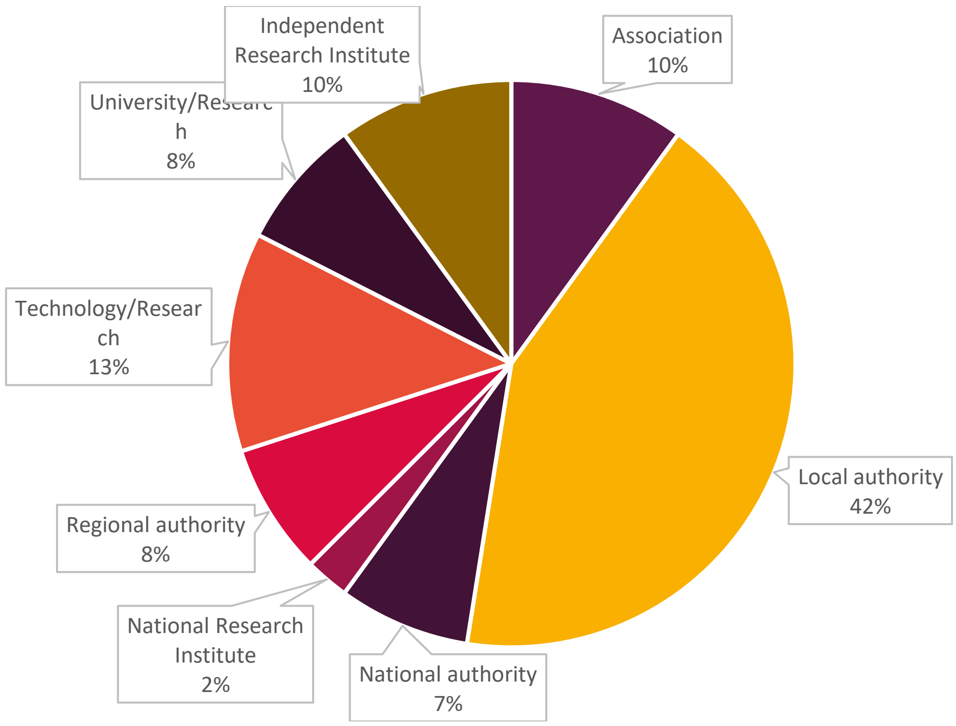


Figure 2.1 Workshop participants by type of organisation.

Figure 2.2 shows the distribution of participants by country. There was a good mix of partners from Europe. However, the majority were from western Europe possibly due to convenience of location of the Workshop.

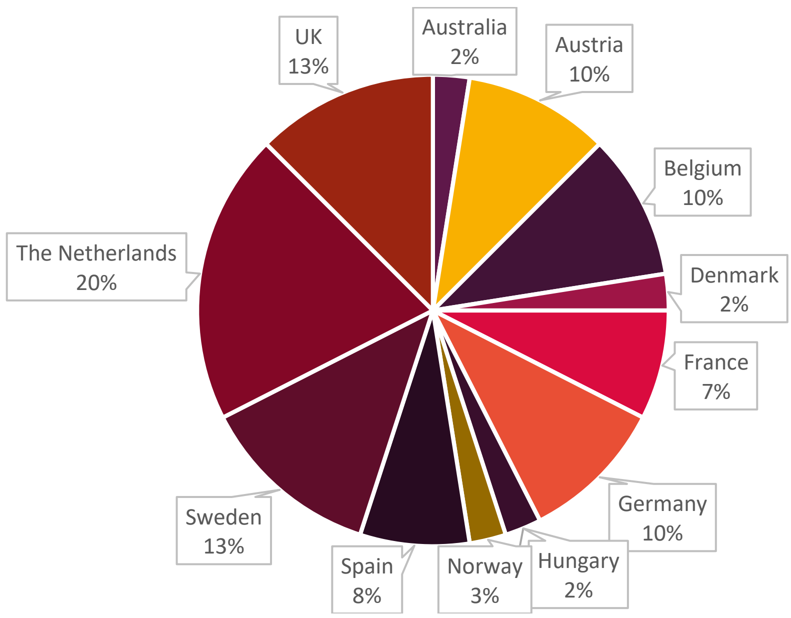


Figure 2.2 Workshop participants by country.

Figure 2.3 shows the distribution of participants according to their designated roles / positions within their organisations. All participants were involved in roles / positions that were highly influential in decision-making within their own organisations, thus being directrly related to future directions of CATS.

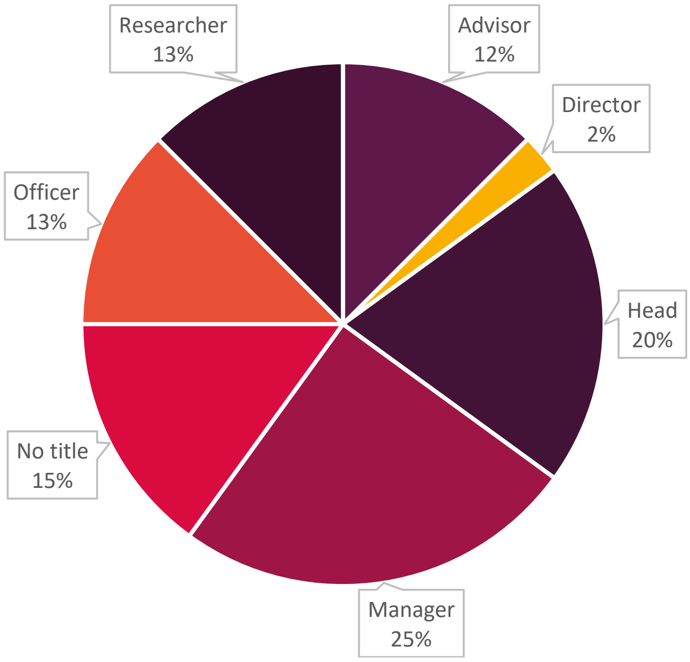


Figure 2.3 Workshop participants by their roles / positions within their organisations.

Participants were further divided into smaller groups to discuss futures of automated urban transport (22 persons), passenger cars (11 persons), and freight transport (7 persons).

2.2.4 Ethics

Whenever data is being collected within the LEVITATE project all relevant data protection rules are followed. LEVITATE complies with the General Data Protection Regulation (GDPR) and provides confidentiality of any personal information collected within the project (e.g. no transfer of personal information between partners i.e. personal information is processed and anonymised within the organisation that collected the data, dataset is cleared of personal data as soon as possible after collection, only personal data that is really necessary is collected, asked for informed consent).

Ethics approval was granted by Loughborough University. A survey was conducted between partners to aid in understanding the ethics issues that are likely to be faced and simultaneously, to provide the basis for a public statement on the way GDPR requirements are managed within the project. All appropriate measures are taken within LEVITATE to assure that ethical requirements are addressed appropriately.

2.2.5 Pre-workshop pilot interviews

Before the workshop, three interviews were conducted as a scoping exercise to improve the understanding of the sub-use cases that are of most interest to city administrations and ensure the project is addressing the most important mobility interventions. Two representatives from Transport for Greater Manchester and one from Transport for

London were interviewed. The interviews were designed according to the workshop structure, lasted 30 minutes each and the aim was to define the short, medium & long term future of passenger car, urban and freight transport. The interview questions can be found in the 6.1 section of the Appendix. The main points for the discussion were sent to the participants 2 hours before the interview and were structured into the following parts:

Part 1: First thoughts on future cities and CATS
Part 2: What is currently being done for future planning and is it working?
Part 3: Specific future vision
Part 4: Sub-use cases
Part 5: The Policy Support Tool

Regarding the future of urban transport, the following **key comments** were collected during the pre-workshop pilot interviews.

The situation in future cities could be chaotic in case of private use of CATS but can have a positive aspect in case of providing public transport sustainable solutions. More specifically, CATS in public transport could offer inclusive solutions to customers with improved pricing and mobility services. The local economy could also grow with new modes for short journeys and shared solutions that aid connecting people to first and last mile of the journey to public transport. Urban transport is already more controlled with rules and planned routes; hence it can be quicker and easier to automate that experience. The concept of MaaS will be a key feature.

2.2.6 Pre-workshop online survey

In addition to the pilot interviews, SRG members who registered for the workshop were also asked to complete an online survey to obtain a general assessment of the proposed indicators and to enable using the survey results as an impulse for inspiring discussions during the workshop. The questions were focused on the importance of goal dimensions and indicators of the future cities, as well as ongoing and planned activities on sub-use cases and interventions. The pre-workshop survey questionnaire and a summary of relevant results can be found in section 4.1 and in section 6.2 of the Appendix.

2.2.7 Workshop structure

A full-day workshop took place in Gothenburg, Sweden, in the Lindholmen Conference Centre on 28th May 2019. Besides project introduction and impulse presentations (i.e. intended to induce lively discussions), the main discussion was split into four sessions, and each session was further split into thematic groups. The overall structure was as follows:

- Project introduction
- Session 1: Visions of CATS Futures (discussion about the role of CATS in the short- medium- and long-term future)
  - Group 1: Automated Urban Transport
  - Group 2: Passenger Cars
  - Group 3: Freight Transport & Logistics
- Impulse presentation on the City of the future
- Session 2: Ideal Futures (discussion about goal dimensions and indicators of the desired future city)
  - Group 1: Environment

- Group 2: Society
  - Group 3: Economy
  - Group 4: Safety
- Session 3: Selecting Interventions & Activities (identification and prioritisation of sub-use cases)
  - Group 1: Automated Urban Transport
  - Group 2: Passenger Cars
  - Group 3: Freight Transport & Logistics
- Round 4: Expectations and Needs regarding the PST
- Closing

In session 1 and 3, participants were split into self-selecting groups based on their expertise/subject area for cars, urban transport and freight. Since the group for urban transport was large, it was split into further two, creating four groups overall. In session 2, the participants were randomly split based on the coloured dots that were provided on their name badges. The coloured dots represented impact dimensions – safety, environment, economy and society.

The whole workshop was planned and organised by LEVITATE project team members.

- Moderator: Alexandra Millonig (AIT)
- Group facilitators: Ashleigh Filtness (LOUGH), Bin Hu (AIT), Alexandra Millonig (AIT), Julia Roussou (NTUA)
- Registration and organisation: Dagmar Köhler, Suzanne Hoadley, Balázs Németh (all POLIS)

3 Literature review findings

3.1 Introduction (Background and Research Problems)

In this chapter, the review of literature is presented which is split into two parts: existing **Advanced Driver Assistance Systems (ADAS) technologies** and **expected future of CATS**.

ADAS technologies were considered because such systems incorporate technologies that can be considered as Automation level 1 or level 2 and there are important lessons to be learnt. For example, considering the initial impacts of ADAS on society and the penetration of ADAS can inform what might be expected for Automation levels 3-5.

Potential impacts of future CATS technologies of level 3-5 and their forecasted penetration rates have also been reviewed. It is notef that the purpose of this preliminary literature review was not to review research in automated urban transport from a methodological point, but to define the future of CATS and identify sub-use cases of interest. An extensive literature review of the impacts on urban transport for the short, medium and long-term future will be provided as an outcome of the corresponding subsequent tasks 5.2, 5.3 and 5.4.

3.2 Current ADAS Technologies

In this section, current ADAS technologies, i.e., SAE level 1 and 2 systems, and their impacts are discussed. As these systems are the closest existing comparison to future CATS, information in this section can be used as a basis for prediction of impacts and penetration rate evolution of future CATS. Due to the overlap between systems for freight transport, urban transport and personal cars, similarities between part 3.2 of deliverables 5.1, 6.1, and 7.1 are present.

3.2.1 Which technologies are already out there?

Buses can be equipped with ADAS. They can be grouped in different ways. Systems can, for example, be grouped by their operational domain: lateral control, longitudinal control, a combination of both, systems concerned with the state of the driver, and systems designed for special manoeuvres. Another way to group the systems is to look at the level of guidance they provide: systems can inform or warn the driver, may take over part of the driving task or can intervene when necessary. Table 3.1 provides an overview of the available ADAS in different groups.

There are many different driver-assist systems on the market. Most relevant to future CATS (Level 3-5) are those that influence lateral and/or longitudinal movements by either warning, performing autonomously, intervening, or a combination of these. As such the current review focuses on these. Systems that do not translate to future CATS, such as Seatbelt Reminders and Adaptive Headlights, will not be discussed in more detail. Assistance systems that are only in use during backing manoeuvres, on motorways or monitor driver state are also not discussed. These include Back-up

Cameras, Back-up Warning, Rear Traffic Warning, Adaptive Cruise Control (ACC), Speed Limiters, Drowsiness Alert (DrowA), Distraction Alert (DisA), and Alcohol Interlock systems. The remainder of this section will focus on those systems that influence lateral and/or longitudinal movements in urban environments by either warning, automating or intervening, or a combination of these.

ADAS that influence lateral movement are lane Departure Warning (LDW) that warns the driver when the vehicle moves too close to the edge of the lane. Lane Keeping Assist (LKA) uses the same technique but steers the vehicle back towards the centre of the lane when necessary. Lane Change Assist (LCA) warns the driver when a vehicle is present in a blind spot during lane changes.

Systems involved with longitudinal movement inform about and adjust the speed of the vehicle when necessary. Intelligent Speed Assist (ISA) helps drivers by displaying the current speed limit. Some versions of this system warn the user when they surpass the speed limit or even prevent speeding on many roads. Forward Collision Warning (FCW) detects an object in front and warns the driver when a collision is likely to appear. Autonomous Emergency Braking (AEB) is similar to FCW but intervenes when a collision would otherwise occur.

Bicycle and Pedestrian Detection systems assist the driver by issuing a warning when trajectories of the vehicle and person intersect. More advanced versions intervene by braking when a collision is deemed likely. These systems often focus on turning and other slower manoeuvres like approaching or leaving a bus stop.

Systems that indirectly facilitate the driving task are intersection priority and digital fare systems. Intersection priority enables communication between a bus and an intersection in order to reduce wait times, increasing efficiency and reliability of the route. Digital fare systems allow for reduced waiting times at bus-stops, further increasing efficiency.

Table 3.1. Overview of effective areas from different ADAS. The '+' sign indicates more advanced versions of a system

	Inform	**Warn**	**Automate**	**Intervene**
Lateral		LCA, LDW	LKA	LKA
Longitudinal	ISA	FCW, ISA	ACC, ISA	AEB, ISA
Combined		Bike and ped. detection		Bike and ped. detection
Driver State		DrowA, DisA		DisA+, alcohol interlock
Special Manoeuvres	Back-up cameras	Back-up warning, Rear traffic warning		Back-up warning+, Rear traffic warning+
Other		Seatbelt reminders	Adaptive headlights	

Next to these systems in buses, first pilots with driverless shuttles are being held.

3.2.2 Examples of societal level impacts of these systems

The remainder of this paragraph will focus on the systems that are most closely related to AVs in urban environments. These systems influence lateral and/or longitudinal movements and are capable of warning, automating and/or intervening. Systems that influence driving related factors such as intersection priority are also discussed. Extra attention is given to detection and prevention of pedestrian related crashes. Only those systems that influence specific impacts are discussed in each paragraph.

3.2.2.1 Safety impacts

The expected results of the different systems are estimated by using historical crash data and determining what percentage of crashes would be prevented if the vehicle was equipped with the system.

Actual impacts of the systems are determined from Field Operational Trials, comparing data between vehicles with an active system to those without.

LCA influences crashes occurring during intentional lane changes. These crashes account for 6% of all bus crashes (Mertz et al., 2000; Schneeberger et al., 2013). The system was expected to prevent 5% of all crashes (Hummel et al., 2011; Schneeberger et al., 2013). No actual impact of LCA could be determined due to insufficient data. When LCA is combined with FCW 25% of relevant crashes were prevented (Bayly et al., 2007).

LDW and **LKA** influence unintended lane departure crashes, accounting for around 6% of all bus crashes (Mertz et al., 2000). LDW was expected to reduce all crashes by less than 1% (Dunn et al., 2007; Hummel et al., 2011). No data on actual effects of LDW is present. LKA predicted effects are likely higher than LDW, but no percentages are given. Actual effects of LKA show a reduction of up to 26% in lateral movement when the system is active (Pessaro, 2013; Ward et al., 2006).

ISA systems impact crashes due to inappropriate speed. These crashes account for 1% of bus crashes on motorways, and likely less on urban roads (Transport & Mobility Leuven, 2013). Predicted effects of a mandatory ISA system show a 2% reduction in all injury crashes and 9% reduction in fatal crashes (Transport & Mobility Leuven, 2013). Field trials with an ISA system show a reduction in speed of 12% on 30kmh roads (AVV, 2001). No actual effects on crashes are found in the current literature.

FCW and **AEB** systems influence collisions occurring due to objects in front of the vehicle. Systems capable of detecting pedestrians are discussed separately. FCW and AEB crashes account for 14% of all bus crashes (Dunn et al., 2007). FCW expectations are between 10-22% reduction in relevant crashes, or 2% of all crashes (Bayly et al., 2007; Dunn et al., 2007). Other sources state a predicted 19% reduction in fatal crashes (Mangones et al., 2017). Actual effects show a 72% reduction of conflicts, not actual crashes (Lutin et al., 2017). When combined with LCA, FCW prevents 25 to 34 percent of relevant crashes (Bayly et al., 2007; Maccubbin et al., 2005). AEB was expected to reduce all crashes by 9%, increasing to 15% when capable of detecting stationary vehicles (Hummel et al., 2011). Higher expectations are also reported at 35% (Schneeberger et al., 2013). Actual effects of an AEB system for vehicle detection are not present in the current literature.

Pedestrian and Cyclist detection systems influence crash rates with pedestrians and cyclists, often occurring near bus-stops and intersections or turns. These crashes account for around 8% of all bus crashes, but almost half of all fatal crashes (McNeil et al., 2002; Mertz et al., 2000). Front detection of pedestrians was expected to prevent 2-12% of all crashes (Dunn et al., 2007; Hummel et al., 2011; Schneeberger et al., 2013). Actual impact shows a 43% reduction of relevant crashes (Lutin et al., 2017), with a simulation study showing reduced reaction times (Girbés et al., 2017). Systems capable of detecting pedestrians and cyclists on the side of the vehicle were expected to reduce relevant crashes by 45% and all crashes by 15% (Dunn et al., 2007; McNeil et al., 2002). Actual effects show a 35% reduction of relevant crashes (Rephlo et al., 2008).

Table 3.2 summarizes how the actual impacts of the systems relate to the estimated impacts. For many systems it is not possible to make a comparison due to a lack of data on predicted or actual effects.

Table 3.2. Estimate comparison to actual effects

Crash type	Not clear	Low estimate	Good estimate	High estimate
All relevant crashes	LCA, LDW, LKA, ISA, AEB	FCW, Front ped. detection		Side ped. detection

3.2.2.2 Traffic flow impacts

The effects of advanced systems on traffic flow are less pronounced for urban transport than they are for passenger cars or freight traffic. No data on the effect of ACC, ISA or Speed limiters on travel time is found in the current data. It should however be noted that, during a large-scale **ISA** field operational trial done in Sweden bus drivers showed a tendency to no longer give way to pedestrians at zebra crossings. While this effect was not significant, it indicates a possible tendency to make up for time lost due to ISA by yielding less at crossings (Biding & Lind, 2002).

A system that has been shown to increase traffic flow is the priority system at signalized intersections. An increase in bus travel speed of 5-16%, and an increase in punctuality of 5-20% have been shown when both buses and intersections are equipped with a priority system (Hounsell & Shrestha, 2005).

Digital Fare Collection is a system that allows passengers to pay fares by using a contactless card instead of using cash. By implementing digital fares the boarding time of a bus can be reduced significantly. Multiple studies show a reduction in boarding time of 40% compared to magnetic transit cards, and up to 62% compared to cash payments (Luk & Yang, 2001; Tirachini, 2013). These reductions translate to less time spend standing still, enabling faster and more efficient routes.

3.2.2.3 Economic impacts

With the many different types of ADAS considered within the literature, no clear cost implications can be determined. It is clear that vehicles that have these systems implemented cost more to produce and buy. The installation, maintenance and possible repair costs of ADAS equipped vehicles are higher than comparable vehicles without these systems. A reduction in crashes will reduce costs associated with these crashes. However, because the absolute number of crashes for buses is relatively low, cost-benefit analysis often shows higher costs than benefits. Increases in efficiency as an effect of intersection priority, enable bus operators to make more trips in the same time. This would decrease downtime, and therefore increase profitability.

3.2.2.4 Environmental impacts

Because most systems focus on detection and avoidance of possible collisions there are no significant impacts on the environment due to changes in fuel consumption or emissions. The reduction in stop-start scenarios at signalled intersections due to priority clearance has the potential to reduce fuel consumption and emissions. No data on the actual effects have been presented yet.

3.2.2.5 Societal/mobility impacts

Because of the limited scope of the current systems, and the lack of widespread availability, no discernible impacts on society are currently present. While the systems are in part designed to reduce driver workload, this is not always the case. Drivers that use a new system for the first time often experience an increase in workload, especially if the system is a prototype (Collet, Petit, Champely, & Dittmar, 2003; Rephlo et al., 2008; Ward et al., 2006). In some cases, drivers were so unhappy with the system they resorted to sabotaging it (Biding & Lind, 2002). Driver training focused on learning the installed systems, possible drawbacks and limitations, and ensuring clear knowledge of different warnings can help to reduce workload. This does however place strain on the company to facilitate these trainings, and makes it more difficult for drivers to get started at new companies with different systems/buses.

The increased punctuality as a result of priority intersections makes it possible to provide passengers with exact departure times and possible delays. This extra information makes passengers more likely to use the bus as their mode of transport (Tang & Thakuriah, 2012).

3.2.3 Which factors influenced the adoption of these systems?

Adaptation of new systems for urban transport vehicles is influenced by many different factors. Trust, effectiveness and cost are the most important in determining the rate of adoption (Dunn et al., 2007). Implementation in urban transport vehicles follows a different trend than other heavy vehicles or passenger cars. Due to the unique challenges of an urban environment, combined with higher costs and stricter regulation of buses, adaptation faces additional hurdles. The higher bus lifecycle of 12-18 years means that new systems can take a long time to become prevalent (Lutin, Kornhauser, Spears, & Sanders, 2016). This process can be sped up by facilitating the implementation of safety systems.

Acceptance of the systems seems high among management and drivers, with both indicating that safety is one of their primary concerns (Cafiso, Di Graziano, & Pappalardo, 2013). However, when drivers are tasked with driving an equipped vehicle, opinions often become negative. Drivers indicate that collision warning systems are distracting, difficult to work with, annoying, unreliable, and even try to disable or sabotage the system (Biding & Lind, 2002; Rephlo et al., 2008). The number of false warnings seems to be disproportionate to the number of actual warnings. This problem is further enlarged with situations where a warning would be helpful, but none was given (Rephlo et al., 2008). This problem is mostly a result of the highly demanding urban environment, with pedestrians and cars traveling very close to each other. Technological advancements are needed to create a system with an acceptable level of false positives. Until such a system is available, adoption rates will suffer.

3.2.4 What was the penetration rate evolution of these systems?

Information on the equipment rate of ADAS on buses is very scarce. While AEB and LDW are mandatory for other heavy vehicles, urban buses are exempt from this mandate (Council Regulation (EC) 661/2009). New agreements to implement mandatory detection of vulnerable road users to the front and side of the vehicle will likely result in rapidly increasing penetration rates starting from 2022 (European Commission, 2019)

3.3 The expected future of urban transport

3.3.1 CATS within public transport

Regarding the future of road transport, there are four prevalent trends that will emerge: automation, connectivity, sharing and decarbonisation (Alonso Raposo et al., 2019). Although CAVs incorporate all these trends, their beneficial impact on road transport is dependent on their effectiveness, their penetration speed and their possible negative effects. Low levels of automation enhance user comfort and safety, but significant changes will occur when a critical number of AV road trips have been performed and level 4 automation has been succeeded.

Communication technologies are also an important element in future CAVs and according to prioritisation of use cases for connected and automated mobility from European Commission (EC), the Member States (MS) and industry, automated shuttles and buses were top rated. There were three categories of use cases: private transport, collective transport, and freight transport. This result indicates that the benefits in public transport are expected to be greater than in private mobility although the expectations of connected and automated mobility between them are significantly different (Alonso Raposo et al., 2019).

Public transport consists of buses and other vehicles on the road, but also includes rail-bound services. The International Association of Public Transport (UITP) defines five grades of automation (UITP, 2012). Grade 0 is the conventonal train operation in ordinary roadways, Grade 1 combines train control and manual operation (the driver operates the doors, starts and stops the vehicle, but some parameters of the trip can be managed by a train control), in Grade 2 the driver starts the vehicle and control the doors, while the trip is in a semi-automatic train operation (STO), Grade 3 constitutes the driverless train operation (DTO) where there is only a train attendant to take control in the event of emergency and Grade 4 is the unattended train operation (UTO, or manless train operation MTO) where all the operations are automated and there is no staff on the vehicle while only the control centre can intervene. Furthermore, regarding the road traffic, according to the J3016 standard (SAE International, 2016), there are six levels of automation: no automation (0), driver assistance (1), partial automation (2), conditional automation (3), high automation (4) and full automation (5).

Public transport constitutes a significant element of urban mobility (Pakusch & Bossauer, 2017) as it can alleviate congestion issues in cities and promote sustainability. According to VDV (2015), there are two extreme scenarios describing the uptake of CATS as far as urban transport is concerned. According to the **pessimistic** scenario, public transport will suffer due to the focus on autonomous private cars, whereas, according to the **optimistic** one, shared autonomous cars will be fully integrated into public transport and provide great coverage for all regions of the city, thus rendering private cars superfluous.

3.3.2 An overview of societal level impacts of high automation in urban transport

In order to provide a structure to assist in understanding how CATS impacts will emerge in the short, medium and long-term, a preliminary taxonomy of the potential impacts of CATS was developed by Elvik et al. (2019). This process involved identifying an extensive range of potential impacts which may occur from the future expansion of CATS. A range of impacts were classified into three categories, **direct impacts, systemic impacts and wider impacts**. Direct impacts are changes that are noticed by each road user on each trip. These impacts are relatively short-term in nature and can be measured directly after the introduction of intervention or technology. Systemic impacts are system-wide impacts within the transport system. These are measured indirectly from direct impacts and are considered medium-term. Wider impacts are changes occurring outside the transport system, such as changes in land use and employment. These are inferred impacts measured at a larger scale and are result of direct and system wide impacts. They are considered to be long-term impacts.

This definition is applicable to work packages 5, 6 and 7 and therefore will not necessarily inform classification of impacts in the PST (from WP8). This is simply because from the user (of PST)'s viewpoint, this classification may encounter some confusion for the impacts that lie within the fuzzy boundary of either short-, medium- or long-term. So, this definition is adopted in this work package in order to progress with the tasks in next phase of the project. Over the future phase of this project, the draft taxonomy will be systematically evaluated and become more extensive during structured workshops, where stakeholders will be asked to prioritise and indicate missing topics. Additionally, in order to facilitate analysis, all impacts are divided in four wider categories, safety, environment, society and economy. In this section a short overview of societal impacts of CATS in urban transport will be presented.

The large scale introduction of CATS in urban environments will affect fundamentally urban transport and space (Fraedrich et al., 2019). The benefits from fully automated public transport could include reduced crash rate, increased punctuality, shorter headways and greater availability (Pakusch & Bossauer, 2017). Under these circumstances, a greater proportion of people are expected to be using public transport. Nevertheless, the role of AVs for public transport can be controversial. On one hand, by providing first and last mile services, AVs can boost the use of other transport systems by providing efficient door to door transport along with the time and the chance for passengers to relax, work or read while travelling. On the other hand, they raise this unique advantage of the public transport. Therefore, transport modal split could be affected, and public transport suppliers would face challenges as serious reconsideration would be required for existing business plans. These changes in modal split could lead to congestion unless changes in road network also take place (Boesch & Ciari, 2015). A study by Owczarzak and Żak (2015) compared several public transport solutions in relation to AVs and regular urban transport and concluded that the combination of AVs with the urban bus system is expected to increase travel comfort by reducing crowdedness and enhancing privacy, reduced travel costs and increased availability, timeliness and reliability of transportation service. The authors stated that the operation of AVs in public transport systems could be beneficial towards their efficiency and effectiveness of the latter.

Automation can also facilitate a transition to Mobility as a Service (MaaS) that could limit the negative effects of road transport (European Commission, 2017), as long as it promotes car sharing, ride sharing or sourcing and not private mobility solutions. According to Firnkorn and Müller, (2015), automation could attract more people to car sharing for the first or last mile of their trip instead of walking, cycling or using a private car. Autonomous taxis or car sharing could be considered as part of the public transport as with suitable business models they can promote sustainability, reducing the number of private cars and accordingly, the congestion. Fewer vehicles that operate more efficiently would reduce car traffic and advance public transport (Pakusch & Bossauer, 2017).

3.3.3 User acceptance of these systems

Autonomous public transport is already a reality in some regions, e.g. autonomous buses in Lyon (France) and Michigan (USA) or driverless trams or trains, e.g. shuttles at airports (Frankfurt airport) or subways (Paris, Vancouver, Singapore). A measure of user acceptance could be the number of passengers daily. According to a study conducted by Pakusch and Bossauer (2017), willingness to use AVs is high (77,6%) and affected by previous experience with autonomous transport. Participants that have experienced autonomous driving were keener on trying different and new transport modes than others and all showed a preference in using railway-based means of transport instead of buses. Moreover, females were less willing to use every transport mode than males. In line with these results, several studies have shown that men (Hohenberger et al., 2016) and younger people (Bansal & Kockelman, 2017; Festjens & Janiszewski, 2015; Dungs et al., 2016) are more willing to use or pay for AVs.

The results of other studies were also optimistic overall about the user acceptance of these systems (World Economic Forum, 2015; Bansal & Kockelman, 2017; Kyriakidis et al., 2015). However, 2017 Eurobarometer survey showed that more than 50% of users would not feel comfortable being driven in a full AV.

Regarding car sharing, a study from Prieto et al. (2017) indicated that it is more probable for residents of city-centre, degree graduates and younger people to adopt this mean of transport. Moreover, according to Pakusch and Bossauer (2017), the choice of using a shared autonomous vehicle could depend on waiting and travel time as well as travel cost.

3.3.4 Market penetration of AV technologies in urban transport

According to existing literature, the penetration rates of different CATS automation levels for the short-, medium- and long-term future are dependent on several factors, including available technologies, acceptance by general public, trust on CATS and other.

Centre for Connected and Autonomous Vehicles (CCAV) of the UK Department for Transport and Transport Systems Catapult (TSC) have agreed in three scenarios regarding the global uptake of CATS: the progressive, the central and the obstructed. According to this forecast, global sales penetration of automation levels 3-5 by 2035 will be 85%, 25% and 10% for the three scenarios respectively. Bus, van and HGV markets are assumed to occur at the same rate as for cars and all scenarios assume that the sales will increase over time; 1% annual increase for the UK and approximately 2% for global market. Figure 3.1 presents the projected global annual vehicle sales in thousands.

Scenario	LDVs (cars & vans)			HGVs			Buses		
	2025	2030	2035	2025	2030	2035	2025	2030	2035
Total (including CAVs)	110,000	120,000	130,000	4,000	4,300	4,600	900	1,400	2,200
L3-L5 CAV sales									
Progressive	11,940	44,600	108,930	470	1,680	4,050	90	470	1,740
Central	11,880	25,200	32,240	429	900	1,150	90	290	560
Obstructed	220	3,840	10,400	8	140	370	2	40	180

Figure 3.1 Projected global annual vehicle sales (thousands) (Babbar & Lyons, 2017)

The information that is accessible regarding the development state of CATS and market penetration is restricted only to public research projects and as they prevalently refer to passenger cars, it is difficult and speculative to define CATS penetration rate regarding public transport. Relevant studies and additional information regarding the market penetration of CATS technologies can be found in LEVITATE Deliverable 6.1, Defining the future of passenger car transport (Boghani et al., 2019).

3.3.5 Planning for the future of AV technologies in urban transport

In Europe there already exist particular solutions involving high automation with low velocity vehicles and specific infrastructure. A 2016 OECD study has further explored the potential of all car trips replacement with shared or on-demand vehicles. According to ERTRAC Connected Automated Driving Roadmap (2019), there are two development paths that relate to high levels of automation in the urban environment: The first is the Personal Rapid Transit (PRT) including urban shuttles and the second are city-buses and coaches.

PRT involves smaller vehicles mostly utilised for the transportation of people, e.g. for first and last mile use or even longer distances. They can operate both in a collective or individual mode on restricted, specific or open roads.

Automated PRT or shuttles that will operate on dedicated infrastructure and on designated lanes could be enriched by other automated functions to improve traffic flow and safety. These services could possibly be incorporated into public transport. Concerning PRT or shuttles that will operate in mixed traffic, they are expected to travel at the same speed as other road users and do not require any intervention from the passengers in driving task. They can be part of a connected network of mobility services, including parking, booking and sharing platforms, maintenance and managing vehicles software solutions. Furthermore, ridesharing could have a positive impact on the environment by reducing traffic in the cities, and shuttles could provide such services 24/7 by exploiting algorithms that could optimise the process of identifying the closest vehicle and the number of passengers for a similar route. The number of passengers will also define the price of the journey (the more passengers, the less expensive for everyone).

Essential for the safety of automated shuttles is security that relates to data connectivity and software updates and also, a service that could identify accurately their location based on a map. Moreover, Level 4 shuttles or PRTs would require: 1) control centres, responsible for emergency remote control of the vehicle, maintenance and authority interventions and 2) data cloud support, managing cooperative environment, traffic data and automated driving functions.

The city buses and coaches incorporate numerous automated functionalities, such as traffic jam and driver assistance, bus-platooning, bus-stop automation and other tasks on restricted, dedicated or open roads. These highly automated buses on dedicated lanes are envisioned to drive without intervention according to pre-defined operational design domains (ODDs) and to be mixed with non-automated city buses. They will operate at normal speed while regulations and specific rules will apply, such as speed limits. These buses may include functions such as bus-stop automation for high productivity and enhanced safety, traffic flow and network utilization. The same principles are expected to apply for high automated buses in mixed traffic on open roads.

In summary, according to the roadmap by ERTRAC (2019), see Figure 3.2, the envisioned AV systems in urban transport are:

1. Automated PRT/Shuttles on dedicated roads (Level 4)
2. Automated PRT/Shuttles in mixed traffic (Level 4)
3. Highly Automated Buses on dedicated lanes (Level 4)
4. Highly Automated Buses in mixed traffic (Level 4)

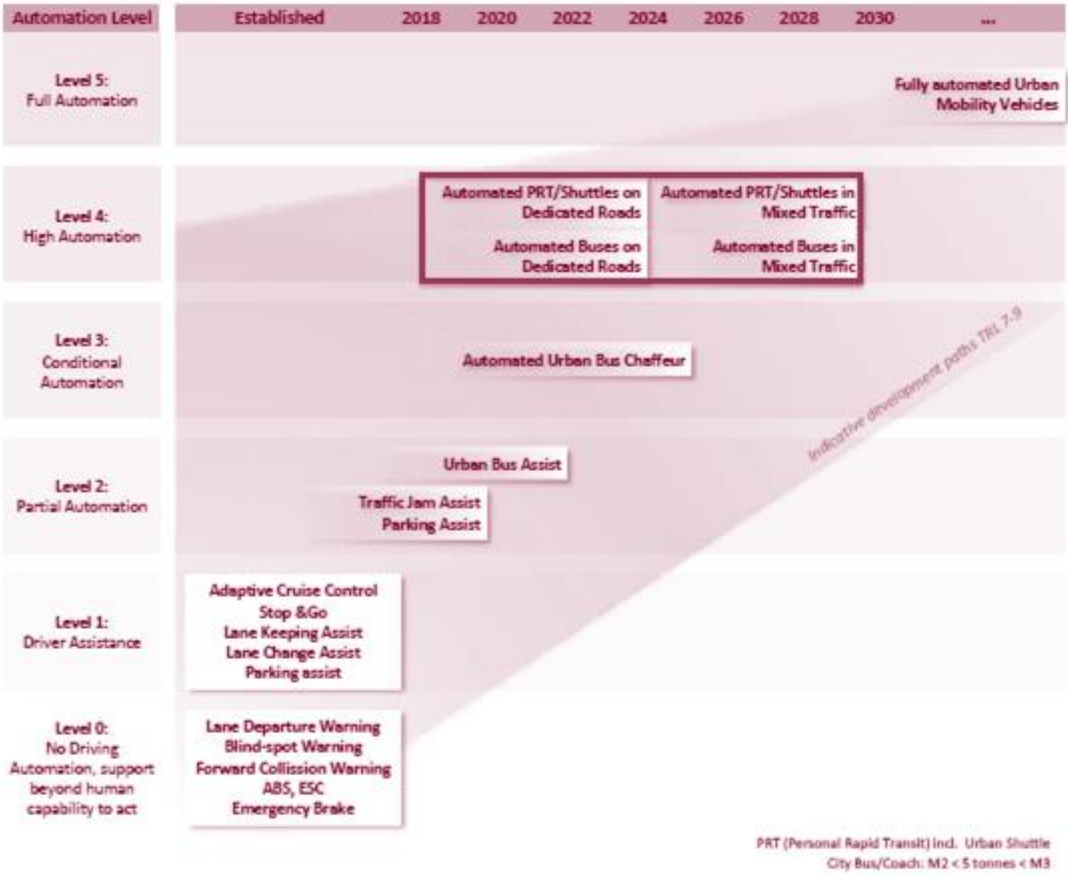


Figure 3.2 The Automated Driving development path for urban mobility vehicles (ERTRAC, 2019)

3.4 First Identification of sub-use cases

The Policy Support Tool (PST) to be developed within LEVITATE will support policy makers by allowing consideration of the potential impacts of interventions and scenarios relevant to each of the key use cases (freight transport, passenger cars and urban transport). Within the work on urban transport a set of sub-use cases and interventions will be developed to inform the predicted impacts of CATS. The final sub-use cases to be used in the PST will be developed and refined over multiple steps of which the first 3 are presented in the current report. These steps are,

1. Initial generation of sub-use cases (section 3.4)
2. Definition and categorisation of sub-use cases (section 3.4)
3. Consultation with stakeholders (section 4.2)
4. Predictability assessment (Tasks 5.2, 5.3, 5.4)
5. Refinement and clustering (Tasks 5.2, 5.3, 5.4)
6. Prioritisation (Tasks 5.2, 5.3, 5.4)

As a first step to develop sub-use cases, an overall list was developed from the existing expertise of the project partnership and existing knowledge from scientific literature. This was subsequently refined; their descriptions were clarified, and they were classified into their logical categories. Also, impact indicators and assessment methodologies for sub-use cases are currently being identified in separate work packages in this project (WP4 and WP3, respectively). Some sub-use cases were renamed so that the wording is less scientific / technical, but more understandable for the broad audience such as city administrators or SRG members (e.g. "System-aware route optimization" renamed to "Centralized traffic management")

Furthermore, we use three categories for the classification:

- Interventions: We see them as city / government driven policy interventions with the goal of actively regulating the use of CATS.
- Applications: They cover the actual usage of CATS. Compared to interventions, applications are market / business driven.
- Technology: These are (sub) systems for certain CATS functionalities and therefore enable other technologies or applications

The refinement of sub-use cases is an ongoing work and will continue in the tasks 5.2, 5.3 and 5.4 (Assessing the short-, medium- and long-term impact, cost and benefits) within WP6 of this project. This work includes the following:

- Prioritisation of the sub-use cases to enable their inclusion in pilot version of the PST.
- Clustering of sub-use cases to facilitate the assessment methodologies (T5.2, 5.3 and 5.4) and the inclusion into PST (WP8).
- Extend the list of interventions specific to urban transport.

The prioritisation of the sub-use cases will mainly take these three input directions into account:

- Scientific literature: They indicate the scientific knowledge and the available assessment methodologies for the sub-use cases. However, this might not be directly linked to their importance / relevance for practice.
- Roadmaps: They indicate the relevance of sub-use cases from the industrial/ political point of view, independent of available scientific methodologies.
- SRG Workshop: They contain first hand feedback for the sub-use cases, but might only reflect the opinions of organisations and people who participated.

In Table 3.3 and Table 3.4, the sub-use cases which are seen as general, i.e., relevant for all three use cases, and those which are specific for passenger cars are shown.

Table 3.3. General sub-use cases that are applicable for all Use Cases. Please note that this list also includes suggestions from the SRG workshop. Indicator column indicates whether the sub-use case was discussed in literature, roadmap and/or workshop.

Sub-Use Case	**Description**	**Category**	**Indicator** Literature (L) Roadmap (R) Workshop (W)
Geo-fencing based powertrain use	Different powertrains on hybrid vehicles are used according to defined zones (e.g. low-emission zone in the city center).	Application	L
Green light optimized speed advisory	Vehicles approach traffic lights with optimal speed to avoid stopping at red, hence increasing energy efficiency.	Application	L,R

Sub-Use Case	Description	Category	**Indicator** Literature (L) Roadmap (R) Workshop (W)
C-ITS day 1 services	Hazardous location notifications (slow or stationary vehicle, road works warning, emergency brake light, …) Signage applications (in-vehicle signage, in-vehicle speed limits, signal violation / intersection safety, …)	Application	L,R
C-ITS day 1.5 services	Charging stations info, vulnerable road user protection, on street parking management, off street parking info, park & ride info, connected & cooperative navigation, traffic info & smart routing	Application	R
Road use pricing	Prices are applied on certain road (segments) with the goal to incentivize load-balancing. Can be dynamic depending on area, traffic load, and time.	Interventio n	L,R,W
Centralized traffic management	Routing / navigation of vehicles is managed by a centralized system with access to traffic loads. The goal is to balance the traffic load across the road network.	Interventio n	L,R
Segregated pathway operations	A policy measure where automated vehicles operate on separate roads/ lanes, for example a dedicated CATS lane or an automated urban transport lane	Interventio n	L
Option to select route by motivation	A multiple choice of routes available to users based on motivations. The motivations being, fastest, shortest, most environment friendly, safest, etc.	Application	W
Street re-design	Redesigning of streets would need to be considered for automated vehicles. For example, automated vehicles can make precise manoeuvres and so streets could be made narrower.	Interventio n	R,W
Cluster-wise cooperative eco-approach and departure	Strategically coordinate CAVs' manoeuvers to form clusters with following methodologies: initial vehicle clustering, intra-cluster sequence optimization, and cluster formation control. This could increase traffic throughput by 50% and reduce emissions by 20%	Application	L

Table 3.4. Urban transport sub-use cases - Descriptions and categorizations. Please note that this list also includes suggestions from the SRG workshop. Indicator column indicates whether the sub-use case was discussed in literature, roadmap and workshop.

Sub-Use Case	**Description**	**Category**	**Indicator** Literature (L) Roadmap (R) Workshop (W)
Point to point shuttle	Automated urban shuttles travelling between fixed stations. Passengers will be able to take any passing shuttle from the fixed stations and choose any other station as a destination.	Application	L,R,W
Anywhere to anywhere shuttle	Automated urban shuttles travelling between different, not fixed locations	Application	L,R,W
Last-mile shuttle	Automated urban shuttles provide convenient first/last mile solutions supporting public transport. They are not competing with main lines of public transport.	Application	L,W
On road operations	Automated urban shuttles on different road situations, e.g. urban shuttles on junctions, urban shuttles when construction sites block traffic	Scenario	L
Street design implications	Road infrastructure should assist the operation of automated urban transport and be influenced by automated urban transport, e.g. lane size, intersections design	Interventio n	R,W
Multi-modal integrated payments	Apply an integrated price depending on the use of multiple modes of urban transport (shuttle-to-shuttle, shuttle to underground, etc) Can be dynamic depending on area, traffic load, and time.	Application	L,W
e-hailing	Passengers will book rides from anywhere to anywhere with automated vehicles through a smartphone app with a transportation network company	Application	L
Automated ride sharing	Automated passenger cars will be booked by multiple passengers (using a smartphone app) to travel between convenient points. Passengers' final destinations could be near to each other, but not necessarily the same.	Application	L,W

A preliminary list of sub-use cases will be taken forward for further refinement in future tasks bases on indications from workshop and in terms of how feasible it is to predict impact for those sub-use cases. Furthermore, these sub-use cases will be clustered to add more clarity in the workflow and when designing the PST.

4 Workshop outcomes

This section constitutes a summary of the main results of the first Stakeholder Reference Group (SRG) workshop and the pre-workshop online survey described in section 4.1.

The first Stakeholders Reference Group workshop took place in Gothenburg and 45 experts from Europe and Australia discussed their visions, expectations, use cases and conflicts for a future with connected automated vehicles. The workshop was organised in the following four sessions each one dedicated to a different part of the LEVITATE project:

- Session 1 – Visions of CATS futures (current approaches to future planning in order to define important characteristics of short medium and long term future to take into account in WPs 5, 6 and 7)
- Session 2 – Ideal futures (definition of future goals and indicators needed in order to develop the scenarios in WP4)
- Session 3 – Selecting interventions and activities (feedback on the sub-use cases identified in WPs 5, 6 and 7)
- Session 4 – Feedback on the PST (discussion on expectations and needs regarding the PST to be developed in WP8)

The workshop agenda can be found in the section 6.3 of the Appendix.
The outcomes of sessions 1 and 3 provided feedback to WPs 5, 6 and 7 and those concerning urban transport will be presented in this section. Out of the 45 participants, 22 took part in the urban transport group during these two sessions.

4.1 Pre-workshop online survey

The online survey was sent to all registered participants prior to the workshop to obtain a general assessment of the proposed indicators and to allow using the survey results as an impulse for inspiring discussions during the workshop. Twenty-four (24) workshop participants responded to the online survey. The details of the setting and outcome can be found in deliverable D4.1. Here we provide a summary on:

- the number and organisation type of the participants (Figure 4.1)
- their indicated importance of the goal dimensions (Figure 4.2)
- the number of ongoing and planned activities on the sub-use cases (Figure 4.9) and broken down to organisation types:
    - governmental organisations (Figure 4.3)
    - municipalities (Figure 4.4)
    - research and developmental organisations (Figure 4.5)

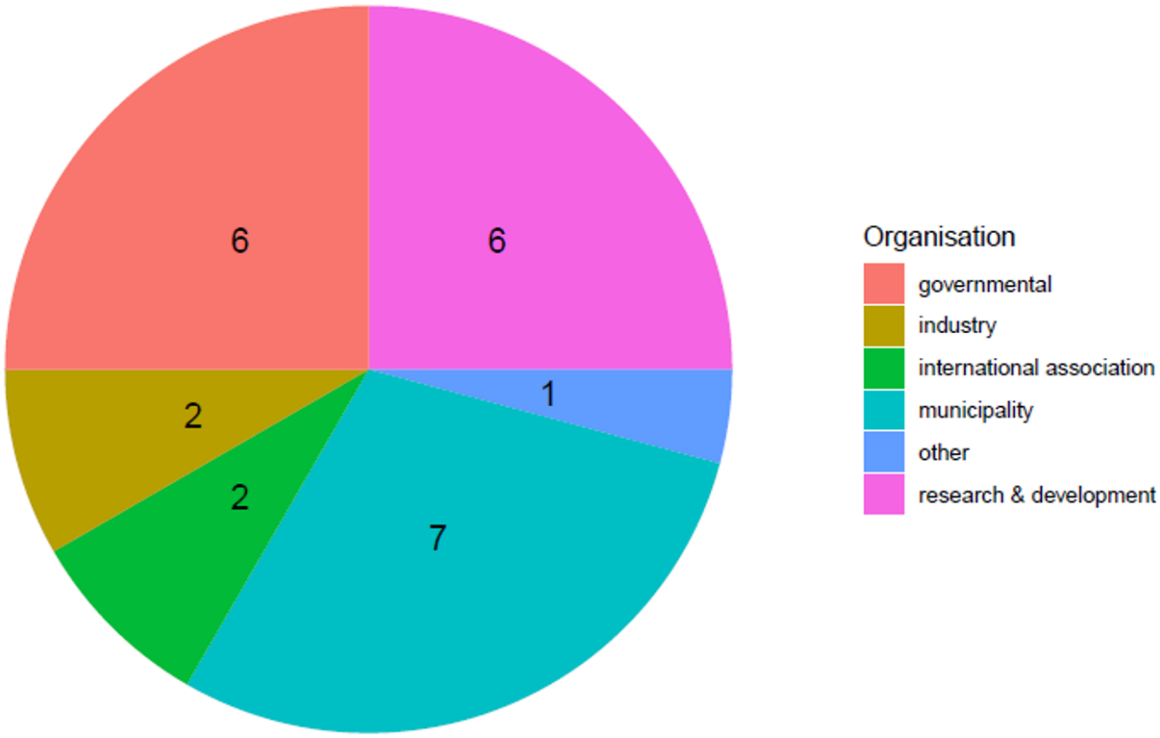


Figure 4.1 Number of participants for each organisation type. N=24.

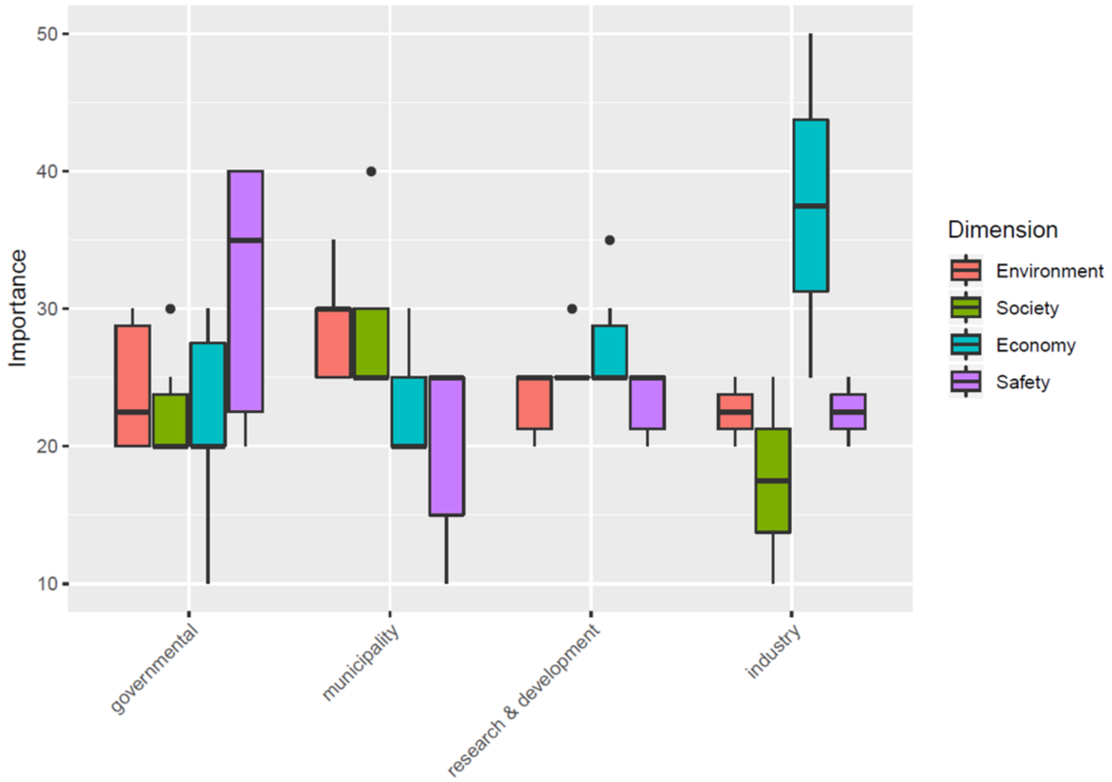


Figure 4.2 Indicated importance of goal dimensions, results for each organisation type. N=24.

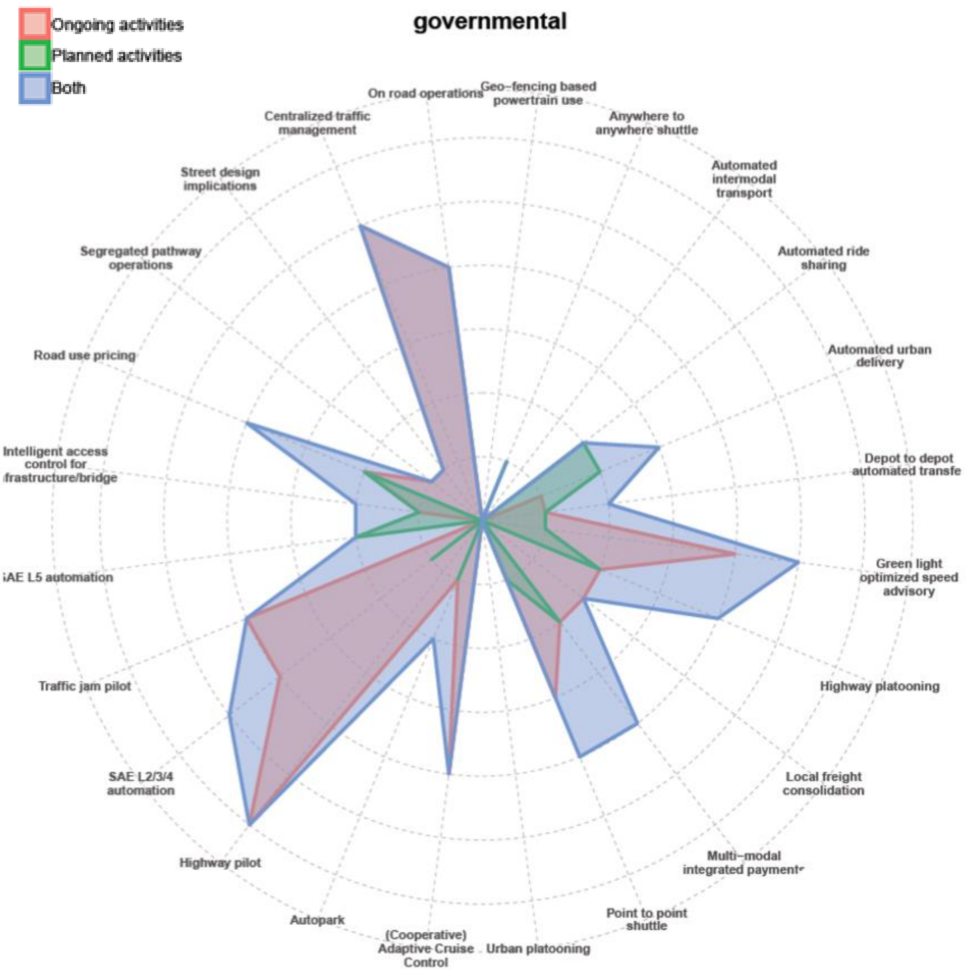


Figure 4.3 Ongoing and planned activities on the sub-use cases within governmental organisations. N=24.

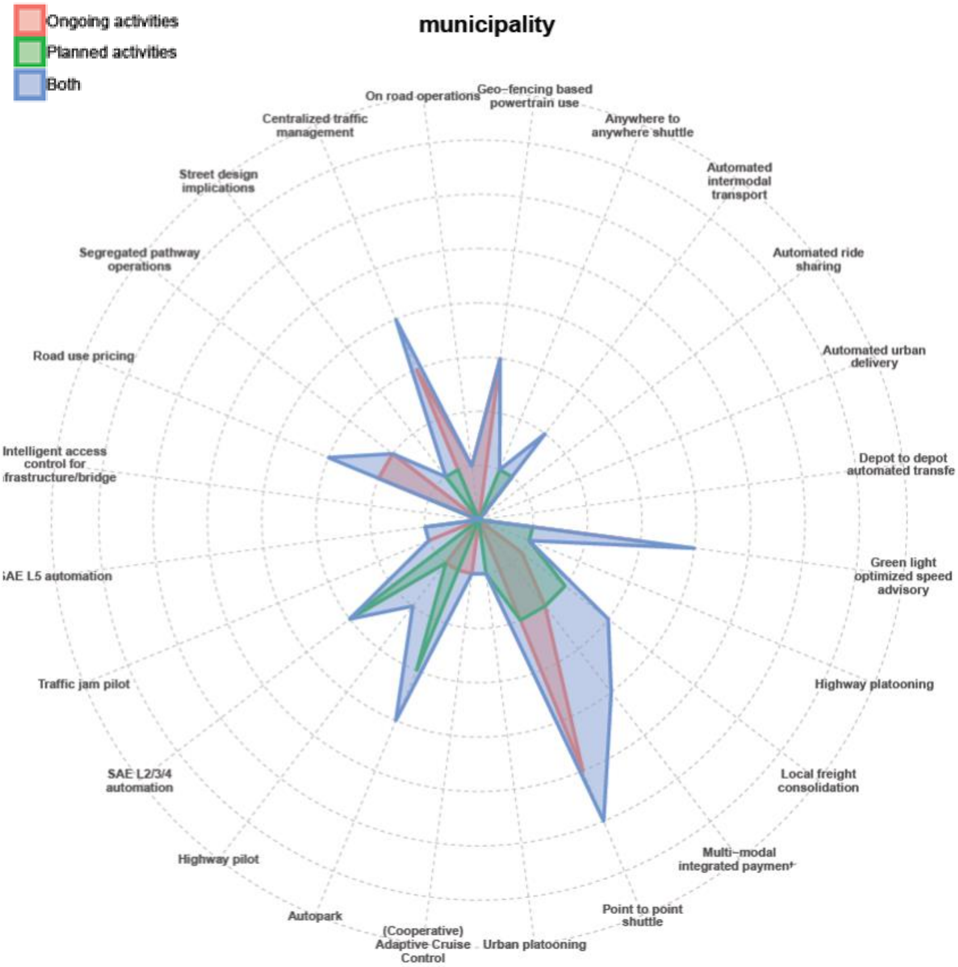


Figure 4.4 Ongoing and planned activities on the sub-use cases within municipalities. N=24.

Figure 4.5 Ongoing and planned activities on the sub-use cases within research and developmental organisations. N=24.

Based on the results of the pre-workshop online survey, it seems that some sub-use cases were common amongst all the participants, but some were only common across two types of organisations. These are listed in Figure 6.7 accordingly.

Sub-use cases that were prioritised by **only** governmental organisations are:

- On road operations and,
- Traffic jam pilot

Sub-use cases that were prioritised by **only** municipality organisations are:

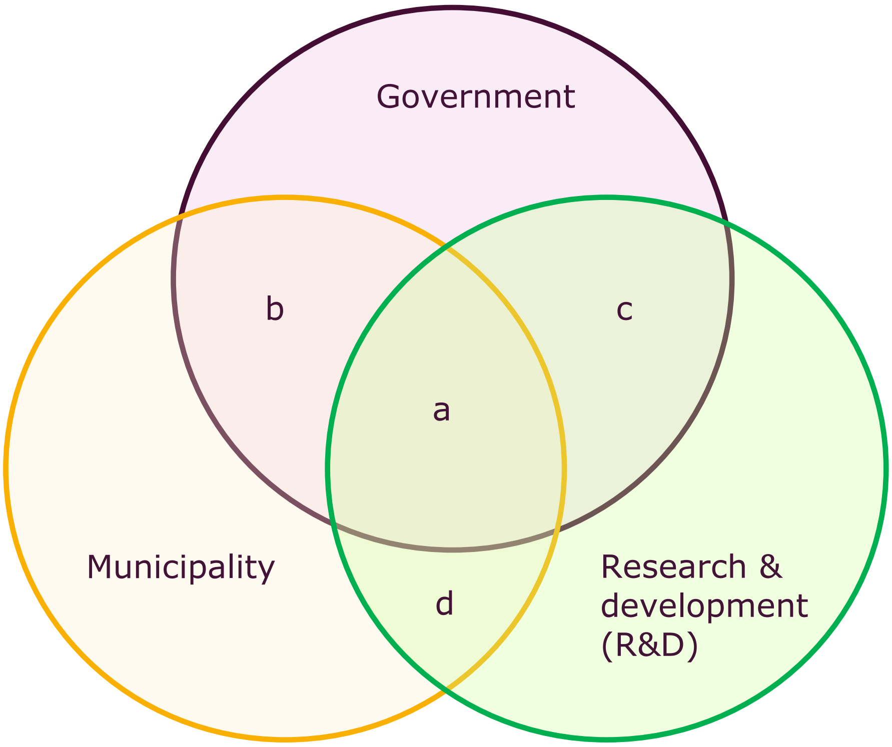
- Autopark and,
- Geo-fencing-based powertrain use

And finally, sub-use cases that were prioritised by **only** research and development organisations are:

- Street design implications,

- Depot to depot automated transfer,
- Automated urban delivery and,
- Automated intermodal transport

It seems that most activities are related to passenger cars and public (urban) transport and all organisations are focused on those related sub-use cases. In contrast, only municipalities and some research and development organisations are focused on freight related sub-use cases.



(a) Common sub-use cases across all

1. Centralised traffic management
2. SAE L2/3/4 automation
3. Point-to-point shuttle
4. Multi-modal integrated payments

(b) Common sub-use cases between government and municipality (but not R&D)

1. Road use pricing
2. Green light optimised speed advisory

(c) Common sub-use cases between government and research & development organisations (but not municipality)

1. Highway pilot
2. Cooperative Adaptive Cruise Control (CACC)
3. Highway platooning

(d) Common sub-use cases between research & development organisations and municipality (but not government)

4. Local freight consolidation

Figure 4.6 Common priorities amongst government, municipalities and research and development organisations that were deduced from pre-workshop survey.

4.2 Session 1 – Defining futures

The purpose of this session was to identify stakeholder expectations for the short, medium and long term future of CATS and gain insight on how they plan for future to meet their goals. More specifically, the objectives of this session were to:

- Identify current approaches of planning for the short, medium and long term future as the tools in the PST need to fit in with their way of thinking.
- Identify what technologies (e.g. 5G), infrastructure (e.g. parking spaces, infrastructure-based CATS scenarios such as dedicated lanes), or driver behaviour changes (e.g. change in vehicle usage, change in vehicle demand) that cities envisage, play a role in the short, medium and long term (specifically which time period) as the parameters used in the simulations should include accurate reflection of what stakeholders believe will be available.
- If possible identify any features/parameters which are more appropriate to either short, medium or long term.

Workshop participants within urban transport theme were asked the following questions and collective responses to those questions are summarised below:

4.2.1 Future overview

Question

When you think of future cities what positive outcomes do you think CATS will bring?

Response:

Response from participants is summarised in Figure 4.7. Comments are grouped into appropriate categories.

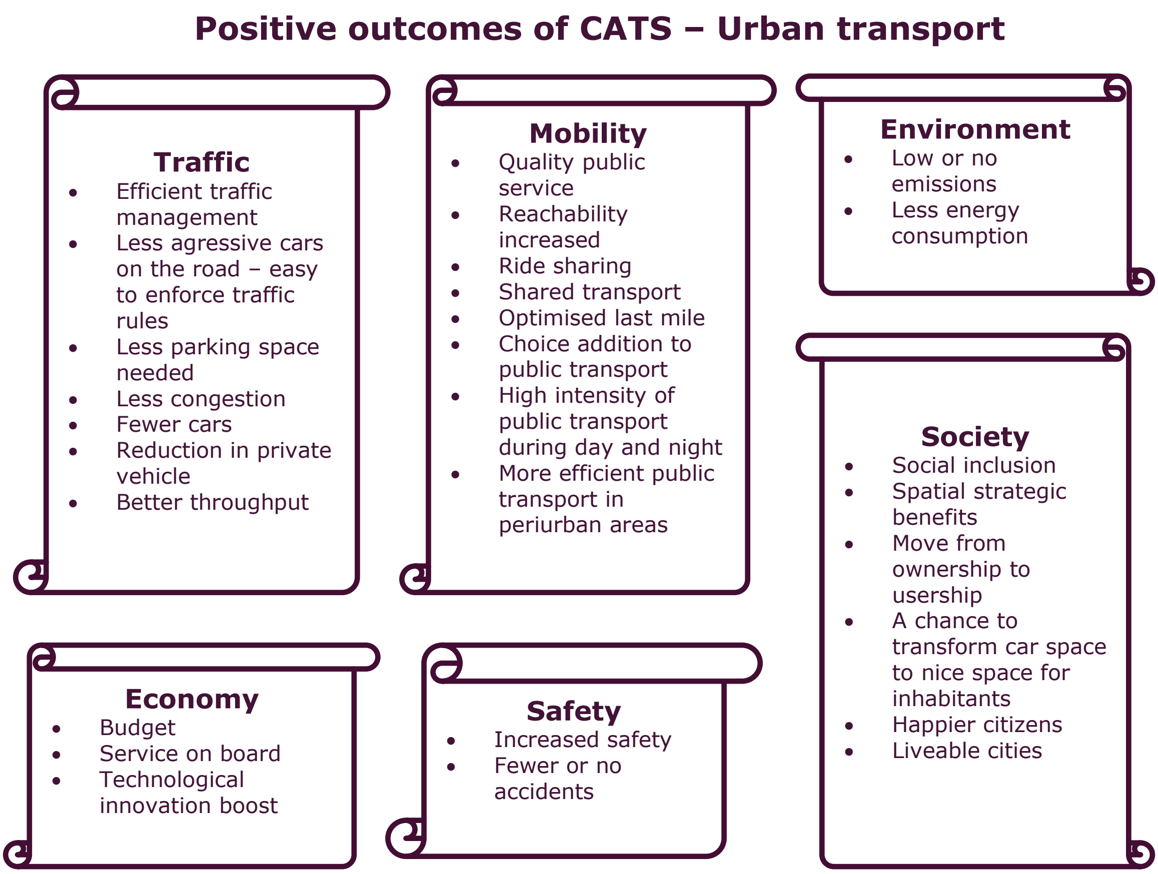


Figure 4.7 Summarised comments from the workshop participants on positive outcomes of CATS.

Question
When you think of future cities and CATS what are the biggest challenges will need to be overcome to achieve the positive outcomes that you think of?
Response:
Response from participants is summarised in Figure 4.8. Comments are grouped into appropriate categories.

Challenges in achieving positive outcomes of CATS – Urban transport

Traffic

- Regulation of traffic laws
- Mixed traffic issues
- Regulating demand to avoid more traffic
- Common rules for signage and map descriptions
- Infrastructure developments
- Mix of CATS and conventional vehicles
- Infrastructure not in favour of CATS

Economy

- Financial regulation
- Integrated booking and payment
- Liability
- Affordability
- Vested interest

Technology

- Technical regulation
- Technical issues
- AV and human (non-user) interaction
- Ensuring safety
- Reliance on connectivity
- Cyber security
- Poor technology
- Data quality

Transport

- Increase in demand
- Must not compete with public transport
- Increase in capacity
- Km travelled per person must stay constant
- Modal shift
- Focus on mass public transport rather than individula trips
- Lack of proven benefits

Governance

- Legislations
- Policy to keep up with technological advancements
- Multibrand
- Public policy goals
- Users not respecting rules

Society

- Trust and acceptance at individual and society level
- Behavioural challenge
- Lack of physical activity and increase in obesity
- Citizens reliability
- Valuing cycling and walking
- Public opposition to pricing
- Fatalism
- Ethics inclusivity
- Distrust on politicians
- Co-existence

Figure 4.8 Summarised comments from the workshop participants on challenges to overcome to achieve positive outcomes of CATS.

It is clear that CATS are expected to bring benefits to society, economy and environment through increase in safety and mobility and through traffic optimisation. However, there are organisational and societal level challenges that need to be addressed. Not surprisingly, the technological and traffic management related issues are immediate but there is also rising need for governance. Financial regulation will need to be in place to avoid vested interests and be able to provide affordable public transport. There are questions arising in terms of adoption of the technology, behavioural changes and public health. On extreme cases, there is also fear of fatalism.

4.2.2 Current approaches to future planning

Set of questions:

- *Describe the current approach to plan for the future of urban transport.*
- *What are the main principles of the approach?*
- *How far in the future do you plan, is short, medium and long term defined?*
- *What features of a future do you expect to occur/take into account when planning? E.g. technologies (mobility as a service, vehicle platooning, V2X communications), infrastructure (parking space availability), change in driver*

behaviour (reduced vehicle use), change to economy, change in employment skills etc

- *What are the biggest difficulties to planning (find the "pain points" the PST might help with.*

Responses:

Planning
Currently, the responders in the workshop consider that the concept of Mobility as a Service, C-ITS services, digital infrastructure and data sync are key enablers to plan for the future of AVs in urban transport. Public acceptance and trust are considered fundamental for the implementation of CATS in urban transport, for this reason authorities must use social media to promote automated urban transport. Stakeholders take also into account, while planning for the future, the dependence on political decisions. They emphasized the fact that automated urban transport should not compete with public transport but should complement it. Additionally, they expressed their concerns about how the implementation of CATS in urban transport will affect in the medium-term active modes of transport, e.g. walking and cycling. Finally, they highlighted the importance of implementing CATS in urban transport due to their environmental and societal impacts.

Timeline
The majority of participants claimed that they are planning in a twenty-five year viewpoint, but they also have some short term actions planned.

4.2.3 Expectations of the future

Set of questions:

Mind map voting and parameter notes

- *Place your dots on the features which you expect will have greatest importance for the short, medium and long term?*

Responses:
Several short-, medium- and long-term features were identified and rated. A mind map was generated during the workshop discussions and is provided in Figure 6.2 within the appendix. Table 4.1 shows the features from mind map that were given ratings.

Table 4.1. Voting of parameters that were identified during the discussions of passenger cars in workshop. Number of letters in the table shows the number of votes. Parameters are shown in Bold whereas the elements that were considered within each parameter are shown in Italics. N=22.

Parameters/Elements	Short-term (S)	Medium-term (M)	Long-term (L)
Policy	SS	M	
Dependence on political decisions		M	
Acceptability	S		
Behaviour change	S	M	LL

Parameters/Elements	Short-term (S)	Medium-term (M)	Long-term (L)
Inclusiveness		M	
Accessibility	S		L
Environmental pollution	SS		
Technology			
Data sync		M	
Connectivity	S	M	
Mixed traffic			LL
Electric vehicles	S	M	
Economy	S		
Affordability		M	
Promote innovation	S		
Infrastructure			
C-ITS		M	
Digital infrastructure			L
Traffic management	S	MM	L
Mobility as a Service		M	L
Services	S		
Authorities	S	M	
Social media	SS		
Lack of evidence of future impact	S		
More pilot projects	SSSSS		

According to the participants in the urban transport theme, there is a need of more pilot projects in the short term in order to gain evidence of future impacts. Additionally, users' acceptance and trust, as well as promotion of the automated urban transport by authorities via social media are part of the short-term expectations. In terms of medium-term expectations, *infrastructure and technology* were the most important features. In terms of long-term expectations, there was no clear importance of a particular feature, but *mixed traffic and behaviour change* were considered to be more important than other features that were identified during the workshop.

4.3 Session 3 - Selecting interventions and activities

The purpose of this session was to prioritise sub-use cases, as well as to identify potential challenges and complete the list of proposed sub-use cases. More specifically, the goals of this session were:

- Gain feedback on the resulted sub-use cases hierarchy, based on the pre-workshop survey.
- Identify potential challenges and ways to tackle them during the implementation of sub-use cases.
- Identify which sub-use cases are more appropriate for the identification of short, medium and long-term impacts.
- Complete the list of proposed sub-use cases with additions from the stakeholders.

4.3.1 Prioritisation of interventions

During this session, selection of sub-use cases was presented in its prioritised form, shown below in Figure 4.9. The priorities were deduced from the pre-workshop survey with 24 participants as mentioned in the previous section. It should be noted that all sub-use cases are shown, not only the ones relevant for urban transport.

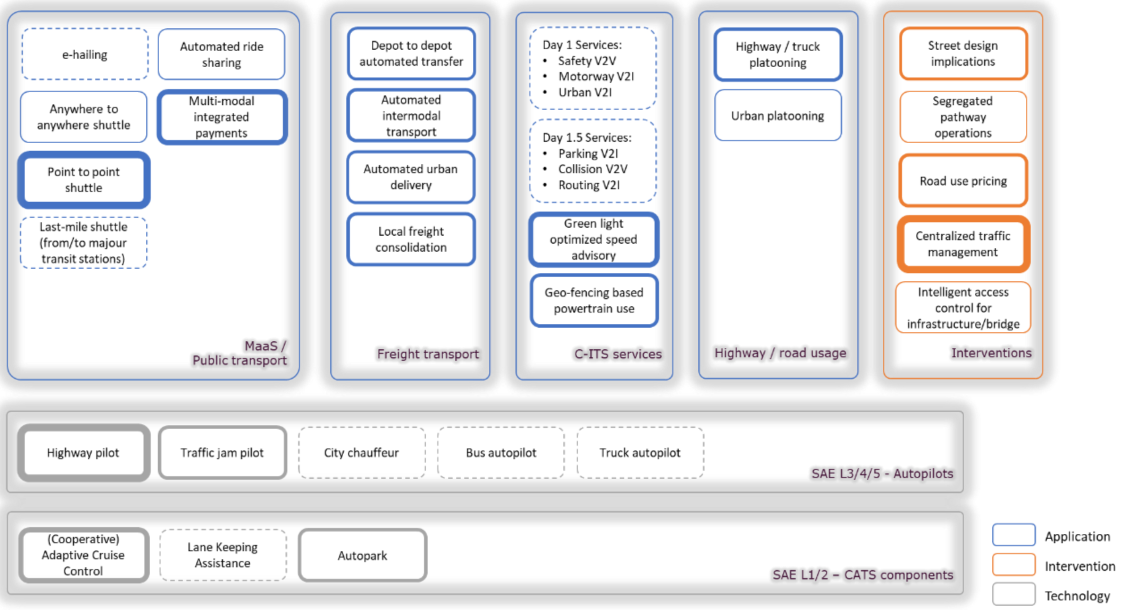


Figure 4.9 List of sub-use cases that were clustered together before workshop and prioritised based on pre-workshop survey. The thickness of boxes show priority, going from thickest with high priority to thinnest for low priority.

Workshop participants were then asked the following questions:

Question:
Do you agree with this (presented) order of the sub-use cases?

Response:
14 participants (63,64%) out of 22 in the urban transport group disagreed with the presented order of the sub-use cases.

Set of questions:
Which sub-use case you consider important but less feasible?
Brainstorming how the sub-use cases that are not easily feasible can be realised.
Which of these sub-use cases are most appropriate for the short, medium and long term?

Response:
The respondents consider point to point shuttle and multi-modal integrated payments the most important sub-use cases to be studied for the short term, based on the concept that automated urban transport will be a last mile thing which complements to public transport mainlines and not a competing service to public transport, which is anywhere in the city.

Table 4.2. Identifying sub-use cases for short-, medium- and long-term futures. Number of letters in the table shows the number of votes. N=22.

Sub-use cases	Short-term (S)	Medium-term (M)	Long-term (L)
Anywhere to anywhere shuttle			LLL
e-hailing			L
Point to point shuttle	SSS		LL
Automated ride sharing			
Last-mile shuttle (from/to major transit stations)	S	MMM	
Multi-modal integrated payments	SSS	M	LL
Green light optimised speed advisory			L
Automated urban delivery		M	L
Highway/truck platooning		MM	
Street design implications		M	LL
Urban platooning			L
Centralised traffic management	SS		L
Road use pricing	SS	MMM	L
Bus autopilot	S	MM	L
Adaptive speed limits	SS	MM	
Multi-modal trip options	SS	M	
Cyber-security regulation	SS		
Data sharing	SSS	M	

4.3.2 Challenges

Set of questions:
Which are the most important (1-2) sub-use cases that must necessarily take place in the project and be part of the PST?
Given your experience what are the challenges that might be faced for the implementation of each one of these sub-use cases in the cities?
How each one of the top challenges can be tackled in your opinion?

Response:
Multi-modal integrated payments - if we want the user to become a multimodal user, we need to have the mobility as a service approach in mind from the very beginning. And that means including non-motorised options which are completely out of the picture of autonomous driving.

According to the respondents an additional challenge is the consideration of active modes of transport (walking, cycling, etc.). When we talk about street space, street design, traffic lights, crossings, there's a whole range of things that can happen. It can be done in a way that it's getting better and it can become much worse, for this reason it is important to see the interactions with other modes of transport.

4.3.3 Interventions list completion

Set of questions:
Do you consider that the list of sub-use cases is complete?
State 1-2 other sub-use cases that you would consider as important to add.

Response:
The list below is summarised from the discussions in this entire session.

- Take into consideration the effect of cyber security regulations and data sharing for the short term.
- Take into consideration the effect of user interaction services, e.g. apps, information on demand
- Add more policy interventions, such as regulating the number of on-demand services, the size of the fleet
- Point to point shuttle and multi-modal integrated payments are relevant for short term impacts
- Not encouraging last mile shuttles because the aim is for people to walk unless they are disabled, so it is suggested to make it last two or three miles.
- Prioritise MaaS and interventions, such as centralized traffic management, road use pricing, street design implications
- Enhance mobility rather than traffic
- Sustainable mobility planning to enlarge active modes
- Multi-modal planning is a first step to ticketing and payment tool
- Focus on enablers such as pricing and regulations
- Proper regulations can change impacts

4.4 Key outcomes

The aim of the workshop was to gauge stakeholders' view on defining future of CATS and prioritising sub-use cases for urban transport. It appears that the stakeholders have high expectations from CATS and they also recognise challenges in achieving those. When planning futures, they have considered roughly 5 years per level of automation (those defined by SAE). In their opinion, public acceptance, appropriate policies and technology adoption were the most important things to consider in planning.

In terms of sub-use cases (also interventions), it was found that all organisations had some common sub-use cases that they have either planned or ongoing activities. It was also emphasised that the analysis should be human-centred rather than technology-centred. Participants identified that some sub-use cases were missing in the list and therefore additional sub-use cases were proposed.

5 Conclusion and future work

5.1 Conclusions

5.1.1 Defining the future of urban transport

Literature on potential impacts of automation technologies within urban transport domain, as well as factors influencing the user acceptance were analysed. Evidence from ADAS technologies was also analysed and it became evident that the forecasts of ADAS penetration were overoptimistic, although systems with greater focus on driver comfort had higher penetration rates.

In order to progress in impact assessment, a future needed to be defined and this was considered by examining literature on available market penetration forecasts along with technology roadmaps and, information gathering through a stakeholders' workshop. Even with some inconsistencies, a consensus was found. It must be emphasised that the technological roadmaps are generally focused on when a particular technology will be available but not on its market penetration. Therefore, it was difficult to translate roadmaps into market penetration and so only those reports that provided market forecasts were considered.

According to stakeholders, the short-term expectations were, user acceptance and trust, as well as promotion of the automated urban transport by authorities via social media. In terms of medium-term expectations, infrastructure and technology were the most important features. In terms of long-term expectations, there was no clear importance of a particular feature, but mixed traffic and behaviour change were considered to be more important than other features that were identified during the workshop.

It was considered that for the purposes of this project, short-, medium- and long-term impacts would be those defined by deliverable 3.1 in this project (Elvik et al., 2019) as direct, systemic and wider impacts, respectively.

5.1.2 Urban transport sub-use cases

Based on the initial list of sub-use cases for urban transport, workshop participants suggested additional sub-use cases, that include prioritisation of MaaS, cyber-security regulations and data sharing sub-use cases as well as more policy interventions, such as regulating the number of on-demand services. It was emphasised that in order to have a better future of automated urban transport, it is necessary to take into consideration changes in regulations and opt for a sustainable mobility planning.

Sub-use cases of the urban transport use case will be prioritised for their consideration in further investigation. When prioritising, factors such as widespread studies being followed on those sub-use cases and the feasibility of impact assessment will be considered.

For the sake of simplicity and applicability of assessment methods, it is assumed that for the appropriate level of automation, adequate infrastructure exists. It is also assumed that the pure technological obstacles for the sub-use cases in consideration are solved.

5.2 Future work

Further work to be carried out in WP5 is mentioned below.

1. Prioritisation of sub-use cases
2. Literature review specific to sub-use cases and impacts
3. Analysing impacts using appropriate methodologies (from task 3.2)
4. Provide input to WP8.

On step 3, tasks 5.2, 5.3 and 5.4 will respectively assess short-, medium- and long-term impacts on society, economy, environment and safety from introduction of interventions and sub-use cases that have been identified in this deliverable. These introductions would be considered on case-by-case. For example, some sub-use cases can be introduced gradually such as level 4 automation for urban transport by means of market penetration. Whereas, some intervention such as multi-modal integrated payments can be introduced almost instantly on a relative timescale (in decades).

Types of impacts that are presented in deliverable 3.1 of LEVITATE (Elvik et al., 2019) will be forecasted using appropriate assessment methods that are developed in task 3.2. For example, traffic micro-simulations can directly provide short-term impacts and therefore, they will be used to forecast short-term impacts to be able to develop relationships that can infer dose (in terms of introduction of sub-use case) and response (selected impact). They also provide further input to assess medium-term impacts by processing those results appropriately to infer medium-term impacts. System level analysis (such as by tools within system dynamics) can provide measure of long-term impacts. These results relating to the relationships between sub-use cases, impacts and any intermediate parameters will be provided to WP8 to be incorporated in the PST so that impact assessment can be carried out.

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6 Appendix A

6.1 Stakeholders' pre-workshop interview– Defining the future of passenger cars, urban and freight transport

Introduction

- Welcome, thank you for your time
- Aim of interview – Defining the short, medium & long term future of passenger cars, urban and freight transport
- Approx. 30min discussion
- All data protection rules are followed.

Part 1: First thoughts on future cities and CATS

- When you think of future cities and CATS, what do you think of?

Part 2: What is currently being done for future planning and is it working?

- *Please describe what is currently being done to plan for the future of CATS and what are the main principles?*
- *Consider any project or experience you have regarding CATS introduction, what were the challenges and obstacles you faced?*
- Which approach is working well, and which not? Why?

Part 3: specific future vision

- *What do you envisage the short, medium and long term future of passenger cars will look like?*
- *What do you envisage the short, medium and long term future of urban transport will look like?*

- *What do you envisage the short, medium and long term future of freight will look like?*

(Penetration, Vehicles, Infrastructure, People acceptability)

Mention as many features of this future as you can. Are there any obstacles mentioned previously (Q2) that are relevant?

Part 4: Sub-use cases

A list of proposed sub use cases can be mentioned from the interviewer.

- *Could you think of any other use cases that are missing and would be valuable?*
- *Could you select top use cases within each type (urban transport, passenger car, freight) that you would most like to be able to explore in the future PST?*
- *What problems and questions is each use case addressing?*
- *What are the expected results given your experience?*

Part 5: the PST

- *Considering the future you are trying to plan for, what are the features you would like to see in the PST?*
- *How useful would you find it?*

Closing

- Comments and questions
- Thank you

6.2 A copy of online pre-workshop survey questionnaire

Pre-workshop survey - SRG

Part 1

Thank you very much for participating in this survey, which will give us a first impression about expectations and activities in relation to Connected an Automated Vehicles in different cities in Europe. We will ask you about general development plans and different potential measures in your region. Please answer the questions to the best of your knowledge. The survey will take you about 10 minutes.

Part 2: Background

1. Please provide some information about your background:

a. Organisation: ☐ Required

b. Position: ☐ Required

c. Type of organisation: ☐ Required

- ◯ governmental
- ◯ municipality
- ◯ civil society
- ◯ organisation
- ◯ international
- ◯ association industry
- ◯ research &

d. Country: ☐ Required

e. Please indicate the city or region you will be referring to in your answers. ☐ Required

Part 3

2. Please assess the importance of the following general goal dimensions in the strategic development of your region in relation to each other by allocating specific percentages to the four goals. Please make sure that the sum of the percentages for all the 4 goal dimensions is 100%.

a. Environment

b. Society

c. Economy

d. Safety

Part 4: Indicators & Goals

3. **Please indicate for the following selection of indicators for the development of a livable city are monitored (regularly measured) in your city and whether there are related specific goals (values) defined for the short (appr. 5-10 years), medium (appr. 15-20 years) or long term (appr. 25-30 years).**

Indicators

Please don't select more than 4 answer(s) per row.

	Monitored	Short term goal defined	Mid term goal defined	Long term goal defined
Transport safety: Number of injured per million inhabitants	☐	☐	☐	☐
Transport safety: Number casualties per million inhabitants	☐	☐	☐	☐
Transport safety: other important indicators (please specify on next page)	☐	☐	☐	☐
Reachability: Average travel time per day	☐	☐	☐	☐
Reachability: Number of opportunities per 30 minutes per mode of transport	☐	☐	☐	☐

Reachability: other important indicators (please specify on next page)				
Energy consumption per person in total				
Energy consumption per person transport related				
Energy consumption: other important indicators				
Emissions: SO2				
Emissions: PM2,5				
Emissions: PM10				
Emissions: NO2				
Emissions: NO				
Emissions: Nox				
Emissions: CO				
Emissions: O3				
Emissions: other important indicators (please specify on next page)				
Public space: Lane space per person (e.g. Vienna: multi- purpose area map)				
Public space: Pedestrian/cycling space per person				
Public space: urban atlas data (Eurostat)				

Public space: other important indicators	☐	☐	☐	☐
Urban sprawl: Building volume per square kilometre in total	☐	☐	☐	☐
Urban sprawl: Building volume per square kilometre per built-up area	☐	☐	☐	☐
Urban sprawl: Population density (Eurostat)	☐	☐	☐	☐
Urban sprawl: other important indicators (please specify on next page)	☐	☐	☐	☐
Inclusion: Distance to nearest publicly accessible transport stop (including MaaS)	☐	☐	☐	☐
Inclusion: Affordability/discounts	☐	☐	☐	☐
Inclusion: Barrier free accessibility	☐	☐	☐	☐
Inclusion: Quality of access restrictions/scoring	☐	☐	☐	☐
Inclusion: other important indicators (please specify on next page)	☐	☐	☐	☐
Transport system satisfaction: Satisfaction with active transport infrastructure in neighbourhood (walking and/or cycling)	☐	☐	☐	☐
Transport system satisfaction: Satisfaction public transport in neighbourhood	☐	☐	☐	☐

Transport system satisfaction: other important indicators (please specify on next page)	☐	☐	☐	☐
Prosperity: Taxable income in relation to purchasing power	☐	☐	☐	☐
Prosperity: other important indicators (please specify on next page)	☐	☐	☐	☐

Part 5

4. Please list other important indicators related to the development of a livable city you are monitoring.

Part 6

5. Are there any other specific goals you have defined for a certain time period? Please specify.

Part 7: Strategies

6. Which of the following strategic measures are being taken in your country/by your organisation?

- ☐ National
- ☐ strategy Action
- ☐ Plan
- ☐ Pilot Testing
- ☐ Methodological
- ☐ standards Research
- ☐ Programme Legal

Part 8: Interventions and activities

7. **In which of the following areas in relation to CATS have you started or are you planning to start activities?**

Application: Geo-fencing based powertrain use

☐ More info

- ○ Ongoing
- ○ activities
- ○ Planned
- ○ activities No

Application: Anywhere to anywhere shuttle

☐ More info

- ○ Ongoing
- ○ activities
- ○ Planned
- ○ activities No

Application: Automated intermodal transport

☐ More info

Ongoing
activities
Planned
activities No

Application: Automated ride sharing

☐ More info

Ongoing
activities
Planned
activities No

Application: Automated urban delivery

☐ More info

Ongoing
activities
Planned
activities No

Application: Depot to depot automated transfer

☐ More info

- Ongoing
- activities
- Planned
- activities No

Application: Green light optimized speed advisory

☐ More info

- Ongoing
- activities
- Planned
- activities No

Application: Highway platooning

☐ More info

- Ongoing
- activities
- Planned
- activities No

Application: Local freight consolidation

☐ More info

Ongoing
activities
Planned
activities No

Application: Multi-modal integrated payments
☐ More info

Ongoing
activities
Planned
activities No

Application: Point to point shuttle

☐ More info

Ongoing
activities
Planned
activities No

Application: Urban platooning

☐ More info

- ◯ Ongoing activities
- ◯ Planned activities
- ◯ No

Technology: (Cooperative) Adaptive Cruise Control

☐ More info

- ◯ Ongoing activities
- ◯ Planned activities
- ◯ No

Technology: Autopark

☐ More info

- ◯ Ongoing activities
- ◯ Planned activities
- ◯ No

Technology: Highway pilot

☐ More info

- ◯ Ongoing
- ◯ activities
- ◯ Planned
- ◯ activities No

Technology: SAE L2/3/4 automation

☐ More info

- ◯ Ongoing
- ◯ activities
- ◯ Planned
- ◯ activities No

Technology: Traffic jam pilot

☐ More info

- ◯ Ongoing
- ◯ activities
- ◯ Planned
- ◯ activities No

Technology: SAE L5 automation

☐ More info

- Ongoing
- activities
- Planned
- activities No

Intervention: Intelligent access control for infrastructure/bridge

☐ More info

- Ongoing
- activities
- Planned
- activities No

Intervention: Road use pricing

☐ More info

- Ongoing
- activities
- Planned
- activities No

Intervention: Segregated pathway operations

☐ More info

- Ongoing
- activities
- Planned
- activities No

Intervention: Street design implications

☐ More info

- Ongoing
- activities
- Planned
- activities No

Intervention: Centralized traffic management

☐ More info

- Ongoing
- activities
- Planned
- activities No

Intervention: On road operations

☐ More info

- Ongoing
- activities
- Planned
- activities No

Other:

Part 9: Final Part

Thank you for taking the time to complete this survey!

Here is a link to LEVITATE project:

https://levitate-project.eu/about/

6.3 Agenda of the SRG workshop

LEVITATE 1st Stakeholder Workshop

28 May 2019, Gothenburg

Lindholmen Conference Centre, Lindholmspiren 5, 417 56 Gothenburg

Societal Level Impacts of Connected and Automated Vehicles	
08:30-09:00	*Registration & Coffee*
09:00-09:20	**Welcome & Introduction to the project** *Pete Thomas, Loughborough University*
09:20-09:30	**Presentation of pre-workshop survey results: Landscape of Goals and Plans** *Alexandra Millonig, AIT Austrian Institute of Technology*
09:30-10:30	**Discussion Round 1: Visions of CAT Futures** *Ashleigh Filtness, Loughborough University* Parallel Group Discussions: • Automated Urban Transport • Passenger Cars • Freight Transport & Logistics
10:30-10:50	*Refreshment Break*
10:50-11:00	**Introduction: Building Ideal Futures with Conflicting Goals** *Alexandra Millonig, AIT Austrian Institute of Technology*
11:00-12:00	**Discussion Round 2: Ideal Futures** *Alexandra Millonig, AIT Austrian Institute of Technology* Parallel Group Discussions: • Environment • Society • Economy • Safety
12:00-13:30	*Lunch Break (including demo visits and video interviews)*
13:30-13:50	**Plenary Discussion: Overlaps & Conflicts** *Alexandra Millonig, AIT Austrian Institute of Technology*
13:50-14:50	**Discussion Round 3: Selecting Interventions & Activities** *Julia Roussou, National Technical University of Athens* Parallel Group Discussions: • Automated Urban Transport • Passenger Cars • Freight Transport & Logistics
14:50-15:30	**Introduction to the Policy Support Tool (PST), followed by discussion on expectations and needs regarding the PST** *Julia Roussou, National Technical University of Athens*
15:30-16:00	**Closing & networking coffee, demo visits, video interviews**

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 824361.

Figure 6.1: Agenda of the SRG Workshop on 28 May 2019.

6.4 Results of the stakeholders engagement workshop

(a)

(b)

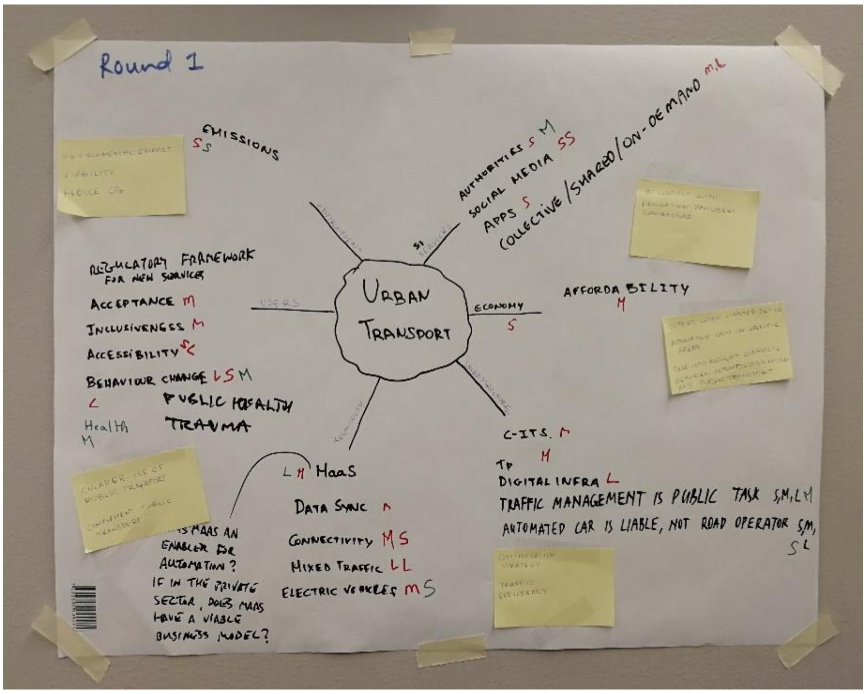
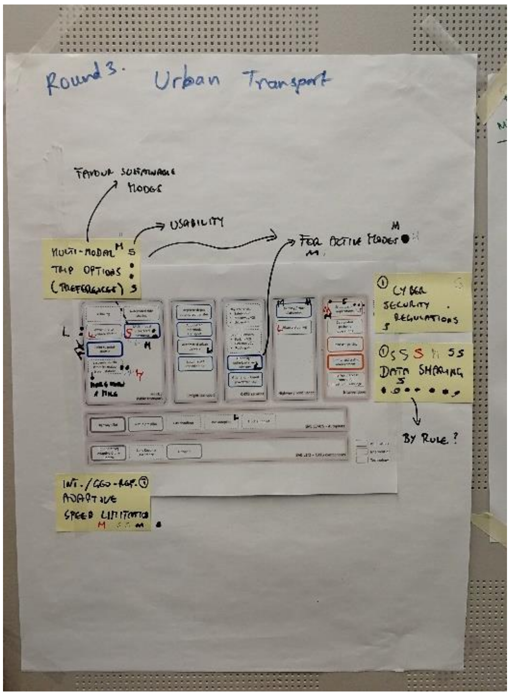


Figure 6.2 (a) Mind map generated during workshop on urban transport theme group 1 – Defining futures. (b) Mind map generated during workshop on urban transport theme group 2 – Defining futures.

(a)



(b)

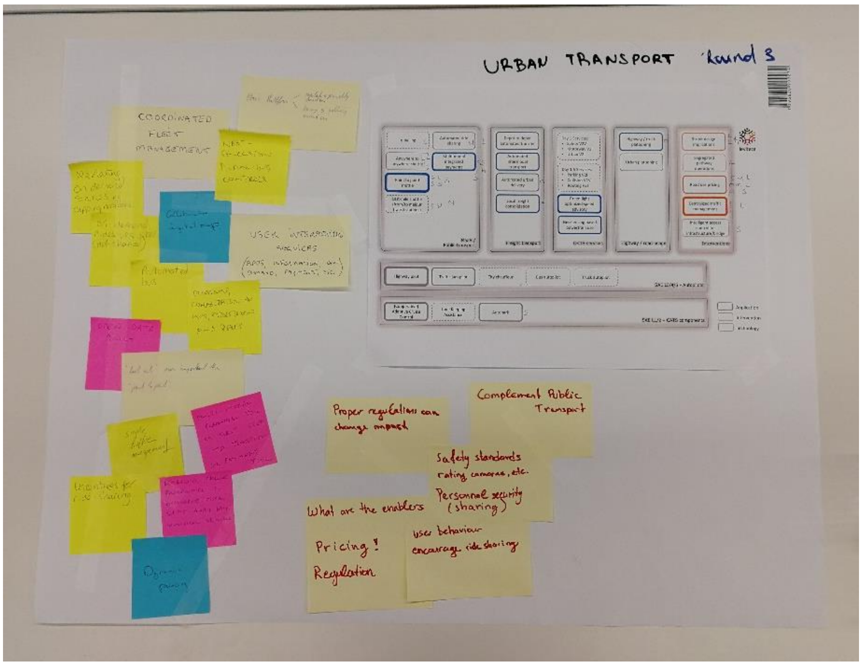


Figure 6.3 (a) Additional sub-use cases and comments that were added to the list of sub-use cases during session 3 of workshop group 1. (b) Additional sub-use cases and comments that were added to the list of sub-use cases during session 3 of workshop group 2.

6.5 EU Projects on CATS

Table 6.1 summarises the EU Projects on CATS.

Table 6.1 EU Projects on CATS

EU Projects on CATS		
CoEXist 05/2017 – 04/2020	https://www.h2020-coexist.eu/	focusing on the technological development of microscopic and macroscopic transport modelling tools, CAV-simulators and CAV control logistics and aims to strengthen the capabilities of urban road authorities for the planning and integration of CAVs on their networks
AUTOPILOT 01/2017-31/12/2019	http://autopilot-project.eu/	AUTOPILOT brings together relevant knowledge and technology from the automotive and the IoT (internet of Things) value chains in order to develop IoT-architectures and platforms which will bring automated driving towards a new dimension
Connected automated driving.eu (SCOUT, CARTRE) Both completed	https://connectedautomateddriving.eu/about-us/	two projects (SCOUT, CARTRE) that work together with a broad range of international stakeholders to ensure that these technologies are deployed in a coordinated and harmonised manner, which will accelerate the implementation of safe and connected automated driving in Europe.
SCOUT (H20202) 01/07/2016-2018	https://connectedautomateddriving.eu/about-us/scout/	aims to promote a common roadmap of the automotive and the telecommunication and digital sectors for the development and accelerated implementation of safe and connected and high-degree automated driving in Europe. It will support identification of deployment scenarios in LEVITATE.
CARTRE (H2020) 01/10/2016-2018	https://connectedautomateddriving.eu/about-us/cartre/	aims to establish a joint stakeholders forum in order to coordinate and harmonise automated road transport approaches at European (e.g. strategic alignment of national action plans for automated driving) and international level (in particular with the US and Japan).
ARCADE (will continue the work of CARTRE)	https://connectedautomateddriving.eu/arcade-project/	aims to coordinate consensus-building across stakeholders in order to enable smooth deployment of connected and automated driving (CAD) on European

01/10/2018-2021		roads and beyond. EC, Member States and industry are committed to develop a common approach to development, testing, validation and deployment of connected and automated driving.
interACT 01/05/2017-30-04/2020	https://www.interact-roadautomation.eu/	Works towards cooperative interaction of automated vehicles with other road users in mixed traffic environments
L3Pilot 09/2017-2021	http://www.l3pilot.eu/home/	The overall objective of L3Pilot is to test the viability of automated driving as a safe and efficient means of transportation, exploring and promoting new service concepts to provide inclusive mobility (assessment of level 3 & 4 in-vehicle functions).
AdaptIVe Level1 -level 4 of automation 01/2014-06/2017	https://www.adaptive-ip.eu/	AdaptIVe develops various automated driving functions for daily traffic by dynamically adapting the level of automation to situation and driver status. Further, the project addresses legal issues that might impact successful market introduction.
iTETRIS 2008-2010?	http://www.ict-itetris.eu/simulator/	iTETRIS integrates wireless communications and road traffic simulation platforms in an environment that is easily tailored to specific situations allowing performance analysis of cooperative ITS at city level. The accuracy and scale of the simulations leveraged by iTETRIS will clearly reveal the impact of traffic engineering on city road traffic efficiency, operational strategy, and communications interoperability.
FUTURE-RADAR (H2020) *Jan 2017 – Dec 2020*	https://www.ertrac.org/index.php?page=future-radar POLIS is project partner	- support action for ERTRAC and EGVIA to create and implement the needed research and innovation strategies for a sustainable and competitive European road transport system. ERTRAC has a Working Group on road transport automation.
CIVITAS SATELLITE (H2020) *2002-2020*	https://civitas.eu/ POLIS is project partner	- CIVITAS can help to maximise the outreach of LEVITATE results. This includes, among others, making tools available in the online CIVITAS transport tools inventory.

Drive2theFuture (H2020) *2019-2022*	https://www.ait.ac.at/en/research-fields/integrated-mobility-systems/projects/drive2thefuture/	- The aim of the Drive2theFuture project is to prepare future "drivers" and travellers for networked, cooperative and automated means of transport and to increase acceptance accordingly.
MAVEN (H2020) *2016-2019*	http://maven-its.eu/ POLIS is project partner	- aims to provide solutions for managing automated vehicles in an urban environment (with signalised intersections and mixed traffic). - It develops algorithms for organising the flow of infrastructure-assisted automated vehicles.
STAPLE (CEDR) 2018-2020	AIT is project partner http://www.stapleproject.eu/	- Identification of relevant connected and automated driving test sites in Europe and beyond and creation of an online catalogue to be used and further enhanced by the NRAs for further research beyond the project duration - Investigation of the relevance of test sites against the NRA core business taking into account the roles and responsibilities of different stakeholders and looking at the areas of road safety, traffic efficiency, customer service, maintenance and construction
CityMobil 05/2006 – 12/2011	http://www.citymobil-project.eu/	- Safety applications and technologies: safe speed and safe following, lateral support, intersection safety, active 3D sensor technology for pre-crash and blind spot surveillance.
PICAV 08/2009 – 09/2012	https://cordis.europa.eu/project/rcn/91186/factsheet/en	- Passenger transport, urban traffic, car sharing, networking, assisted driving, vulnerable road users.
CATS 01/2010 – 12/2014	https://cordis.europa.eu/project/rcn/93669/factsheet/en	- Robotic driverless electric vehicle, passenger transport, transport management, urban transport.
FURBOT 11/2011 –	http://www.furbot.eu/	- Fully electrical vehicle for freight transport in urban areas,

02/2015		robotics.
V-Charge 06/2011 – 09/2015	http://www.v-charge.eu/	- Autonomous valet parking, EVs coordinated recharging, smart car system, autonomous driving, multicamera system, multi-sensor systems.
Cargo-ANTs 09/2013 – 08/2016	https://ict.eu/case/eu-fp7-project-cargo-ants/	- Create smart Automated Guided Vehicles (AGVs) and Automated Trucks (ATs) that can co-operate in shared workspaces for efficient and safe freight transportation in main ports and freight terminals.
CityMobil2 09/2012 – 08/2016	http://www.citymobil2.eu/en/	- Automated road transport system, automated vehicle, driverless, urban transport, safety, infrastructure, legislation.
PReVENT 02/2004 – 03/2008	https://trimis.ec.europa.eu/project/preventive-and-active-safety-application	- Development and demonstration of preventive safety applications and technologies (advanced sensor, communication and positioning technologies).
Have-it 02/2008 – 07/2011	https://cordis.europa.eu/project/rcn/85267/factsheet/en	- Automated assistance in congestion, temporary auto-pilot.
ASSESS 07/2009 – 12/2012	https://cordis.europa.eu/project/rcn/91187/factsheet/en	- To develop a relevant set of test and assessment methods applicable to a wide range of integrated vehicle safety systems, mainly AEB for car to car. Methods developed for driver behavioural aspects, pre-crash sensing performance and crash performance under conditions influenced by pre-crash driver and vehicle actions.
Digibus Austria (National Austrian Funding) *2018-2021*	https://www.digibus.at/en/ AIT is project partner	- pursues the goal to research and test methods, technologies and models for proofing a reliable and traffic-safe operation of automated shuttles on open roads in mixed traffic in a regional driving environment on automated driving level 3 ("Conditional Automation") and creating

		foundations for automation level 4 - The results form the basis for an Austrian reference model for the real testing and operation of highly or fully automated vehicles in local public transport. -
DIGITrans (National Austrian Funding) *2018-2023*	https://www.testregion-digitrans.at/ AIT is project partner	- Exploration of needs and cases of application regarding heavy duty and special purpose vehicles - Use of automated vehicles in areas of logistics hubs, e.g., inland ports like Ennshafen, airport or company sites - Common use of infrastructure for test regions regarding automated driving -
auto.Bus - Seestadt (National Austrian Funding) *2017-2020*	https://www.ait.ac.at/en/research-fields/integrated-mobility-systems/projects/autobus-seestadt/	- The findings of the project will be: (a) robustness through the use and fusion of modern image processing technology, (b) trust and acceptance-building interactions with passengers and other road users as well as their impact, and (c) planning and design principles. - These findings form the central prerequisites to enable a successful use of autonomous buses for public transport covering tomorrow's mobility needs.

Further list of projects can be found in Annex of Automated Driving Roadmap document from ERTRAC available at: https://www.ertrac.org/uploads/documentsearch/id38/ERTRAC_Automated-Driving-2015.pdf