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AVENUE

Automated Vehicles to Evolve to a New Urban Experience

DELIVERABLE

D2.9 Final Stakeholder analysis and AVENUE strategies

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Acronyms

AEV	Automated and Electric Vehicles
API	application programming interfaces
AV	Automated Vehicle
ENGO	Environmental Non-governmental Organisation
EU	European Union
GNSS	Global Navigation Signal System
ID	Identification
NGO	Non-Governmental Organisation
MaaS	Mobility as a Service
LiDar	Light Detection and Ranging
OEM	Original Equipment Manufacturers
PTC	Parametric Technology Corp.
PTO	Public Transport Operators
PRM	People with Reduced Mobility
SAE	Society of Automotive Engineers
SUMP	Sustainable Urban Mobility Plans
TDM	Travel Demand Management
TPG	Transport Public de Genève
UICR	Union Internationale des Chauffeurs Routiers
V2I	Vehicle-to-infrastructure
V2V	Vehicle- to- vehicle
V2X	Vehicle-to-everything

Executive Summary

The document at hand is the final stakeholder analysis. As an accumulation of the previous iterations, it showcases the key actors involved in the testing and deploying the automated minibuses for public transport in European cities. The stakeholder analysis is task 2.3 of WP2. This assessment helps construct a strategic overview of the expectations, needs, and impact of the stakeholders and the connection between them. The focus of this analysis is on the strategic actors, hence organisations, networks and institutions. The (potential) users of the Avenue automated minibuses are studied in more detail in WP8, the social impact analysis. The Avenue stakeholder analysis is conducted in several phases, and this report presents the final stakeholder analysis.

The presented stakeholder analysis relies on qualitative methods, and involved four steps. The first step was the initial stakeholder scan. Through (grey and academic) literature review and stakeholder mapping techniques, the main stakeholder groups were defined. In a second step, in-depth understanding of the goals, perceptions and information behaviour of these stakeholder groups was assessed through qualitative semi-structured interviews. In a third step, a content analysis of the interviews led to seven key themes: The crucial role of city government; Technology development and legal regulations; Restructuring the mobility industry; Social acceptance; Financial aspects; Environmental aspects and; Futures scenarios. The first three steps focussed on an EU-level analysis. In the fourth step, we zoomed into the Avenue stakeholder and mobility services map. Through a combination of literature review and expert interviews, we defined the main relations and themes for the Avenue ecosystem.

Section 2 describes the research design. The initial stakeholder scan and the results of the content analysis are included in section 3. Section 4 presents the Avenue stakeholder and mobility services map. Section 5 describes recommended stakeholder strategies.

The analysis delivers valuable findings.

- The Avenue centred map shows that automated minibuses are expected to be integrated into a multi and intermodal mobility system and offered as Mobility as a Service (MaaS). Also, there is a need for collective action to settle one legal framework and specific guidelines for AVs within the EU. Finally, the integration of AVs into the mobility system has to be promoted in synergy with the goals of Sustainable Urban Mobility Planning (SUMP)
- The stakeholders EU level map demonstrated that not all actors have an equal influence on the development of automated minibuses in urban public transportation systems. The primary actors are city governments, the public transport operators, the manufacturers, the software developers, the European Union, and citizens/end-users. Moreover, the relation between the city government and the PTO is a central one.
- The strategy presents key recommendations for different stakeholders, such as:
    - More emphasis should be given to the crucial role of the government and the legal framework in the deployment of automated minibuses
    - PTOs need more support from the local government, and they should reach out to other key stakeholders such as NGO and policymakers

- A MaaS platform should be operated in collaboration with private and public partners.
- There should be active involvement from citizens and civil society; this is done through strategic tools for citizens participation and inclusion in the debate about AV in general.
- For AVENUE and similar projects, it is important to involve stakeholders such as civil society organisations, e.g. as driver unions and environmental NGOs. Also, they need to cooperate more with city governments and focus on user-centric services and not only technological achievements

1 Introduction

AVENUE aims to design and carry out full-scale demonstrations of urban transport automation by deploying, for the first time worldwide, fleets of Automated minibuses in low to medium demand areas of 4 European demonstrator cities (Geneva, Lyon, Copenhagen and Luxembourg) and 2 to 3 replicator cities. The AVENUE vision for future public transport in urban and suburban areas, is that Automated vehicles will ensure safe, rapid, economic, sustainable and personalised transport of passengers. AVENUE introduces disruptive public transportation paradigms on the basis of on-demand, door-to-door services, aiming to set up a new model of public transportation, by revisiting the offered public transportation services, and aiming to suppress prescheduled fixed bus itineraries.

Vehicle services that substantially enhance the passenger experience as well as the overall quality and value of the service will be introduced, also targeting elderly people, people with disabilities and vulnerable users. Road behaviour, security of the Automated vehicles and passengers' safety are central points of the AVENUE project.

At the end of the AVENUE project four-year period the mission is to have demonstrated that Automated vehicles will become the future solution for public transport. The AVENUE project will demonstrate the economic, environmental and social potential of Automated vehicles for both companies and public commuters while assessing vehicle road behaviour safety.

1.1 On-demand Mobility

Public transportation is a key element of a region's economic development and the quality of life of its citizens.

Governments around the world are defining strategies for the development of efficient public transport based on different criteria of importance to their regions, such as topography, citizens' needs, social and economic barriers, environmental concerns and historical development. However, new technologies, modes of transport and services are appearing, which seem very promising to the support of regional strategies for the development of public transport.

On-demand transport is a public transport service that only works when a reservation has been recorded and will be a relevant solution where the demand for transport is diffuse and regular transport is inefficient.

On-demand transport differs from other public transport services in that vehicles do not follow a fixed route and do not use a predefined timetable. Unlike taxis, on-demand public transport is usually also not individual. An operator or an automated system takes care of the booking, planning and organization.

It is recognized that the use and integration of on-demand Automated vehicles have the potential to significantly improve services and provide solutions to many of the problems encountered today in the development of sustainable and efficient public transport.

1.2 Fully Automated Vehicles

A self-driving car, referred in the AVENUE project as **a Fully Automated Vehicle** (**AV**), also referred as Autonomous Vehicle, is a vehicle that is capable of sensing its environment and moving safely with no human input. The terms *automated vehicles* and *autonomous vehicles* are often used together. The Regulation 2019/2144 of the European Parliament and of the Council of 27 November 2019 on type-approval requirements for motor vehicles defines "automated vehicle" and "fully automated vehicle" based on their autonomous capacity:

- An "automated vehicle" means a motor vehicle designed and constructed to move autonomously for certain periods of time without continuous driver supervision but in respect of which driver intervention is still expected or required
- "fully automated vehicle" means a motor vehicle that has been designed and constructed to move autonomously without any driver supervision

In AVENUE we operate ***Fully Automated minibuses for public transport***, (previously referred as Autonomous shuttles, or Autonomous buses), and we refer to them as simply *Automated minibuses* or *the AVENUE minibuses.*

In relation to the SAE levels, the AVENUE project will operate SAE Level 4 vehicles.

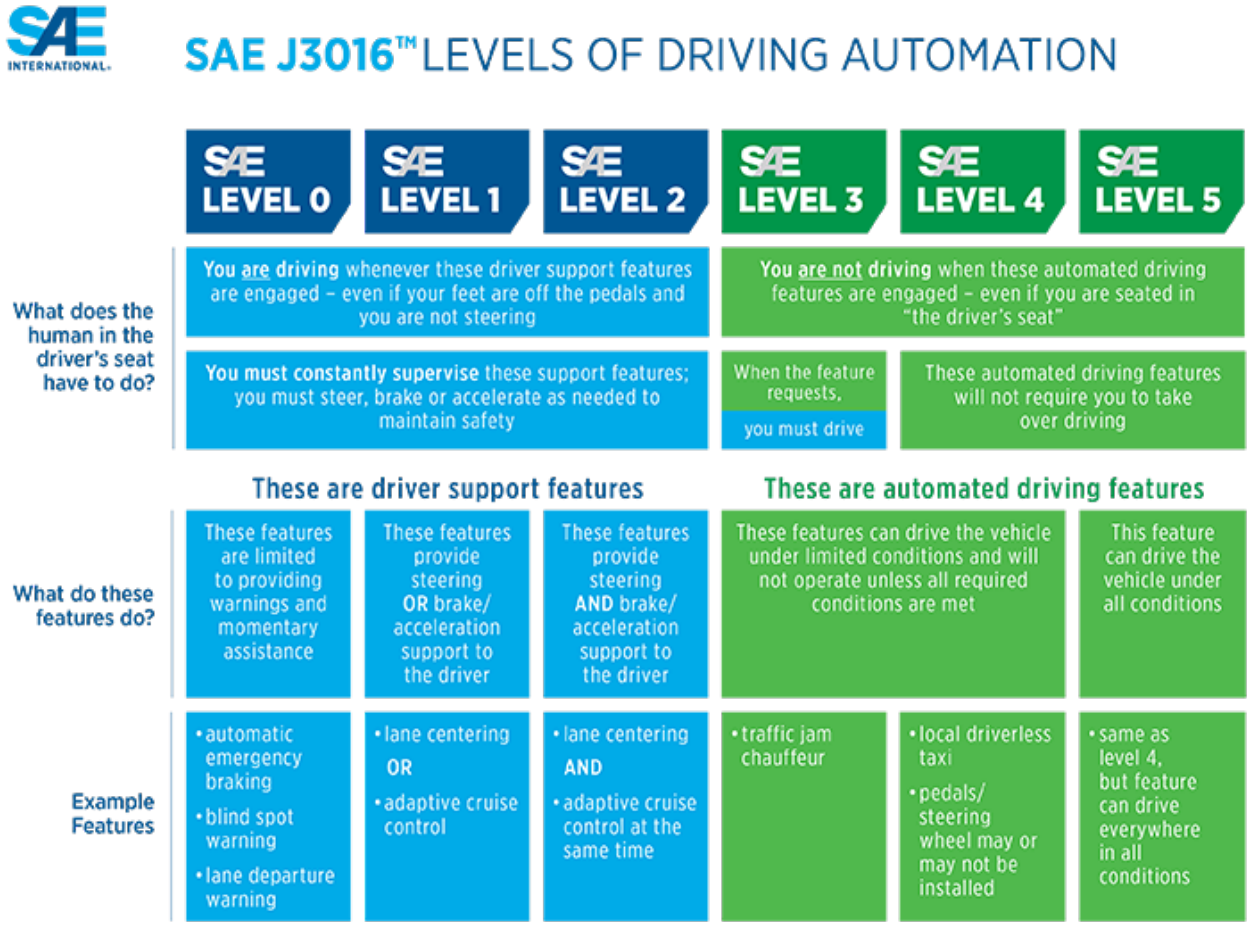

Figure 1 SAE levels of driving automation ©2020 SAE International

1.2.1 Automated vehicle operation overview

We distinguish in AVENUE two levels of control of the AV: micro-navigation and macro-navigation. Micro navigation is fully integrated in the vehicle and implements the road behaviour of the vehicle, while macro-navigation is controlled by the operator running the vehicle and defines the destination and path of the vehicle, as defined the higher view of the overall fleet management.

For micro-navigation Automated Vehicles combine a variety of sensors to perceive their surroundings, such as 3D video, LIDAR, sonar, GNSS, odometry and other types sensors. Control software and systems, integrated in the vehicle, fusion and interpret the sensor information to identify the current position of the vehicle, detecting obstacles in the surround environment, and choosing the most appropriate reaction of the vehicle, ranging from stopping to bypassing the obstacle, reducing its speed, making a turn etc.

For the Macro-navigation, that is the destination to reach, the Automated Vehicle receives the information from either the in-vehicle operator (in the current configuration with a fixed path route), or from the remote-control service via a dedicated 4/5G communication channel, for a fleet-managed operation. The fleet management system considers all available vehicles in the services area, the passenger request, the operator policies, the street conditions (closed streets) and send route and stop information to the vehicle (route to follow and destination to reach).

1.2.2 Automated vehicle capabilities in AVENUE

The Automated vehicles employed in AVENUE fully and automatically manage the above defined, micro-navigation and road behaviour, in an open street environment. The vehicles are Automatically capable to recognise obstacles (and identify some of them), identify moving and stationary objects, and Automatically decide to bypass them or wait behind them, based on the defined policies. For example, with small changes in its route the AVENUE shuttle is able to bypass a parked car, while it will slow down and follow behind a slowly moving car. The AVENUE vehicles are able to handle different complex road situations, like entering and exiting round-about in the presence of other fast running cars, stop in zebra crossings, communicate with infrastructure via V2I interfaces (ex. red light control).

The shuttles used in the AVENUE project technically can achieve speeds of more than 60Km/h. However, this speed cannot be used in the project demonstrators for several reasons, ranging from regulatory to safety. Under current regulations the maximum authorised speed is 25 or 30 Km/h (depending on the site). In the current demonstrators the speed does not exceed 23 Km/h, with an operational speed of 14 to 18 Km/h. Another, more important reason for limiting the vehicle speed is safety for passengers and pedestrians. Due to the fact that the current LIDAR has a range of 100m and the obstacle identification is done for objects no further than 40 meters, and considering that the vehicle must safely stop in case of an obstacle on the road (which will be “seen” at less than 40 meters distance) we cannot guarantee a safe braking if the speed is more than 25 Km/h. Note that technically the vehicle can make harsh break and stop with 40 meters in high speeds (40 -50 Km/h) but then the break would too harsh putting in risk the vehicle passengers. The project is working in finding an optimal point between passenger and pedestrian safety.

Due to legal requirements a **Safety Operator** must always be present in the vehicle, able to take control any moment. Additionally, at the control room, a **Supervisor** is present controlling the fleet operations.

An **Intervention Team** is present in the deployment area ready to intervene in case of incident to any of the mini-busses.

1.3 Preamble

The AVENUE project aims at a full-scale demonstration of urban road transport automation with a particular focus on automated minibuses in public transportation systems. The elaboration of requirements and use cases for such vehicles and systems is an integral part of the project and crucial for the future success of these operations. This includes state of the art of technology studies, user requirement studies, evaluations of legal requirements, and various other assessments conducted within work package 2 of the project. To better understand the expectations and roles of a multitude of organizations, networks, and institutions involved in realizing public automated transportation systems, a stakeholder analysis is one task (2.3) within the work package. This deliverable reports on the AVENUE stakeholder analysis. The focus of this analysis is on the strategic actors, hence organisations, networks and institutions. The (potential) users of the Avenue automated minibuses are studied in more detail in WP8, the social impact analysis. The Avenue stakeholder analysis is conducted in several phases, and this report presents the final stakeholder analysis.

2 Research design

In AVENUE's vision of the future public transport in urban and suburban environments, automated vehicles will revolutionize the way citizens use public transportation by making time-tables and fixed bus stop obsolete and by offering a service that will allow passengers to call and hop a ride at any time, at their doorstep for example, and deposit them as close as possible to their destination.[1]

2.1 Research aim

To deploy and integrate automated minibuses in public transport following the vision of AVENUE requires a social-technical transition. Hence, a combination of both technical and social innovation. Technically, the automated minibuses and the digital infrastructure should operate flawlessly. Socially, a multitude of organizations, networks, and institutions have to accept the use of automated minibuses and have to adapt their current systems to allow for realizing public automated transportation systems. To support this transition, this study aims to identify the stakeholder environment in which the automated minibuses services will operate.

In general, a stakeholder analysis is a tool to gain insights into a multi-actor issue. A stakeholder analysis can be conducted in every situation in which multiple stakeholders are involved, hence the issue at stake (Freeman, 1984; Bryson, 2004). A stakeholder analysis is important for the identification of public interest and concern and becomes even more important due to the increasing interconnectedness of today's world (Bryson, 2004). A stakeholder can be defined as "*any group or individual who can affect or is affected by the achievement of the organization's objectives*" (Freeman, 1984; Bryson, 2004). There is no fixed strategy for conducting a stakeholder analysis. The applied methods depend on the aim and goal of the analysis and can include methods such as focus groups, semi-structured interviews, knowledge mapping, social network analysis and Delphi studies (see for instance; (Spickermann et al., 2014) and (Reed et al., 2009))

2.2 Research approach

The research approach of this stakeholder analysis consisted of steps, as is visualised in Figure 2. Two approaches led to two distinct stakeholder maps; 1) an empirical EU level stakeholder approach and 2) a conceptual approach with the analysis of Avenue stakeholder and mobility services map

[1] See Avenue website: https://h2020-avenue.eu/

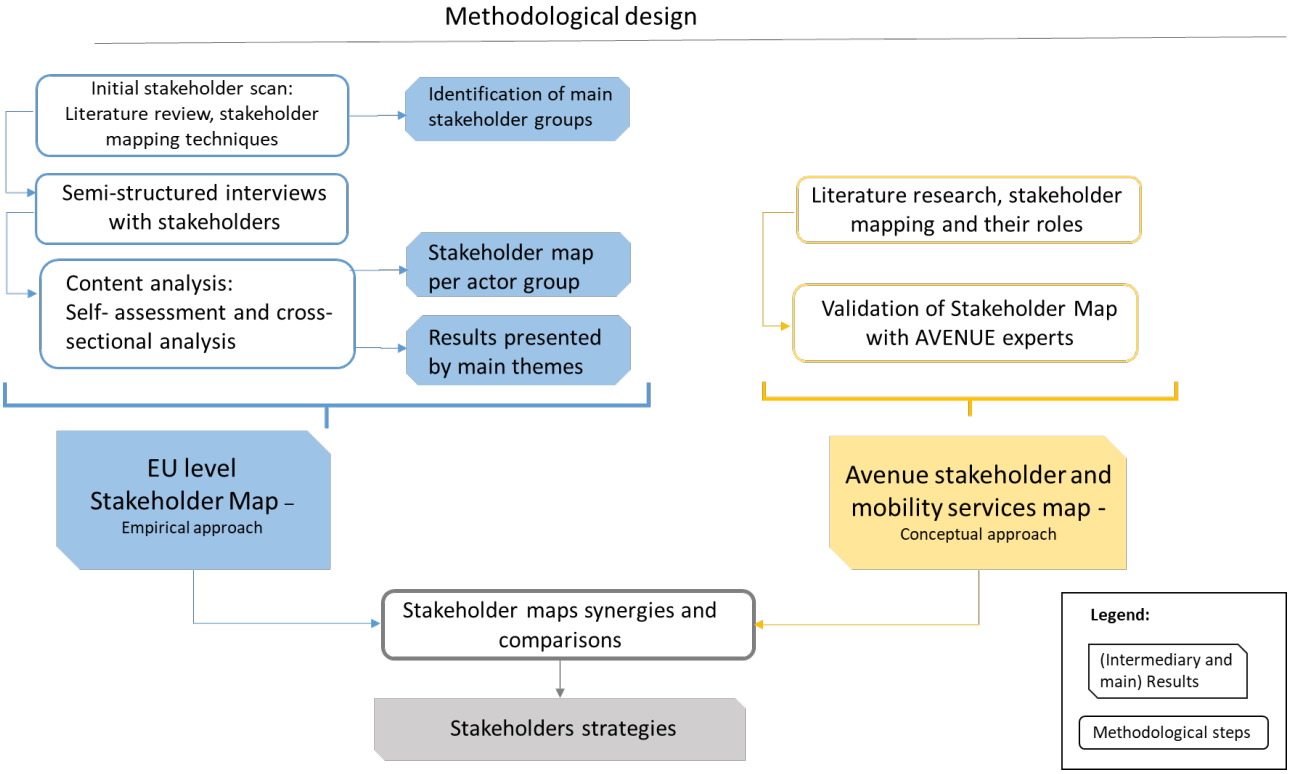

Figure 2 Methodological approach

2.2.1 Initial stakeholder scan

The initial stakeholder scan consisted of three steps. In a first step, all potential stakeholders were identified, through a brainstorming session and literature review. Secondly, we conducted a focussed literature review to gain information on the identified stakeholder groups. We applied stakeholder mapping techniques, such as a power-interest grid. Through these analyses, we defined the main stakeholder groups, that would be studied in depth, through conducted semi-structured interviews.

It was decided, together with Avenue project partners of WP8, that potential users (although included in the initial stakeholder scan) will not be considered the full stakeholder analysis. Individual users and potential users are the prime target group for the social impact assessment, as part of WP8 of the AVENUE project. Citizens (including users and potential users) are represented in this stakeholder analysis through citizen associations. Some of the outcomes of WP8 studies will be integrated in the recommendation and conclusion sections of this deliverable. The results of this stakeholder analysis will also feed into the social impact analysis.

2.2.2 Semi-structured interviews

In this step, interviews were conducted with representative of the eight stakeholder groups that were identified as prime stakeholders in the initial stakeholder scan. Where applicable, we included Avenue partners as interviewees. The semi-structured interviews were guided by a topic list. The topic-list consisted of five central themes (Appendix A: Topic list). A total of 30 interviews were conducted, see Table 1. As anonymity was promised during the interviews, each of the interviews was given an ID (see

third column of Table 1). These IDs are used to identify the quotes in the remainder of this deliverable. The interviews were recorded and transcripts were made.

Table 1: Sample structure empirical stakeholder survey

STAKEHOLDER GROUP	NUMBER OF INTERVIEWEES	ASSOCIATED IDS
PUBLIC TRANSPORT OPERATORS	4	ID 20; ID21; ID22; ID23
MANUFACTURERS (OEM)	4	ID1; ID2; ID3; ID14;
SOFTWARE DEVELOPERS	2	ID4; ID5;
DRIVER UNIONS	3	ID6; ID7; ID11
ENVIRONMENTAL NGOS	3	ID8; ID9; ID10
POLICY MAKERS / CITY GOVERNMENT	3	ID12; ID15; ID19
CONSUMER/CITIZEN ORGANISATION	4	ID13; ID16; ID17; ID18
SAFETY OPERATORS ON THE AUTOMATED MINIBUSES	7	ID24, ID25, ID26, ID27, ID28, ID29, ID30
TOTAL INTERVIEWS	30	

2.2.3 Content analysis

The qualitative analysis consisted of three steps, see also Figure 2. As a first step, we analysed the interviews within the identified stakeholder groups to assess the role, responsibilities of each group. As these are based on the input given by representatives of the stakeholder groups themselves, this results in the self-assessment of stakeholders. The results of this analysis are presented in section 3.2. Based on the inputs, we developed a stakeholder map for each of the stakeholder groups. These maps represent the perception of reality of each stakeholder group. They do not aim to provide a full overview of the stakeholder environment but rather present a bottom-up self-reflection of the stakeholder map from the perspective of the stakeholder group. The aim of this first step is to gain insight in each of the studied stakeholder groups. However, we do not aim to compare the groups.

In the second step of the qualitative analysis, we conducted a cross-sectional analysis. The data from the interviews is compressed and compared using bottom-up (or inductive) coding. The aim of this analysis is to gain insights into the overall stakeholder setting, hence, not relating the stakeholders to their respective stakeholder-group. As a result of this analysis, we defined seven main topics that are discussed in section 3.3. A third step of the analysis, is the integrated stakeholder map.

2.2.4 Conceptual Avenue stakeholder and mobility services analysis

As is visualised in figure 2, the empirical approach to the stakeholder analysis (left site of figure 2) is complemented by a conceptual Avenue stakeholder and mobility services analysis (right site of figure 2). This empirical stakeholder analysis takes a general perspective on the automated minibuses. It does not directly provide insights into the structure of the AVENUE ecosystem or the stakeholder environmental

that the automated minibuses will operate in. Therefore, we conducted a second study, focusing on the AVENUE stakeholder and services. The result of this conceptual study has been presented in deliverable 2.8 (Nemoto et al., 2019) through the presentation of the AVENUE stakeholder and mobility services map. This map was developed based on the vision of AVENUE and identifies, based on literature (both grey and academic) and AVENUE experts, the AVENUE stakeholder ecosystem (see right part of Figure 2). An updated version of this Avenue stakeholder and services map is presented in the current deliverable in chapter 4. In this chapter, we will also use this map to compare and enrich the results of the stakeholder analysis.

3 Empirical stakeholder analysis

In this chapter, we will present the results of the stakeholder analysis. The results are divided into three main parts. We will start with the results of the initial stakeholder scan (section 3.1). The goal of this section is to identify the main stakeholder groups and is based on a literature review. Several stakeholder analysis tools have been applied, such as the power-interest grid. In sections 3.2 and 3.3 we present the outcomes of the qualitative interviews with the main stakeholder groups. In section 3.2, we present the insights and self-perception per stakeholder groups. In section 3.3, we present the results of the cross-sectional analysis.

3.1 Results of the initial stakeholder scan

The following stakeholder groups are identified and are included in the analysis:

- Manufacturers of automated minibuses;
- Original Equipment Manufacturers (OEM) provide hardware;
- Software providers that offer platforms that enable the intelligent operation and optimization of automated mobility services, managing fixed-route and on-demand services;
- Public transport operators are responsible for the public transport system to function;
- European Union (European Commission) as they can set regulations that can hamper or support the implementation of the technology;
- National governments develop regulations, incentives and rules;
- Local level governments set local mobility policies and are responsible for road infrastructure etc.;
- Citizen associations that represent needs and demands of (potential) users;
- Insurance companies that will financially cover costs in case of an accident;
- Electricity charging infrastructure providers that will provide the charging infrastructure for the electric minibuses
- Energy providers that can influence the energy mix for the electric minibuses
- Environmental non-governmental organizations (ENGO) that can influence acceptance and use of the automated minibuses and promote the sustainability aspect;
- Recycling industry;
- Emergency aids;
- Industry lobbies (such as the Society of Automotive Engineers (SAE), International's On-Road Automated vehicle Standards committee, etc.);
- Trade unions;
- Research institutes;
- Consultancy companies

An important stakeholder group that is not included in the analysis are the end-users, the potential users of the system (Kyriakidis et al., 2015; Nordhoff et al., 2018; Wicki and Bernauer, 2018; Litman, 2019) The potential users are not considered as they are the prime target group for a separate work package within the AVENUE project (WP8.3 Social Impact Assessment; (Korbee et al., submitted; Korbee et al., 2019). Insights from WP8 will be included in the recommendation and conclusion sections. A stakeholder group

that is included in this stakeholder analysis are the citizen associations representing citizens, potential users and users.

3.1.1 Power-Interest grid

The first analysis is the power-interest grid (Figure 3). In a power-interest grid, the power and interest of particular stakeholders are used to classify different actors (Hermans & Cunningham, 2018). Stakeholders are placed on this grid, based on their interest (high or low) in the topic and to their power (high-low). Power is defined by the resources possessed by an actor and the relative importance of these resources in the implementation and feasibility of the system. The graph also points to the supportive, opposing, ambivalent, or indifferent positioning of the actors. A power-interest grid is dividing the stakeholders into four quadrants, also providing implications for analysis. Actors in the quadrant in the upper-right (high power/high interest) are key players and should be taken along in the analysis. Actors in the quadrant in the bottom-right (low power/high interest) are so-called context-setters and could be taken along in the analysis, depending on the boundaries of the analysis. The actors on the left side of the grid could, in principle, be left out (Hermans and Cunningham, 2018).

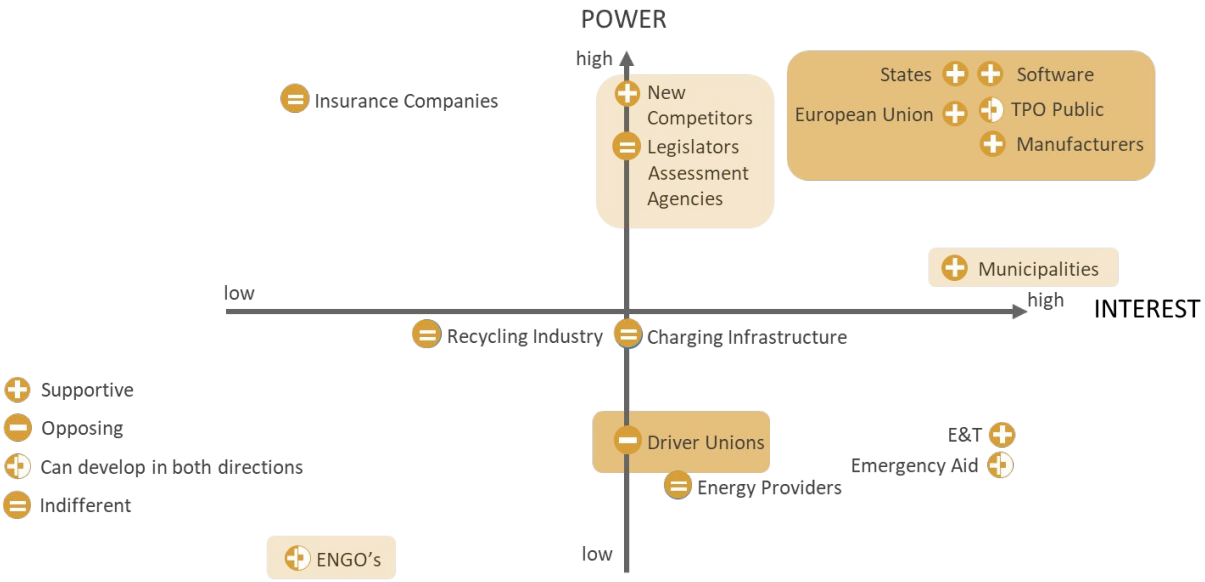

Figure 3: Power-Interest grid towards the implementation of automated vehicles in the public transport system

According to the power-interest grid, the countries, European Union, software providers, manufactures and the PTOs are key actors with high power and high interest. The countries and EU have the high institutional power to influence and to set policies, regulations and incentives to support the implementation of automated minibuses. Software providers and manufactures are strategic for technical feasibility and daily improvements. The PTOs are key operational actors and the bridge between the new mobility technology and society. New competitors that are proposing new services and products on mobility present high power and medium interest. Legislators have a high power since they are responsible for setting the laws and specific conditions for the implementation of automated vehicles. Municipalities present medium power and high interest in the AV's as a source of innovation, attractiveness, sustainability and improvements for the transport system. Secondary, but interesting actors are the drivers' union, with an opposing positioning due to their fear to lose their jobs. They present

medium interest in the topic and low power. The environmental NGO's are divided and can be supportive or opposing to the AV's implementation.

3.1.2 Impact-Attribute grid

The Impact-Attitude grid, places the actors according to their opposing, neutral or supportive attitude towards a project and the high or low impact that they represent towards the integration of AV's on mobility (Figure 4). The majority of stakeholders have a supportive or neutral attitude concerning automated minibuses in the public transport sector. The driver unions and environmental NGO's present a low impact and opposing attitude, and due to this fact, these actors have to be taken on board on discussions and decision making in order to mitigate potential negative impacts on society and the environment. No stakeholder with high impact and opposing attitude was identified through this literature study. This means that there are no stakeholder actors threatening the project's success. Thus, it is of importance to keep an eye on the further development of the position of each stakeholder and respond appropriately once stakeholder groups will change their attitude towards the project.

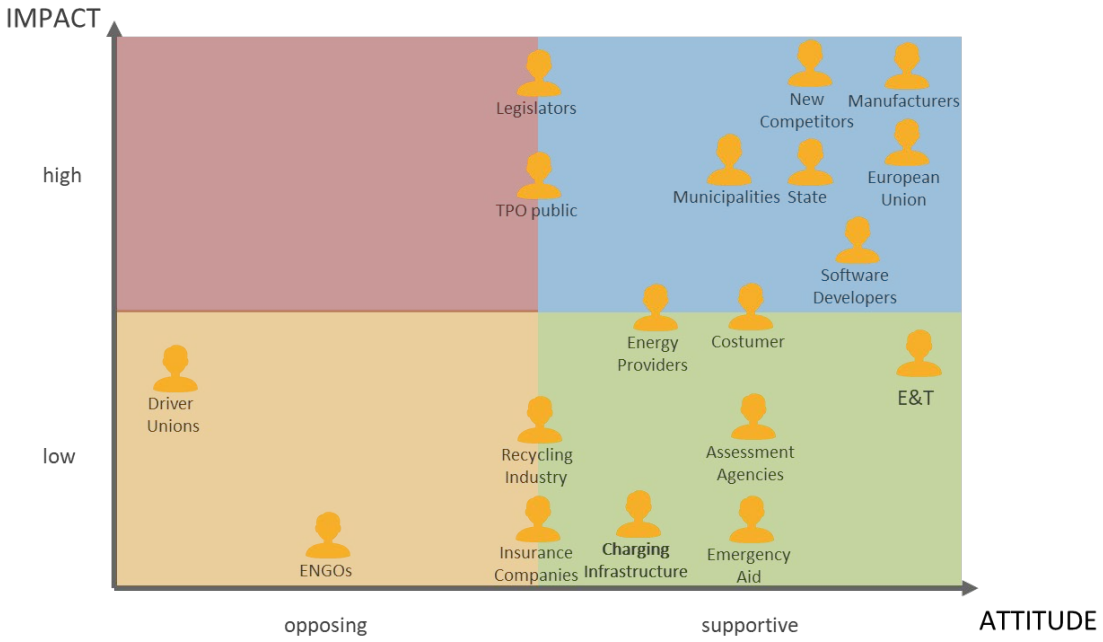

Figure 4: Impact-Attitude grid representation regarding the implementation of automated vehicles in the public transport system

3.1.3 Onion diagram

As a third analysis, an onion diagram is presented in Figure 5. An onion diagram represents a structure organized into circles representing different levels. At the centre, the primary level places the stakeholders with significant influence in the project and strong control over essential resources regarding AV's and public transport (Bodnar et al., 2015; Czischke, 2018). Therefore, a high and direct impact is assumed. At the secondary level, stakeholders with relevant importance for the project and medium control over

essential resources are placed. The wider environment is represented at the tertiary level, including stakeholders with weak control over essential resources that affect the project indirectly or on a low scale (Bodnar et al., 2015; Czischke, 2018)

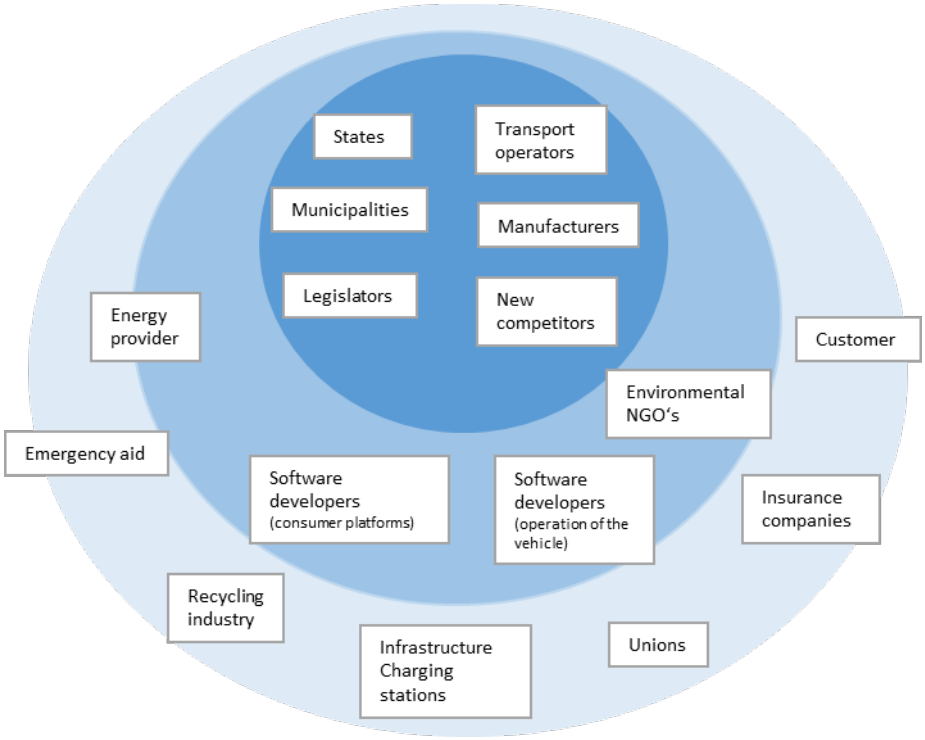

Figure 5: Stakeholders Onion Diagram concerning the implementation of automated vehicles in the public transport system

Stakeholders at the primary level are market actors - transport operators, manufacturers, and new competitors - and the government actors - states, municipalities and legislators. As already identified in the graphs before, they are crucial stakeholders with financial, technical and institutional. Moreover, their decisions and actions will definitely shape our future mobility. On a secondary level, the software providers and energy providers are depicted, also providing important knowledge and resources. Environmental NGO's can be classified in the second level as well, as they are active in the dialogue with multi-stakeholders, in social awareness, and influencing policymakers. The tertiary level consists of customers, insurance companies, unions, actors providing electricity charging stations, recycling industry. They do not have a direct impact or a strong influence on AV's decision-making and implementation. Some of these actors, such as the insurance companies, are still awaiting more results before setting their strategies.

3.1.4 Selection of stakeholder groups

Based on the three analyses, we can define key stakeholder groups. The first actor group are the developers of the system: the vehicle manufacturers, the software providers and the hardware providers. A distinction between these three actors, was made due to differences in roles and impacts of the actors within the system. These three actors are key actors, as primary innovators and proponents of the system. Manufacturers of automated minibuses are important stakeholders. NAVYA, the manufacturer of the

minibuses in the AVENUE project, has as primary goals offering new mobility solutions, the establishment of a good market position, and consumer confidence/acceptance. In order to do so, they focus on implementing their products in public systems as soon as possible. Well-drafted standards can increase the rate of development and reduce overall system cost per vehicle.

Software providers offer platforms that enable the intelligent operation and optimization of automated mobility services, managing fixed-route and on-demand services. These cloud-based platforms are crucial for the system to function. Furthermore, the platform should also function as the interface between vehicles, travellers and mobility providers. Software providers are crucial stakeholders, as an automated system cannot function without a proper software platform.

The prime objective for public transport operators is to seek a high market share and good market positioning. Public transport operators are responsible for the public transport system to function. In order to stay competitive, they have to innovate and reduce costs. The instalment of automated minibuses could be a solution to pursue both goals; as this system is both more flexible, due to the smaller sizes of the buses and its possibility to drive 'on demand', as well as it can be more cost-effective, as it reduces personal costs. However, public transport operators are also holding back, as recent studies show that the development of automated vehicles could result in public transport losing its attractiveness due to innovative services, such as on-demand taxi services and private car-pooling.

All in all, public transport operators are important stakeholders in the development of a system of automated minibuses but are not crucial; their role could be overtaken by new competitors that share similar objectives. In addition to increasing their market share and market positioning, they pursue to gain consumer's trust by offering to innovate mobility systems. To do so, new competitors will have to face constant evaluation and comparison of competitors, seek partnerships, and adapt ideas and methodologies. Hence, all involved competitors are focusing on developing the most innovative, secure and trustworthy vehicle for the market (Boersma et al., 2018).

A current barrier for the establishment of fully-functional automated minibus systems are regulations that require stewards on board (Ainsalu et al., 2018). The European Union (EU) is an important stakeholder in this respect. Promoting automated driving will challenge the EU to create incentives and regulations and remove possible barriers that can stop the development of this technology. Currently, the EU is supportive of this development through stimulating innovations and knowledge creation by funding large-scale research projects, such as AVENUE, under the Horizon2020 programme.

The EU can develop general guidelines and policies, but it is up to the member states (they are referred to as countries in the remainder of this deliverable) to develop regulations, incentives and rules. There is great differentiation in the level of application between different countries and cities. Some countries within the European Union already offered space for experimentation with automated vehicles on public roads (such as France, the Netherlands, Luxembourg and Germany), whereas others are more conservative. The same accounts for local level government, where cities like Copenhagen, Lyon, Geneva, and Luxembourg show a high interest in conducting field experiments. On a city level, it is not so much the formal rules and regulation that are key resources, but local incentive structures – mobility policy, willingness to adapt road infrastructure etc. – that are crucial for a successful system of automated minibuses. Overall, both state-level and city-level governments are crucial stakeholders as they must provide an enabling institutional environment for the system to function.

A strong opposing position is taken by unions of transport operators, as bus drivers fear losing their jobs once automated minibuses are in place. The unions would favour an automatic unemployment assurance, provide education and retraining for the transport operators to find comparable or even better jobs, and expand support for displaced workers to start and sustain their own business.

Other stakeholders, like Insurance companies, electricity charging infrastructure providers, energy providers, environmental non-governmental organizations (ENGO), Recycling industry, Emergency aids, Industry lobbies (such as Society of Automotive Engineers (SAE), International's On-Road Automated vehicle Standards committee, etc.), Trade unions, Research institutes, Consultancy companies, and the United Nations, were identified but will not be further detailed in this part, as their influence is, not yet, crucial for the project's success.

3.2 Self-assessment stakeholder groups

In the stakeholder analysis, we conducted 30 semi-structured interviews with representatives of each of the main stakeholder groups. In Deliverable 2.8 (Nemoto et al., 2019), the outcomes of these interviews were presented a detailed description of each of the interviewed stakeholder groups. In the following section, we will provide a short overview, focusing on the self-assessment of the main roles of each stakeholder group and their strategic objectives.

3.2.1 Public Transport Operators

The Public Transport Operators (PTO's) are responsible for providing public transport services in cities. Interviewees stressed the strong need to be competitive in the future. From their personal and company's perspective, interviewees expect automated public transportation to contribute to societal benefits such as better quality of life and improved health and environmental conditions due to reduced pollution. *"I generally think, we're gonna have a better world once the automated vehicles are fully implemented in a lot of different perspectives."* (ID23). PTO's perceive automated vehicles as a "key topic for the future" and as a decisive element of competition. In addition to the traditional transport system, automated vehicles are currently developed by public transport operators.

The map depicted in Figure 6 shows the central role of the PTO, it shows also the important stakeholders according to the PTOs based on the interviews. While some actors such as: the local government, technology providers, and legislators were mentioned in the interviews, other actors such as the NGOs, were not discussed. However, their role remains important. The map also presents the types of relations existing between the PTOs and the other stakeholders and how the PTO perceive the relation from their perspective.

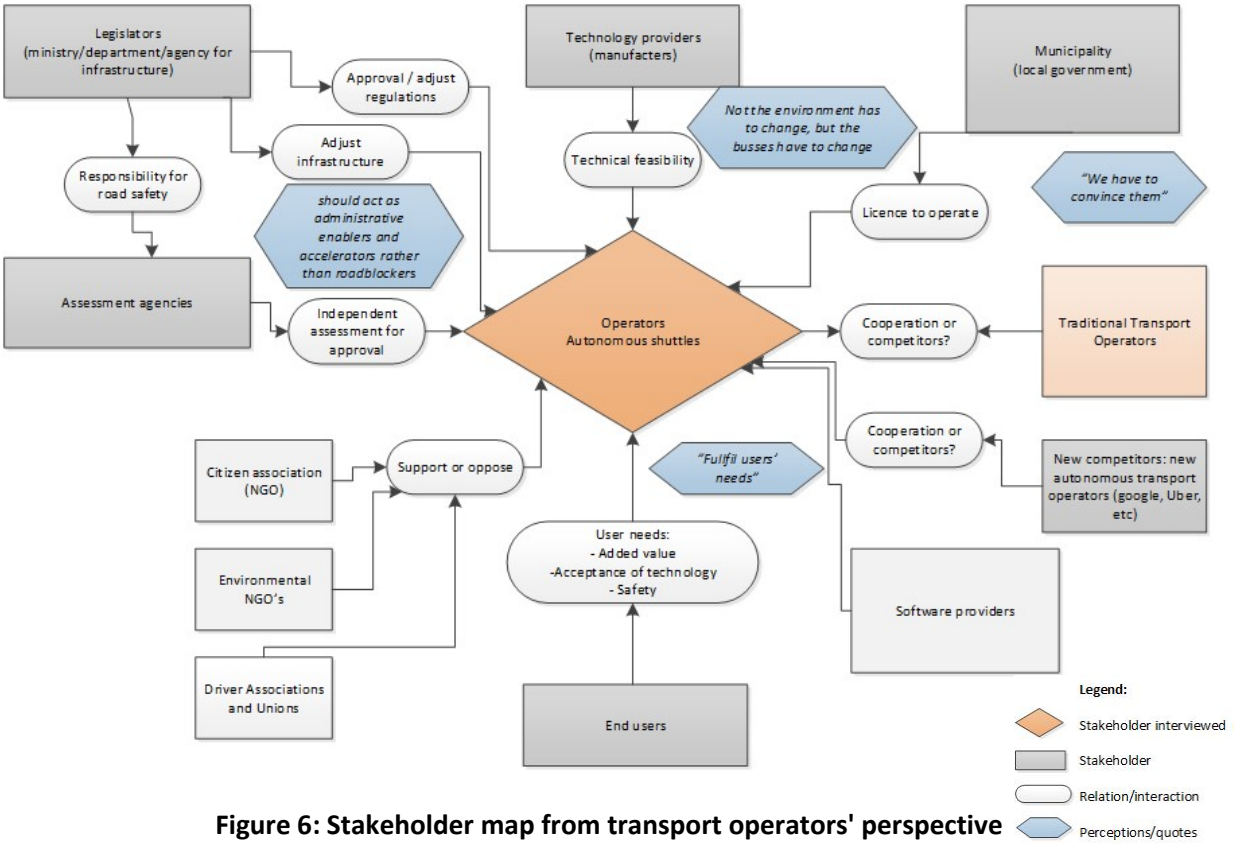

Figure 6: Stakeholder map from transport operators' perspective

3.2.2 Manufacturers

Manufacturers of automated minibuses define the following goals: 1) offering new mobility solutions; 2) establishment of a good market position and; 3) create consumer confidence and acceptance. To accomplish these goals, they focus on implementing their products in public systems as soon as possible. Well-drafted standards can increase the rate of development and reduce overall system cost per vehicle. From the conducted interviews, a homogeneous picture emerges from the group of manufacturers of automated minibuses. The manufacturers all have similar ideas of what future mobility should look like and pursue a similar strategy.

The automated minibuses are currently implemented in pilot projects all over the world to learn more about the requirements of the environment and their use in various practical scenarios. There is still a need to further develop and optimize the products and to extend them to other areas of application. The manufacturers are convinced that with their vision of automated driving in public transport and on short distances, they have developed a concept for the future that will transform traffic in cities in the future with the properties of automated, shared, connected, and electrically driven vehicles.

With their vehicles, manufacturers want to meet the needs of their partners, improve the transportation services, play an active role in shaping the future of mobility, and drive this new technology. Figure 7 presents the manufacturers point of view, based on the interviews, in regard to their interaction to other stakeholders within the mobility ecosystem. The stakeholders such as the PTOs and the local government are key partners for the manufacturers. Their cooperation helps the manufacturers improve their product to provide better deployment, traffic regulations, and concessions.

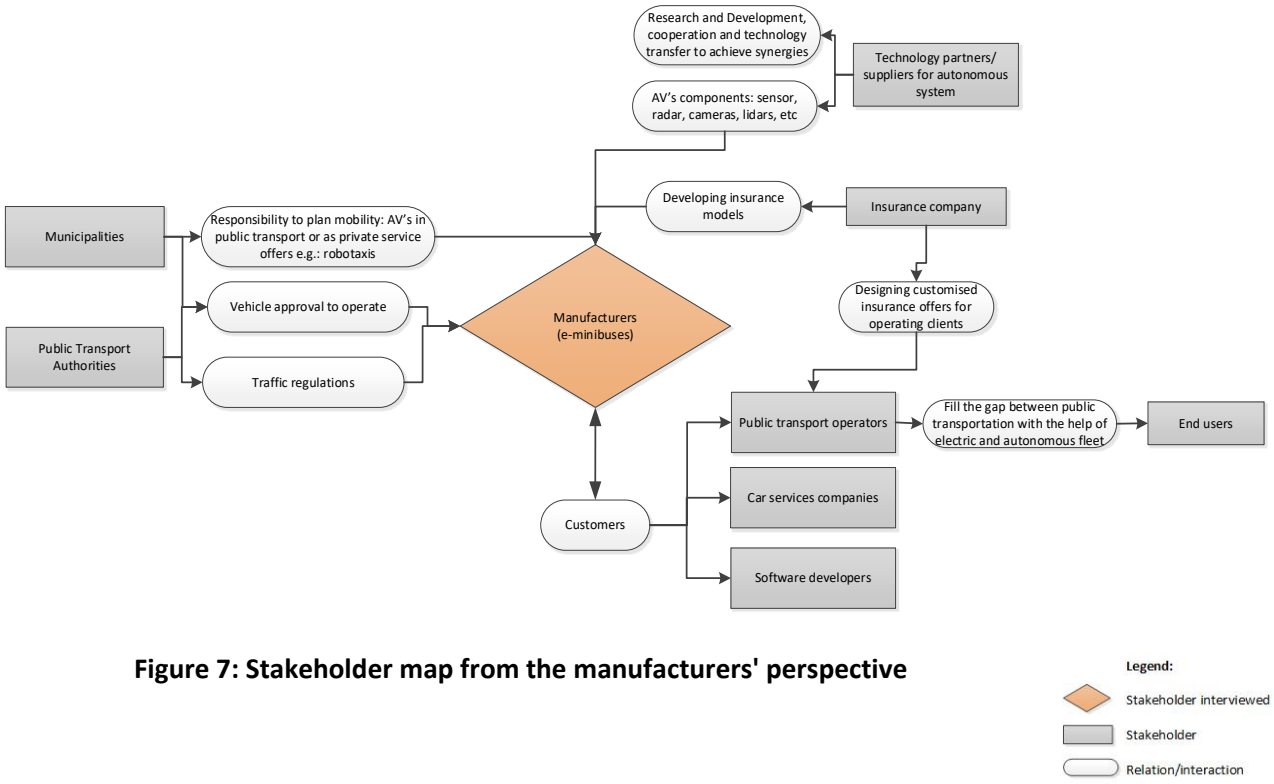

Figure 7: Stakeholder map from the manufacturers' perspective

3.2.3 Software providers

Software providers offer platforms that enable intelligent operation and optimization of automated mobility services, managing fixed-route and on-demand services. These cloud-based platforms are crucial for the system to function. Furthermore, the platform should also function as the interface between vehicles, travellers and mobility providers. The aim of software developers is to offer their services to the greatest number of vehicles possible. *"The goal is (…) to equip as many different vehicle types in different environments and scenarios with our technology and to learn basically from the environment (…)."* (ID2). Therefore, partnerships with government or big fleet managers are crucial. Another common strategic objective of the software developers is to change the mindset about mobility systems. Time that is now spend on transportation, can, when travelling with an automated vehicle, be used for activities that add value to personal life. It is of high importance to have a trustful system, to enable users to forget the road and focus on other activities. As stated by interviewees, once fully automated systems are implemented in daily life, the interactive open space offered by the transportation system can be used to plan the next day`s activities, make a reservation for today`s dinner, check the weather channel, review important news, etc.

The main objectives and responsibilities of software providers are clear: assure safety, efficiency, and punctuality for end users. Similar to the previous parts, the map presented as Figure 8 presents the software developers perspective towards their relation to other key stakeholders.

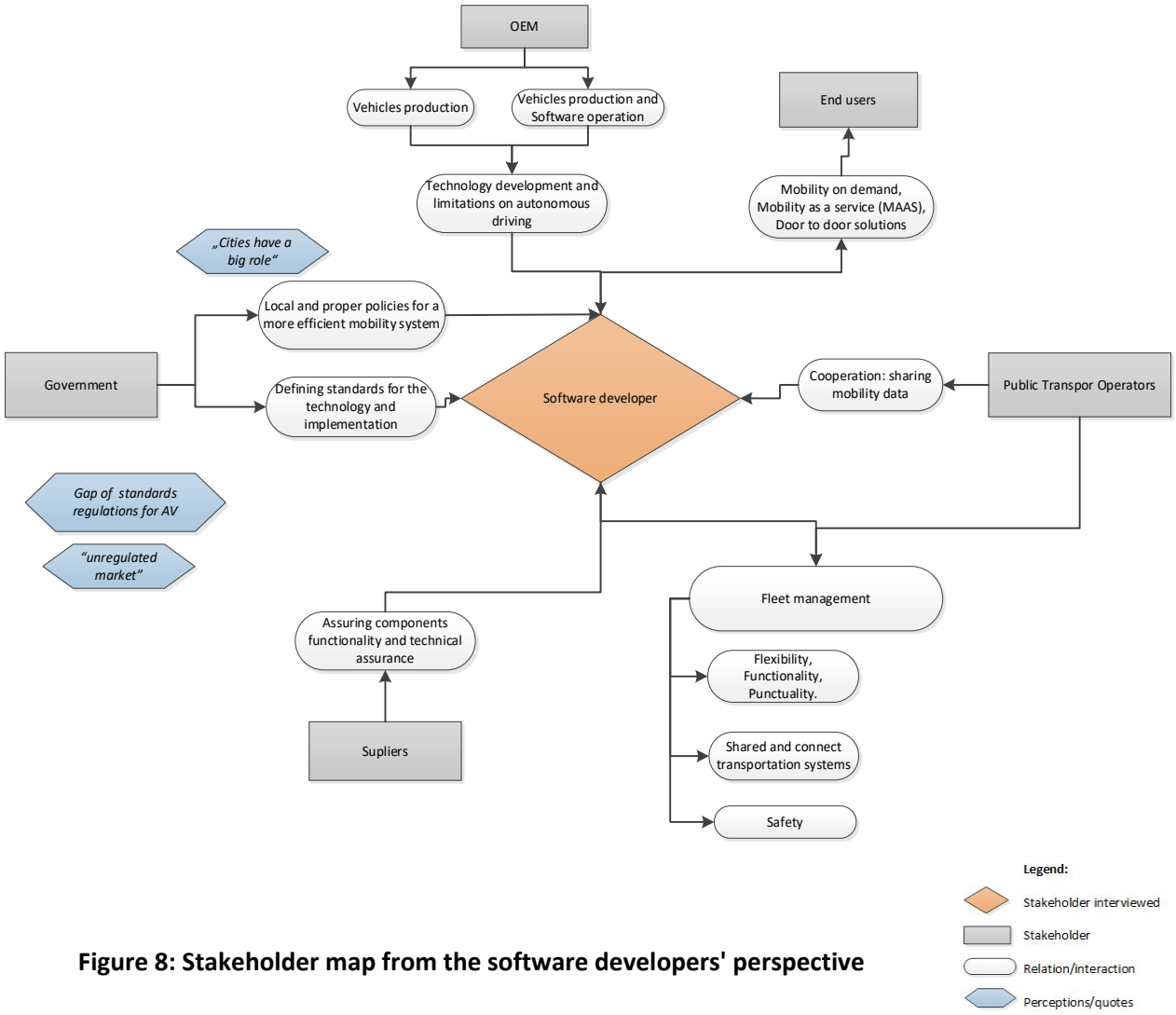

Figure 8: Stakeholder map from the software developers' perspective

3.2.4 Driver unions

Bus drivers, bus-trailer drivers, taxi drivers, truck drivers, and all kind of land transport operators are supported and guided by associations that, among others, help them have better job conditions. Driver unions address topics like the drivers' re-education and formation for work, better road conditions, safety assurance, and agreements with employers' organizations and governments. The interviewed driver unions are well-consolidated organisations with many years of experience, a significant number of members, and local, national, and international networks. One of their primary actions is to be part of the dialogues in the transport sector and to negotiate collective agreements for their members. As stated: "*We have a lot of willingness to negotiate, bargain, make agreements and compromises and bring the work organizations together*" (ID11).

Priority actions address improving the drivers' working conditions, e.g.: better services along the roads (proper places for the mandatory resting time, restaurants, showers, toilets), parking, safety conditions, and common road signs in European countries. The interviewed driver unions highlighted the strategic importance and their focus on professional education, informing and training; as quoted, "*for us is more about re-educating people … there will be a big need for skilled workers*" (ID11).

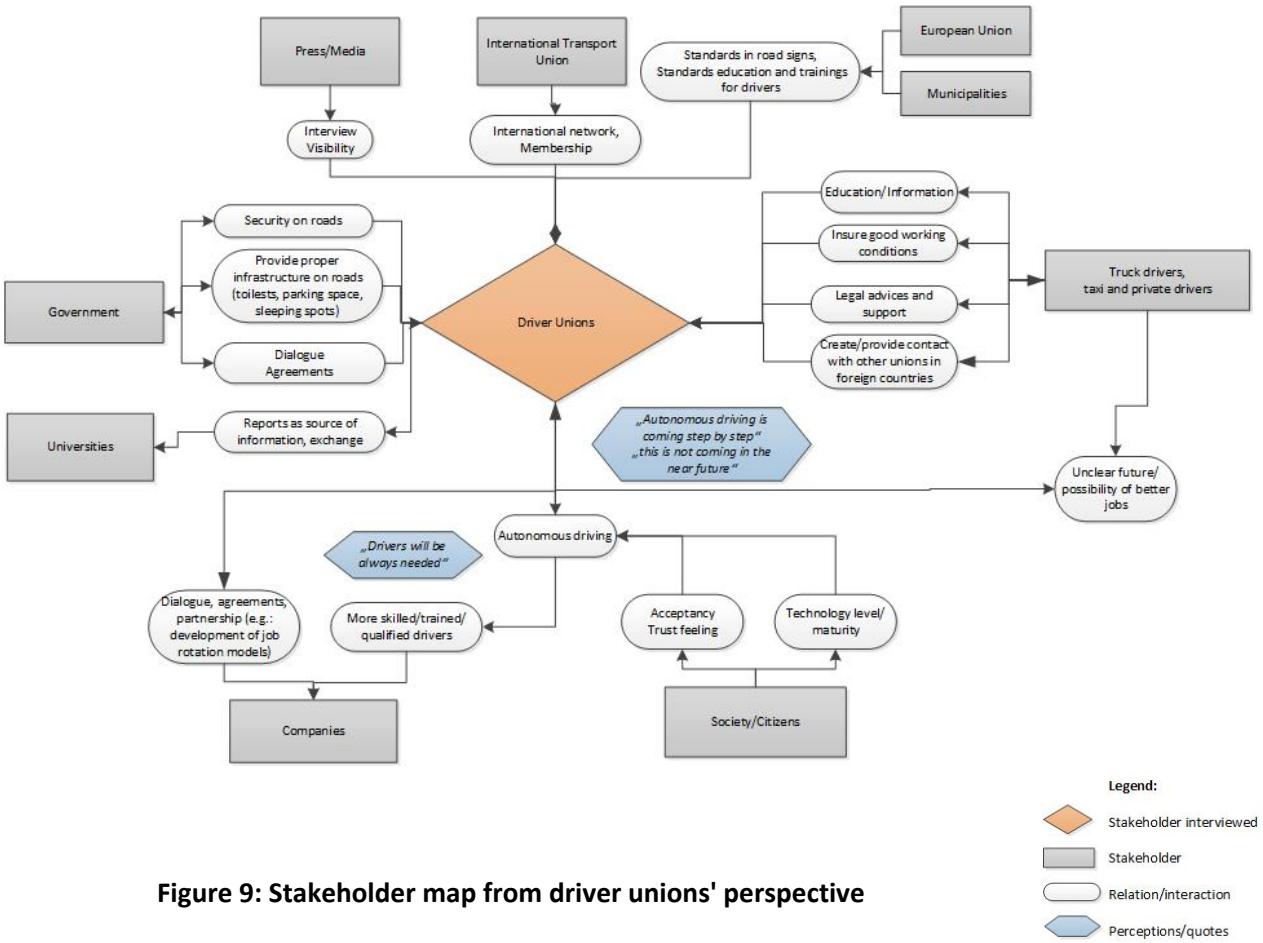

Figure 9: Stakeholder map from driver unions' perspective

3.2.5 Environmental NGOs

Automation, electrification and approaching a shared system are perceived as both opportunities and threats by these organizations (ID8; ID10). The ENGOs aim to promote a new mobility system that is more efficient and environmentally friendly as the current system (ID8). The interviewees state that they strive for future mobility systems that is more flexible and, should focus on shared mobility solutions that are convenient for users (ID10). The NGOs perceive the need to become active and support this development, as industry alone will not necessarily advance towards this new future mobility systems by itself. Therefore, authorities are vital to pave the way towards these target systems by coming up with adequate regulations. Otherwise, NGOs fear to end up with a mobility system that is more problematic; thereby creating more environmental damage than solutions (ID10). This is exactly where NGOs start playing an important role. To achieve their targets, NGOs give recommendations for policy building (ID9). While their lobbying activities might vary in the level of influence and their addressed governmental level, the purpose to influence policy building for the benefit of our environment is perceived as rather homogeneous. On the other hand, their scope of action is very heterogeneous: some of the organisations commission their own studies and research, while others primarily use the results of others (ID8; ID10). In general, the ENGOs need a more solid science and knowledge concerning the effects when scaling up automated vehicles in our mobility system. Figure 10 demonstrates the relation to other stakeholders based on the perspective of the environmental NGOs.

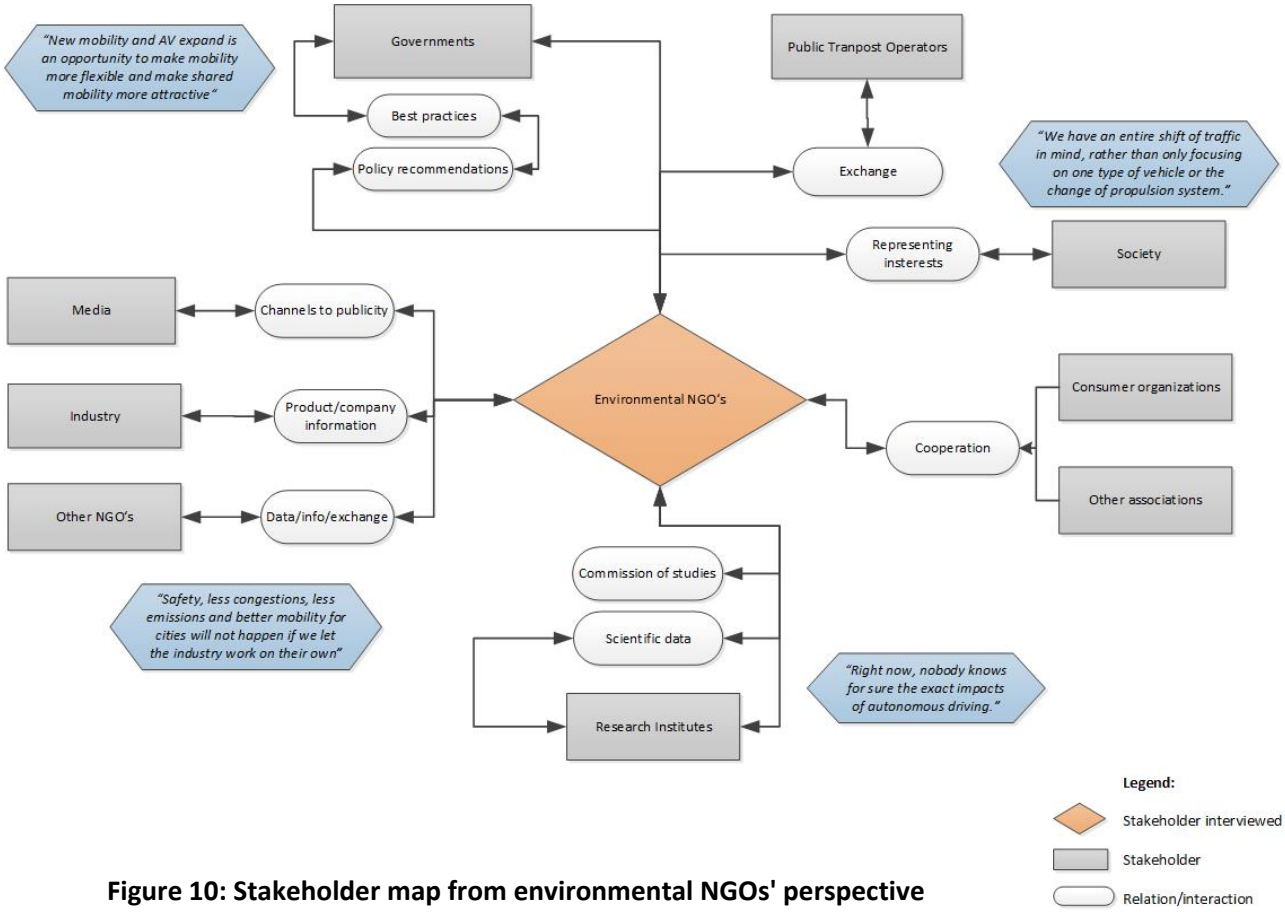

Figure 10: Stakeholder map from environmental NGOs' perspective

3.2.6 Policy makers

The interviews with the policymakers are those conducted with the government representatives of two European cities and a national road directory. Policy makers have a centric role, as they have interactions with most key stakeholders (PTOs, users, manufacturers, NGOs). The policymakers are primarily concerned with urban planning, regulating automated vehicles, and the effects of the mobility on future cities. The interviews demonstrated a recognition of policymakers to adopt a more proactive role towards new forms of mobility such as the automated minibuses and the e-scooters. This role means having an active role in shaping the city of the future rather than only reacting to the consequences of deploying automated vehicles (ID12). The minibuses have the potential to affect the design of urban areas by reducing needed parking spots and urban roads, thus changing the way urban infrastructure will be designed (ID12; ID15; ID19). The change leads to more urban space to be dedicated for green and blue infrastructure (parks, gardens, naturalized water flows) (ID15; ID19). But it will also requires incorporating specific structures for AV such as fibre glass cables, information signs for crossings) which could also benefit the city in general (ID12). Moreover, the interviewees explained the difficulty of drafting regulations for the AV due to concerns about liability, safety, and the ability to react to complex mixed traffic situation (ID15).

Finally, policymakers are aware of the disruptive nature of transport innovations such as the automated minibuses and its potential role in shaping cities and user's perception. Thus, they rely on insights from pilot projects and other stakeholders (ID15).

3.2.7 Civil society organisations/citizen organisations

The Citizen organizations interviewed are working on city, national and EU level. They address issues concerning transport and citizens and represent end users from different sectors (fright, transport, energy). They interact mostly with other transport associations, policymakers and government representatives, transport companies (manufacturers and PTOs), and with citizens. The civil society focuses on promoting public transportation. In the interviews, they expressed the urgency of developing and innovating public transport (ID17; ID16)

They see that public transport should become the first choice and that individual private transport should be reduced (ID16). The emphasis was also put on active modes of transportation, in cities like Antwerp, these organizations are working with policymakers to support biking and biking infrastructure (ID17). The organisations are working on improving the services for the users. The focus is on customized public transport services such as MaaS and first-and-last-mile solutions. Although the automated minibuses are the main focus of the interviewed organisations, the organisations still acknowledged their potential role in supporting public transport, reducing the environmental footprint of mobility, increasing safety, reliability, and comfort (ID16; ID18; ID13). They also displayed concerns about the manner of which theses minibuses will be deployed. Mostly, there is a fear that the automated minibuses will be used as an individual mode of transport and that they will compete with active mobility and public transport (ID 16 ID 17). In general, there was a consensus on using automated driving as an opportunity to make the transport ecosystem more robust and sustainable and to focus on the users' needs (ID13; D16; ID17; ID18). Finally, infrastructure was also an important topic in the interviews, the organisations see that cities should focus less on long-term megaprojects and focus on solution targeted mobility.

3.3 Results from cross-sectional analysis

In this section, we will present the results of the cross-sectional analysis. These results are based on compressed data using bottom-up coding. As a result of this analysis, we defined seven main topics:

1. The crucial role of city government
2. Technology development and legal regulations
3. Restructuring the mobility industry
4. Social acceptance
5. Financial aspects
6. Environmental aspects
7. Futures scenarios

3.3.1 The crucial role of city government

The introduction of new mobility innovations into the transportation network showcases the importance of the government's role in dealing with transportation challenges. The cities are responsible for regulating the usage of automated minibuses in the built environment. Another important role of the city government is to set requirements of the public transport system and the issuing of concessions for a public transport operator. Therefore, based on the interviews, the importance of the government's

position in deploying future mobility and the relation between the PTOs and local government were important issues.

Contracting public transport services

The city governments are responsible for the public transport system within their city boundaries. The cities define the requirements of public transport based on their transport vision, financial resources and requirements from the national government. Based on these requirements, concessions to operate public transport within a city are issued (ID21). Internationally operating private companies, such as Keolis, Connexxion, Arriva, DB Bus, and ÖBB Postbus, provide public transport services in several European cities. However, the routes and the vehicle technology are dependent on the requirements set by the city governments. This includes the percentage of electric vehicles that should be deployed, the frequency of operation and as well as price (ID21; ID22). There are slight differences between the exact contracting forms between the European cities. In some European cities, one PTO has the concession to provide all public transport services, whereas, in other cities, a patchwork of smaller contracts is the norm (ID20; ID23). Different contracts between the government and the PTOs lead to more opportunities for testing and achieving robust results concerning the deployment of different forms of automated mobility such as fixed routes, on-demand, mixed traffic, robotaxis, automated minibus for public transport: *"It is important for city development to have a lot of mobility options"* (ID15).

Financial power of city governments

Testing new mobility innovation requires the financial support of the government. The PTOs cannot afford to procure the needed equipment for such operations. Even more, the use of the mobility service is limited for testing, which means the services are free for users. Hence, it does not offer substantial revenue. It also requires dedicated resources to manage the pilot site, resources that would have supported their traditional services. The PTOs are dependent on governmental funds. Public funds are crucial for the government to ensure that the automated minibuses will meet the overall mobility strategy of cities. Thus, cities should seek to diversify mobility innovation testing in collaboration with the PTO (Nuttall et al., 2018). *"It's the role of cities to decide how to re-balance mobility, and the investments on public transport and private service offers, e.g.: uber and robotaxi". (ID3)*

Collaboration city government and PTOs

The collaboration between the city and the PTOs hinges on the city's understanding of the importance of rolling out innovations within the transportation ecosystem. Mobility trends could exacerbate current mobility and urban planning challenges such as pollution, congestion, and urban sprawl (ID15; ID10). However, they can also provide solutions to these challenges. However, governments are reluctant to approve the testing due to safety and regulation concerns. This could result in delays due to the "the homologation phase", which is the technical inspection and documentation (Nemoto et al., 2021) or even obstructing innovations due to differences in opinion on the definition of public transport (ID22). Whereas AVENUE aims to deploy the automated minibuses as an on-demand, door-to-door service, this is not accepted by all governments, as this service would be classified as Taxis and not public transport (ID22).

There is a need for participatory actions to involve all stakeholders to reach a common understanding of the best practices of deploying automated driving (ID11). Indeed, Denmark, for instance, has organized a workshop to discuss with key stakeholders recommended strategies for automated vehicles. *"In Denmark,*

we have a long tradition for social dialogue…. and recently our former government formed a so-called disruption council with the purpose to discuss and advise our government and ministers about different issues related to automatization, digitalization and the impact of new technology …" (ID11).

City planners key in creating space for urban mobility

The role of the city goes beyond funding and regulating the rolling out of new mobility innovations. They are also responsible for the infrastructure and urban planning needed for deploying these forms of transportation (ID5). Urban planners are focused on reducing urban space dedicated to private cars *"… we want more space for green areas, more for pedestrians, more for cycling which means the space for the car is gonna decline…"- (ID15).* This presents the motivation for cities to work with the PTOs to re-imagine future cities. The use of the automated minibuses could reduce parking and road space: *"If you use automated driving to develop better cities, then it could be interesting if automated cars mean no longer parking spaces in the street…. then that could be interesting, we can use these streets for more green development" (ID15).*

The shift in urban planning is happening from the long term, big-budget infrastructures projects to short term plan that accounts for the potential disruption of mobility trends: *"We are at the point where this change of whole transport is coming, it is a huge opportunity for us to redesign our cities to show a bit of political courage and say no, that we do not want and that we want. And we want to shape it like that, instead of saying in 2046 we will have x million AV's on the road, so we will have to build infrastructure"- (ID10)*

Barriers to alternative mobility systems

Currently, the trials of deploying automated minibuses require adaptation of the infrastructure to accommodate the needs of automated vehicles, such as road sensors and special signalling devices, additional digital infrastructure (5G network, additional capacity for data transmission and storage, data centres etc.), and charging posts (ID13; ID20; ID22; ID 11; ID10; ID12). Civil society organisations are pushing for action at the EU level in terms of infrastructure for charging for electric vehicles (ID13). In the case of automated minibuses, the focus is more on a fleet that operates in a certain district: Therefore, infrastructure is important: beacons and electronic signals are needed for communication for the fleet (cloud-based, network coverage necessary. This is a promising approach with higher economic benefits in the end (ID5). The lack of infrastructure and the focus on developing infrastructure that does not account for future mobility trends present obstacles to the deployment of the automated minibuses *"Infrastructure can oppose to the technology"* (ID1)

Cities as innovation champions

The strategy for mobility as well as mobility trends integration varies between cities. Based on the goals the cities seek to achieve, mobility innovations as automated minibuses could be a key consideration. For instance, Dutch cities adopt a more innovative and connected approach to mobility. They implement planning strategies that promote sustainable transport: they advocate for active mobility such as biking and walking *"The focus of ...our city... is mostly to promote walking and cycling within the city centre, there is an interest in developing better connections to the subway station that could utilize the usage of automated Vehicles"* (ID15). And they envision automated minibuses as a solution to connect to mobility hubs such as train stations. *"Most policy-makers in the Netherlands believe that they should improve their*

mains stations in order to connect public transport, such as train with buses and buses with trains. The Netherlands is recognized as good connectors of first and last miles." (ID18)

3.3.2 Technology development and legal regulations

Rolling out new mobility technologies is intertwined with legal regulation. The legal system should ensure that these innovations are not harmful and unruly. However, it is experienced that the regulatory framework could act as an obstacle for innovations in the public sphere, such as deploying automated minibuses in urban areas. Interviewees state that, because of the innovativeness of the technology, regulators do not have experience with the technology, nor the knowledge on the technological specifications. Hence, it is difficult to explain the important technological considerations to lawmakers and to fit them within existing regulations. Issues related to reliability, insurance, and interoperability for the connected systems are still not clearly defined. Moreover, the effects on other road users also pose a struggle for lawmakers as *"… the connection to cyclists and pedestrians all the accidents, will they stop? Can they stop? Would they recognize all the traffic?" (ID15).* It gets more complicated to consider the technical regulations within the overall transportation system regulations such as the no-car zones and road pricing: *"And we need regulations and not only on automated vehicles but on mobility as a whole (road pricing, sidewalk-management, space views, …" (ID10).* These considerations make it difficult for policymakers to draft regulations that support the innovation of automated minibuses within the transportation ecosystem. Hence, legal regulations are seen as a barrier by the majority of our interviewees. However, some of the interviewees state that legal regulation should not be seen as a barrier to technological development: *"Laws are NOT barriers. Law will follow with the development of AV*" (ID 4).

Legal requirement: Safety

The governments' primary concern remains the safety of the passengers and the citizens in the circulation areas where the automated minibuses are being tested. The need for a safety operator on board is mandatory in all of the AVENUE trials. This is an obligation, especially for the vehicles operating in mixed traffic. Thus, policymakers and operators should work together to prioritize safety while not restricting the advancement of the technology of automated minibuses. Indeed, testing on open roads with a safety operator on board could guarantee both (ID15, ID18, ID1)

Pilot projects and testing to gain insights into the technology

Our interviewees stress that the technology of automated minibuses should be considered as a solution and not a barrier. Therefore, policy-makers should acknowledge the challenge of regulating automated minibuses (ID10, ID15). In the testing phase of the technology, it is advisable to bring the technology in the public sphere, to better understand the opportunities and barriers of the technology: *"…Important to move to "demonstration projects" in order to evaluate social acceptance and law"* (ID4). The regulatory framework should anticipate the consequences of the deployment of automated minibuses rather than just react to it. This means predicting the effects on users, the effects of integration within the public transport system, and how to manage data.

Differences between countries

The regulations also vary between countries. This also has an impact on the advancement, testing, and deployment of automated minibuses. The strategy for automated minibuses depends on the national goals and trends for mobility. The deployment of the AV in the EU is managed on a national level. A unified EU legal framework could facilitate the development of the technology and reduces confusion for the manufacturers of the vehicles and software developers. It could also improve the competitiveness of European countries in the automotive sector (ID10, ID6). *"It will be realistic about scaling up AV´s, and also, we have this wonderful principle in the EU of single markets. It would make sense at least to regulate these standard questions at the EU-level and not at a national level. Where if you are crossing the border, you would find another standard and this would be a huge mess" (ID10).*

It also should prepare for the use of automated and electric driving. This differs again from one country to another. While some have appointed councils and committees on these subjects, others are just trying to fit the technology within the existing regulation for transportation (ID4). For instance, the homologation process in Copenhagen did not include clauses for using automated and shared vehicles in public areas. The involved stakeholders were required to comply with the local laws and apply for different permissions for the alterations needed for the test sites (ID4; ID23). This poses a challenge on the EU-level as well: *"It´s a huge challenge; the Commission either decide to regulate something, then they act through regulation/directive…. It is not really flexible, and it takes a lot of time. So, another channel is also a more informal channel about best practice exchange and the European Commission is doing a lot on that" (ID10).*

Regulation

The lack of standards and regulations is also a bottleneck commonly quoted [ID12; ID15]. In addition to the fact that it is difficult to regulate the use of new mobility modes and specifically AV, more research and results are required. An interesting quote regarding this is: *"We need regulation not only regulations for AV but for mobility as a whole, so we should be looking at road pricing, how to manage sidewalks, regulations for space use, policies that are broader than looking at the vehicles and planning as well. A holistic approach across policies to reduce the uncertainties and not running the risk of ending up with more problems than solutions"* (ID10).

3.3.3 Restructuring the mobility industry

Traditionally, innovation in the mobility industry was the realm of the vehicle manufacturers (these companies are also referred to as Original Equipment Manufacturers – OEM). The processes of digitalization and automation are changing the industry. Companies specialised in software development set requirement for innovation and production of vehicles. Our interviewees state that the majority of OEMs still focus on being a vehicle supplier but are starting to develop their own software as well. Important, however, is the combination and integration of hardware and software. Vehicle manufacturers are dependent on the technology/software providers, but the software providers are dependent on the OEMs to a lesser extent, as they aim to "*equip as many vehicles in different environments and scenarios as possible (both buses and cars*)" (ID2). However, these companies cannot build the vehicles entirely by themselves and require input from OEMs or suppliers. The renewal of the mobility industry has not yet settled; new types of cooperation, competition and rise of innovative companies do require constant

renewal. *"Nowadays users do not care of automobile brands (BMW, Daimler, Audi) in public transport. But the company in charge of transport, therefore the software used can be identified* "(ID4).

The development of automated vehicles, in general, is pushing for this restructuring of the mobility industry and more cooperation. However, Mobility as a Service (MaaS) is pushing this development a step further. The key innovation and requirement for this system is a functioning software that allows end-users to mix several public and private mobility systems.

3.3.4 Social acceptance

Public transportation is a collection of different types of vehicles (such as. buses and trains) that are available to the public and operate at regular times, on fixed routes and charge set fares. Introducing automated minibuses could influence their availability to the public, the end-users. Will they accept the use of automated minibuses, and under what conditions? This section is based on the opinions of the interviewed stakeholders and not of the (potential) users.

Introduction of technology

Automated minibuses are an innovation that the majority of the end-users have no experiences with, other than hearing about its advancements in the news. To enhance social acceptance, it is important that users gain familiarity with the technology. Among the respondents, there is a disagreement on the question of how to introduce the technology to the end-users. Some of the respondents claim that there should be as many tests in public space as possible. For the development of the technology and to address technical barriers, it is important that pilot projects are set up (ID14). Furthermore, engagement with the technology in pilot projects could provide insights into the tolerance regarding accidents; *"Great importance of interaction with citizens to find out their tolerance regarding accidents"* (ID12).

Furthermore, it is claimed to be important how you communicate the minibus:" If you use terminology like driverless or automated, people are less likely to accept the concept than if you use "self-driving vehicle" or "automated assisted vehicle or automated assisted system"" (ID1). Others state that the technology presented to end-users should be incidents and accidents free (ID2). Introducing a technology that is not as advanced as users expect could result in disappointment. In general, users expect a normal bus without drivers (ID21), but find that the service is not as advanced as expected (ID21). Another interviewee depicts this as the 'Over-optimism of people in technologies' (ID10). Hence, it is not only important to introduce people to technological innovations, but also to manage expectations in order to not disappoint.

Based on past and current pilot projects, it is, however, not expected that social acceptance will be problematic (ID16). The large majority of users (97%) of a pilot in France reported being happy and confident. Other pilots show that although users are content, a problem lies in convincing the potential users in the service area of the use and advantages of the service (ID21). Interviewees even claim that "*...Ethical discussion will become irrelevant as the new automated vehicles will be so secure that there will not be accidents any more"* (ID12).

In addition, the respondents addressed diverse current societal issues that reflect the concerns associated with automated driving. Among the main concerns, data protection and data privacy were the most cited

(ID8; ID10; ID7). Other concerns relate to cybersecurity and hacking risks (ID14; ID6) and ethical questions that are still open and need to be addressed (ID5; ID8).

Use oriented

Public transport provides a service for its users; it takes them from A to B. Automated minibuses could provide this service, comparable to a conventional bus. However, there are more possible applications for the minibuses; they could provide an on-demand, door-to-door service and could service additional lines. Our interviewees state that, for the end-users of the automated minibuses, the service provided is important, and not so much whether or not the service is automated or conventional: "*For travellers, it is not really important, how the transport is. Whether the transport is automated or not, people want to stay safe, have reliable transport, reach the destination on time, want a certain type of comfort and the experience is very important" (ID18).* These insights are confirmed by the outcomes of the social impact studies, conducted for WP8. These studies show that users and potential users expect a higher level of flexibility from the deployment of automated minibuses. This higher level of flexibility is defining the willingness to use the automated minibuses, not the fact that these buses are driverless (Korbee et al., 2021).

In general, public transport is on a decline in Europe, although not consistent in all countries. Some regions claim that public transport has lost ¼ of its clients (ID17), that there is a shortage of bus drivers and lack of funding due to cost savings (ID7).

Hence, there is a quest for improving public transport, including an improvement of *"...the overall quality of public transport (service quality, safety, reliability, speed, frequency, ease of use, comfort)*" (ID18). This could be done via the integration of automated minibuses, but this is not a necessity, as stated by an interviewee; "*If it is automated or not, public transport can also deliver*" (ID18). Improving public transport can be done by placing automated minibus services to resolve mobility gaps, such as by "*…linking neighbourhoods, rural and urban areas*" (ID10). According to an interviewee, this is the purpose of the automated minibuses: "*We should only put a shuttle where there is a demand & automated shuttles will not replace existing lines, but adding lines*" (ID21).

The development of automated minibuses has a promise to not only improve the coverage of public transport but to renew it. The introduction of automated minibuses could enhance/enforce the development of MaaS systems and seamless traffic flow. Based on the insights of our interviewees, it is unclear what the need and acceptance of such a system are; furthermore, there are technical barriers to overcome, such as depicted here: *"Challenge: Preparation of line management for seamlessly traffic flow"* (ID16).

Part of the respondents also claims the need for more citizens involvement (for instance, via citizens forums) in order to understand if citizens agree with and would want the use of those new technologies [ID12; ID16; ID8]. One of the statements addressing this issue: *"If you look at the debate about AVs a lot of the debate is about technical aspect, how these shuttles are driving around. It is much less about: do people want AVs, do the cities want AVs? ...the debate has been framed in a way that is super helpful for industries that develop new products and innovation. The industry starting point is saying: This product is coming. We actually don't even have a chance to say we don't want it" (*ID10).

Job loss and job creation

Regarding how automated driving impacts existing jobs, respondents believe that the deployment of automated vehicles will occur in the long term, which would give time for drivers to be re-educated and learn new skills: "*…it gives us 10-20 years to educate, to think, to make new deals. For us is more about re-educating people, as there will be a big need for skilled workers."* (ID11).

Three respondents explained that automated driving would create new and better jobs, e.g. vehicle production, maintenance and supervision of vehicles (ID11; ID16; ID7). Those higher qualifications entail higher wages. Therefore, personnel costs could increase due to increasing qualification needs and the number of automated vehicles. In addition, one respondent highlighted that it is important for driver unions to be part of the discussions before disruptive changes in the sector (ID11). "*Our work and most important role is to create or being part of the discussion before all changes have been completely disruptive for the sector*." (ID11).

Moreover, some respondents point to the fact that the experience that a bus driver gets over the years is very difficult to compensate with automated driving [ID6]. A respondent drew attention to the fact that the elderly and people with reduced mobility (PRM) may rely on the safety drivers' help onboard the minibus, which cannot be replaced by technology (ID7).

3.3.5 Financial aspects

The main advantage of automated minibuses is that they are driverless, which reduces the cost of drivers' wages. This is cost-saving for the operators and provides additional flexibility for the operating hours. An automated minibus can be operational for 24/7, without forcing people to work in off-peak hours or night shifts. This is important because the promise of an on-demand service increases flexibility for the users. However, as long as the law requires safety operators onboard or supervisors in a control room, this flexibility might be at the cost of the flexibility of the drivers that have to be stand-by, waiting for a ride. A comparable issue is visible at Uber, where Uber-drivers have shifts of over 20 hours to cumulate 6-8 productive hours. As described by one of the respondents (ID 11), the example of Uber presents a real problem when a company use digital platforms to disrupt the taxi industry, and the worker places by offering passengers very cheap transportation without paying taxes for the city neither decent wages for the drivers: "*This kind of technology that destroys the labour market, it is more critical than future scenarios of AVs*" (ID 11).

The respondent also exemplified that in Denmark, the arrival of Uber and similar companies caused a huge debate about their mode of operation and consequences on the labour market. As a consequence, Uber shut down its operation in Denmark because it did not comply with the legal standards for established taxi firms and for unfair competition.

The development of a mobility system that does not require drivers has economic benefits. However, there are also some concerns and disadvantages associated. A concern is the replicability of a driver, as '*most of the knowledge of a bus driver is very difficult to automate* (ID6). A second issue is that some users will need assistance during their ride, as they won't be able to use the automated minibus on their own. A solution could be to provide rides with safety drivers on board, booked through the app (ID20). Due to this kind of considerations, interviewees report that the role of bus drivers will become (even) more important: *"This kind of transportation will create new and better jobs…" (ID11).*

It was frequently mentioned that automated driving technologies are expensive. It includes elevated costs of components (sensors, LiDAR, radars, etc.) and the need for investments in more research and development, such as software development. (ID1; ID2; ID4; ID8). On the one hand, technology maturity is seen as an obstacle. On the other hand, it advances fast (ID4; ID5; ID8).

3.3.6 Environmental aspects

Electric automated vehicles are often promoted as a sustainable solution to urban transportation problems, such as congestion and pollution. Our interviewees are not consistent in the positive effects on the environment. Some interviewees stated that additional research is necessary, as they are '*...missing proof, that automated vehicles are beneficial for the environment*' (ID8). Others state that this innovation does indeed entails possibilities to alleviate environmental pressure from the urban transportation system. However, certain requirements need to be fulfilled. The automated minibuses should, for instance, replace the use of cars, rather than substituting walking or cycling. A potential disadvantage could be that automated vehicles will not be operated in a shared manner, as an integral part of public transport, but will be a replacement of individual cars and be privately owned. This will not result in elevating environmental pressures. To stress the relevance and importance of this potential disadvantage, our interviewees report on differences between the USA and the EU. Whereas in the United States of America, the mindset goes much more towards individual mobility (owning the vehicle), the European mindset goes much more towards shared, public mobility.

3.3.7 Expected future scenarios

The vision and perspective of many respondents converge on a transition of mobility services towards a more connected, electric, automated and shared mobility (ID1; ID4; ID10).

AVs will not solve all mobility problems, but they can be seen as an opportunity to reduce emissions, as part of the public transport system to make mobility more flexible, attractive, shared, and as an opportunity to design our cities as we want them (ID10). AVs are also mentioned as an enabler to redefining the traffic flow in cities through shared mobility (ID3). In addition, AVs are also expected to transform urban mobility, providing more reliable and scalable services, which meets the individual needs of each person (ID5). However, different perspectives also stand. One of the respondents stated that AVs are perceived to come in a very far future. They also pointed out that the vehicles operate at a very low speed and are not made for changing road traffic, therefore, requiring even more street space (ID16). The respondent highlights the importance that public transport has to be the first choice and the privately-owned vehicles have to be in third place and that investments in the public transport sector cannot be neglected: "*The introduction of automated vehicles in 10-30 years is used as an excuse to avoid investments in the public transport system*" (ID16).

One respondent mentioned the importance of public authorities to support alternative mobility systems, considering that, currently, public transport is in crisis (ID17). Another respondent presented a different perspective, explaining that public transport is increasing at the moment due to the increasing population, especially in bigger cities (ID18). A respondent also stated that *"automated or not, public transport can also deliver"* (ID18). The respondent added that the investment for adapting for automated driving is very high. Therefore, buses, in general, are getting less and less effective because of the operational costs. Following up, the respondent added that certain modes of transport fit for different contexts, e.g. if we

want to solve the problem of crowded cities, walking or bicycle instead of using the car is a better solution. In the case of the Netherlands, the bicycle is often used for the last miles (ID18).

One of the stakeholders presented concerns about whether AV would be mainly deployed for private and individual mobility or as a shared mobility service (ID10). Most of them agree that shared AV are the best solution, more beneficial and affordable, in contrast to individual AV (ID1; ID3; ID4; ID5; ID8; ID14). One respondent stated that AV at level 5 would be deployed as a shared service, not owned by families for example (ID5). In this regard, one respondent commented that OEMs predict automated driving to be the future, but at the same time, they want individual mobility to be part of a future mobility system (ID14). The respondent added that AV would be instead deployed as minibuses and trucks, then individual mobility solutions (ID14).

When asked about the role that they foresee regarding the automated minibuses, the respondents presented two different perspectives:

i. Deployment of the automated minibuses on a local and small scale would aim to fill the mobility gaps, with a focus on first and last miles (ID1; ID12; ID15; ID16).
ii. Deployment in many different cases (ID2), the automated minibuses would increase driven distances and drive on more complex roads (ID3).

The deployment places mentioned comprehend first and last miles between tramway and metro stations to the office, school, stadium, theatre, shopping centre, and house (ID1). Other respondent mentioned as well the deployment in residential areas, hospitals, universities, airports, and big factories (ID5).

In the context of the Netherlands, one respondent stated that the interest in the automated minibuses is to develop mobility hubs, in which minibuses would be integrated as a multimodal solution, but outside of the inner city: *"… inside the city in the Netherlands is difficult because of all the cycling and the safety, … I believe the automated car cannot be part of that it will be part of the highway system, the outside of the city…"* (ID15)

The respondent added that automated bus is better utilized within a small system, on a specific lane until there is a secure way for it to interact with different traffic groups, as pedestrian and cyclists (ID;15). The interest in deploying the automated minibuses is mostly to reduce parking spaces and reduce the number of 4-lanes roads; in addition, "…*New mobility is connected to the new way of economic development in our city*" (ID15).

Furthermore, one respondent commented on the active role of the city planners: "*either city planners await what will happen in the future, or they actively shape the transition*" (ID 12). The respondent added that future mobility concepts would influence the future design of urban districts, e.g. shared mobility could reduce parking slots and increase gardens and parks; otherwise: "…*If you build parking slots, vehicles will come to your city*." Therefore, the respondent pointed out that it is "*highly relevant for city planners plan now the city for the next 25 years*".

3.4 Stakeholder map

In the previous sections of this chapter, we provided the results of our stakeholder analysis on the field of automated minibuses in European urban public transport systems. Based on the presented analysis, we

defined a 'stakeholder map' as the field is currently seen by the main EU stakeholders (see Figure 11). Hence, this stakeholder map is based on the views of the stakeholders and about the status quo. It depicts who is in contact with whom, shows information flows and formal relations. It builds on the quantitative analysis we conducted by interviewing 30 actors.

3.4.1 Structure of the stakeholder map

Through the analysis, it became clear that not all actors have an equal influence on the development of automated minibuses in urban public transportation systems. We therefore define three types of actors: primary actors, secondary actors and tertiary actors.

- Actors that are able to influence this development and deployment directly, and have a large stake in the direction of the development, are labelled primary actors. These include the city governments, the public transport operators, the manufacturers, the software developers, the European Union, and citizens/end-users. There are strong relations between these primary actors, with the city government and the PTO as a central axe. They connect all other stakeholders together. The testing as well the future deployment of the automated minibuses hinge on the cooperation between these stakeholders, specifically the PTO and the government. The concession for operation is the first component place the automated minibuses in the transportation ecosystem.
- The secondary actors influence the development, but in a more indirect manner; through influencing the prime actors. This category of actors includes civil society organisations, such as driver unions, environmental NGOs and citizen associations, research institutes and the media. This actor group is well connected to each other, but primarily to the groups of primary actors via the PTOs (as employees and users), the city government, and the citizens/end-users. They play an important role in supporting or opposing the key players.
- The third group, the tertiary actors, are important for the technical development of the system (suppliers), as well as for the operation of the system (safety drivers and insurance companies). They provide constraining and enabling conditions but are not actively involved in shaping the system.

The division of strengths in ties between the actors results from the type of connection between the actors. Furthermore, we considered the number of times that the connection was mentioned by the stakeholders and the weight attached to it by them.

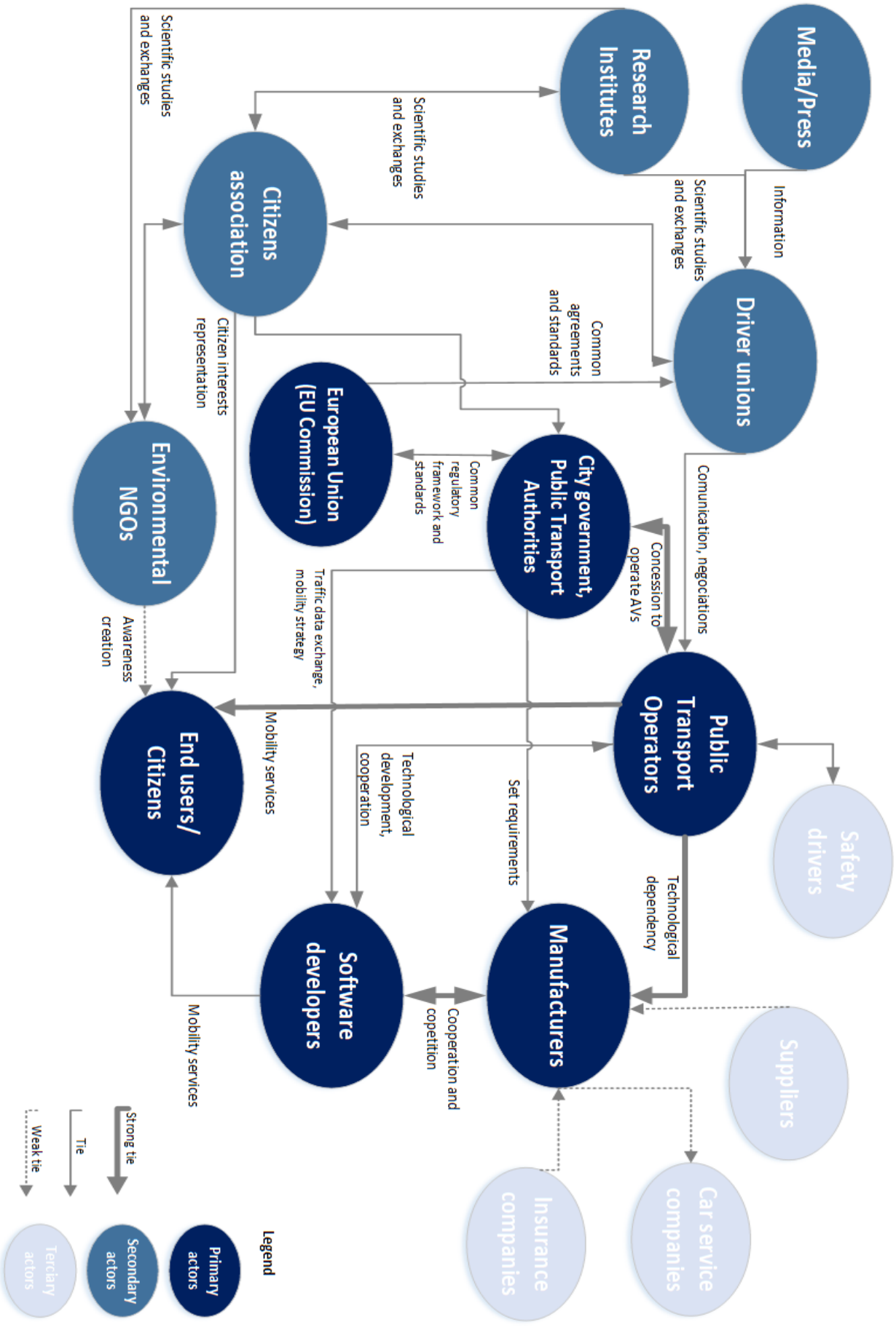

Figure 11: EU level Stakeholder map

3.4.2 Insights from the stakeholder map

The stakeholder map presents insights in the relations between the involved stakeholders in the field of automated minibus deployment. As is made visible through the identification of three types of actors, a group of 6 stakeholders are key for the development of a public transportation system, in which automated minibuses are integrated to allow citizens to call and hop a ride at any time, at any place and deposit them as close as possible to their destination.

The group of manufacturers and the software developers strive to develop the necessary technologies and push for their implementation. In order to so, they are depended on the other four stakeholder groups. Close collaboration with the organisations that provide public transportation services, the PTOs, is necessary. These organisations will have to operate the services, and their commitment to this new service, and the transition to a new public transportation system is a necessity. The PTOs, however, provide transportation services on behalf of the (city) governments. This group of stakeholders defines the rules of the game. This includes a variety of issues, such as the defining the requirements of public transportation (hence, can an on-demand service be classified as a public transport service?), regulating and setting requirements for allowing automated minibuses on public roads, but also more practical issues such as the service hours of public transport. The city governments and public transport authorities are embedded in a multi-level governance system, which means that some governmental responsibilities are dedicated at a national or European level. Hence, decisions of the European Commission and of national governments define the room to manoeuvre for the city government and public transport authorities to enhance and stimulate the development of a revolutionized public transport setting. The final group of stakeholders that is crucial, are the end-users of the system. A technical innovation, such as automated driving can only be successfully implemented once accepted by the (potential) users. Based on the result of this study, and confirmed by the Avenue social impact assessment, there is a high level of goodwill toward automated minibuses. To yield this goodwill, and to assure that end-users will also change their mobility behaviour by using the automated minibuses, the system should provide for a high level of flexibility. To create this high level of flexibility, requires innovate software solutions, and driverless automated shuttles. These interdependencies show that a renewal of the public transportation system, toward a flexible system that focusses on providing tailor-made mobility solutions (hence, on-demand and a door-to-door) requires cooperation between and commitment of the main stakeholder group.

The aforementioned dependencies are crucial for establishing a new public transportation system, however, an additional requirement is the creation of a common discourse; a common wording and understanding of the desired system. This means that the development of innovative techniques, the innovative software and data sharing platforms, the required regulatory alterations and the social and behaviours changes should be aligned. This is only possible once the involved stakeholders accept a common discourse. It should be accepted that the deployment of automated minibuses is not only an extension of the existing public transport system, but it is intended to revolutionize the system. This new system is not structured by fixed routes from the supply side, but is guided by the travel request from the demand site. Only through the acceptance of this common frame of reference can necessary changes be made in, among others, regulatory frames, travel behaviour demands, organisation and contracts of public transport service providers.

The distinction between primary, secondary and tertiary stakeholder does not mean that the secondary and tertiary stakeholder groups are not of importance. On the contrary, each of the stakeholder groups

has the ability to alter and change the perception and position of the primary stakeholders. The environmental NGOs and citizen associations can have a major influence on the position of the end-users, and on the governmental stakeholders. If these stakeholders negatively influence public opinion, the established goodwill toward automated driving and acceptance of using an automated minibus in public transportation could diminish. The civil society stakeholders base their strategies on knowledge acquired through real-life experiments and experiences and publications of research institutes. Pilot projects, such as the Avenue operations in Lyon, Luxembourg, Copenhagen and Geneva, are therefore not only important to develop and test technical innovations (both the automated driving itself and the compatibility with user-oriented software), but are also important in creating goodwill and science-based facts that civil society organisations use to inform citizens.

Most importantly, the stakeholder map shows that the implementation of automated minibuses in the public transport sector is only partly dependent on the technical system – cooperation between the manufacturers, the software developers, and their suppliers. This technical system is embedded in a larger system, that does not only include governmental actors, end-users and civil society organisations, but also competitors, that envision another restructuring of the (public) transport system. To gain better insight in these two systems, and how the interactions between the two systems influence the work and vision of the Avenue project, we focussed on an Avenue stakeholder and mobility services map in chapter 4.

4 Conceptual Avenue stakeholder and mobility services analysis

The Avenue stakeholder and mobility services map was developed to gain insights into the consequences of deploying automated minibuses in the public transport sector. It aims to show the complex ecosystem that this deployment will become part of it. Therefore, aims to identify strategic actors, main mobility trends and their interactions in the process of implementation and integration of automated vehicles in the transport systems of European cities. The map is based on a comprehensive literature review, which is validated by experts and Avenue project partners.

4.1 Avenue stakeholders and mobility services

The starting point of this map is the vision of Avenue that entails that automated minibuses could be integrated into a multi and intermodal mobility system and to be offered as Mobility as a Service (MaaS). AV and Maas could be a game changer in mobility as AV combined with other means of transport could individualised public transport and be a game changer in the future. This approach follows the people centric vision of mobility of the EU (EU and EFTA Ministers of Transport, 2020; UITP, 2020) and the SUMP approach. According to ITS Australia (2018) "*MaaS systems offer customers personalised access to multiple transport modes and services, owned and operated by different mobility service providers, through an integrated digital platform for planning, booking and payment*".

At the centre of the map, as presented in Figure 12, are three means of transport (in light orange): automated vehicles for public transport, vehicles for mass-transport and individual mobility services and; privately owned automated vehicles. The automated vehicles for public transport are connected to four sub-systems: infrastructure (left side); civil society (top left); government (top right), and; the transport sector (bottom). These subsystems each have their own stakeholders and goals and present obstacles and limitations to the integration of automated minibuses in public transport:

- Stakeholders in the infrastructure sub-system include digital infrastructure providers that set requirements of new digital infrastructure, comprehending telecommunications, data centres, cybersecurity system, vehicles intersections (V2V, V2I, V2X), and Energy infrastructure providers that set requirements for infrastructure for EVs and charging stations when combined with electric mobility. Hence, the research and development for those innovations entail more partnerships between the automotive industry and technology providers;
- The civil society sub-system includes stakeholders such as trade unions and industry lobbies. Some of these stakeholders will support the development, while others will oppose it;
- The governmental sub-system consists of multilevel governmental institutions, city governments, country governments, the European Union, as well as regulatory authorities. This governmental sub-system is crucial for the deployment of automated vehicles, as they can set legal obstacles, have to adapt infrastructure and have to authorize and allow automated driving on public streets;
- The mobility sub-system includes operators and owners of the other vehicles that are part of the public transport system as well as those privately owned. For the development of a MaaS system,

the three means of transport need to be connected and integrated. A crucial role herein is foreseen in the mobility aggregator, a service provider that creates and supports an intermodal and/or multimodal on-demand platform. Thus, taking into account a scenario with multimodal mobility and connected vehicles (Attias, 2017; Fielden et al., 2017), the mobility aggregators/integrators play an important role by providing the Integrated Mobility Platforms (IMPs) as a key solution to simplify the journey planning and payment, and providing highly customer-tailored solutions (Baron et al., 2018). Current main players providing IMPs are, for instance, Google Maps, Citymapper, Omio, Qixxit, Moovel, among others. Connecting these means of transport also means connecting both the traditional transport operators and new competitors. The end-users are an integral part of this sub-system, as it is developed being a 'customer-centric approach on mobility services' (Fournier, 2017). In establishing this system, the end-users have several options regarding the means of transport for short and long journeys in European cities.

Banks and insurance companies are stakeholders included in the map that do not directly relate to one of the subsystems. The insurance companies, despite the uncertainties, consider that initially, automated vehicles will increase insurance rates due to the fact that they will become more complex and more expensive to fix (Noble, 2018). Later on, it is expected that the insurance prices for automated vehicles decrease, considering that the frequency of claims might reduce and the percentage of automated vehicles on the roads might increase. (Noble, 2018) In addition, when addressing automated vehicle technology, potential new insurance market fields are pointed for the insurance industry, such as Cyber Risk, Software and Hardware, and Infrastructure (Karp et al., 2017).

From the bank perspective, automated vehicle technology can trigger significant changes in financial services. Therefore, banks should embrace the changes and new technologies (e.g. artificial intelligence, blockchain, distributed ledger technology) and re-think financial services according to these new technologies (e.g. IoT, sensors, connected cars) (Pinto, 2018). Important transformations mentioned by Pinto (2018) include the sharing economy and the changes in how banks model their financial services, considering the shift from ownership to sharing-based models; Open banking and the changes on how users will do their payments, loans, credits, risks; Security concerning privacy and hacking cars; and; Customer trust.

Banks will finally play also a key role when AV are combined with other means of transport e.g. within a MaaS for ticketing.

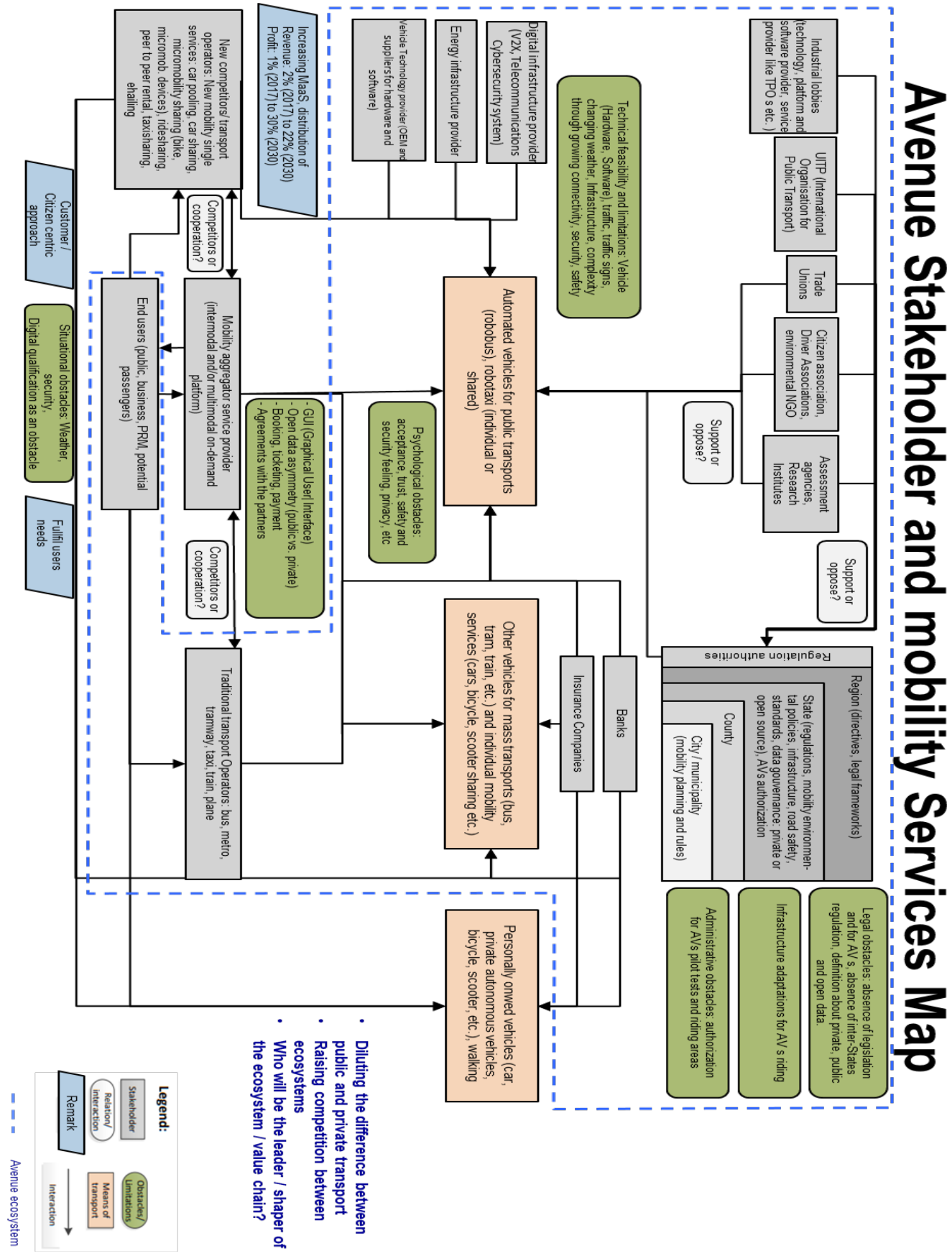

Figure 12: AVENUE Stakeholder and mobility services map

4.2 MaaS strategies

Within Avenue, the deployment of automated minibuses is part of a technical ecosystem, aiming to demonstrate that automated minibuses can operate as integral part of the public transport system. The stakeholders in this ecosystem should cooperate and work towards achieving this goal. However, there is also a bigger ecosystem, that of the entire urban mobility, including private and shared mobility as well.

The Avenue stakeholder and mobility map therefore defined three means of transport:

- automated vehicles for public transport;
- vehicles for mass-transport and individual mobility services and;
- privately owned automated vehicles.

As is shown in Figure 12, the development of privately-owned automated vehicles is excluded from the Avenue scenario, as these automated vehicles will only replace conventional vehicles, and therefore does not contribute to a new transportation system. The difference between the other two means of transport is based on automation. Another crucial aspect is whether the means of transport are part of a public transport system, or of a private transport system. A taxi for instance, is not part of the public transport system, but is shared between users, whereas a bus is both shared between users and part of the public transport system. The same division can be made for automated vehicles. Robo-taxis are shared, but not part of the public transport system, whereas automated minibuses are both shared and part of the public transport system.

Defining two systems (a private transport system and a public transport system) in which automated vehicles can be deployed on-demand and door-to-door in an intermodal mobility concept, invites for a discussion on how these possibilities relate to each other, and to the goals and vision of the Avenue project. The central question therefore is, what are possibilities and consequences for the technical innovations of automated vehicles to revolutionize transportation?

We see three main considerations that are important for future scenarios. First, private automated vehicles could be introduced and developed. This scenario is not part of our AVENUE focus (see above) and not very likely as the price is expected to be very high in the next 10 years (Fournier et al., 2020). Cities would furthermore like to avoid additional traffic and continue to have a policy which tries to keep individual vehicles out from cities (Marsden, 2006; Buehler et al., 2017) .

Secondly, private unimodal robotaxis (such as Waymo/Google, ATG/Uber, Zoox/Amazon) could provide individual mobility services. These services could later integrate preferred private partners and also public means of transport through open data (Directive 2019/1024 of the European Parliament and of the council of June 2019) and offer customer centric mobility services. The private company could thus create a private MaaS. This strategy can be called “laissez-faire” scenario where authorities and regulation (on the EU, national and local level) do not try or are not fast enough to anticipate the digital and automation transformation in mobility. This “laissez-faire” scenario would allow few private companies to become dominant (through the so called “winner takes it all” effects), capture the created values and displace public transport (see e.g. Clewlow and Gouri S.Mishra, 2017) through creating a private MaaS. Huge rebound effects could be the result with more traffic and less benefits for the environment and the

citizens. Displacement of public Transport are likely as well. These scenarios will be further developed in WP8 and should be deepened in future research.

A third consideration is the linkage between the private and public platforms, as a system where on-demand door to door automated minibuses combined with other means of transport through Maas could be a "game changer" making public and private transport individual and providing a real alternative to individual privately-owned vehicles. For that purpose, different combination of complementary means of transport of all private and public Transport Operator are bundled to one trip and thus most effective and sustainable for stakeholders:

- citizen could better satisfy their need in having more choice and a better on-demand and door-to-door service (customer centric approach),
- TPO could better use the existing network capacities (open seats in private and public vehicles, on demand service delivery) and better-informed passengers
- The city could provide a more efficient transport system through:
    - better understanding of the behaviour of passengers,
    - more complementarity between means of transports
    - more competition and innovation
    - cost savings for the city through better use of transport resources (rolling stock, roads etc.) and lowering of negative externalities if certain conditions are satisfied.

These scenarios will be deepened in WP8 and WP9 and are raising several new questions. A representative survey is already planned in WP8 in the 4 cities to evaluate (confirm or deny) expectations of citizens. A consequence of this scenario could be a blurring between public and private transport systems. This question should be deepened in future research.

In admitting the wider ecosystem of urban transport, in which the automated minibuses will be deployed influences the role, position and support of involved stakeholders. Automated minibuses can be deployed to strengthen public transport, but the same technology can be used by private companies (Apple, Uber) to optimize their own ecosystem, which will result in additional competition to the public transport system. In order to gain support for the deployment and development of automated vehicles, it is therefore crucial to invest in creating intermodal transport systems, that rely on open data and open API.

4.3 Open data and open API for mobility

A crucial issue/topic in the integration of automated minibuses into multi and intermodal mobility that requires new connections between different stakeholders is open data and open API (application programming interfaces). API brings data to the potential user to inform him about the location of an automated minibus and when it could arrive. When the user books a mobility demand, an API transforms this demand into a mission for the automated minibus to pick-up the passenger. Data availability is a key issue for users to easily plan and pay for their journey using one single platform. Consequently, end-users have to juggle among different mobility platforms to plan multimodal journeys. (Steinmann, 2019) In this regard, the mobility aggregators/integrators have developed Integrated Mobility Platforms (IMPs) aiming to win the customers by fulfilling this gap and simplifying the route planning and the travelling experience (Baron et al., 2018). However, the encouragement of the emergence of platforms that would centralize

all mobility services offered in one region, involves strategic decisions and regulations regarding mobility open data (Steinmann, 2019).

From the State and local mobility authorities' perspective, enlarging the mobility open data would contribute to have a better overview of the transport flows and especially the private mobility flows in cities, allowing them to adapt public provision according to the customer needs (Hassani, 2018).

Although, the discussions around the mandatory opening of mobility data, without distinction between private and public, present discontents and uncertainties for both sides: mobility companies and public transport operators. On the one hand, mobility companies (e.g. Waze, Uber) agree to cooperate with information for local authorities to improve their transport supply. Nevertheless, they express the concern that opening access to anyone poses a competitive problem (Hassani, 2018) On the other hand, the open data legislation can also be critical for public transport operators once they fear that it would facilitate the hegemony of non-European digital giants (e.g. Google, Uber, Apple) (Mallet, 2019). For instance, operators consider the risk of being deprived of contact with the customer, including the ticket selling, in favour of the "integrators" and their Integrated Mobility Platforms (Julien, 2019).

Hence, the mobility open data regulation is a current strategic topic for private and public stakeholders to plan their next steps.

5 Stakeholder strategies

In this section, we will define strategies and recommendations for the main AVENUE stakeholder groups, the city governments, the transport operators, the MaaS stakeholders and the citizens/civil society. In addition, we will provide recommendations for research and innovation projects like AVENUE. The strategies are based on the two stakeholder maps developed in this deliverable: the EU level stakeholder map (Figure 11) presented in chapter 3 and the Avenue stakeholder and mobility services map (Figure 12) as presented in chapter 4. Both stakeholder maps represent a visualisation of the stakeholder environment of automated minibus development. Due to a different goal and starting point, the maps differ, in the level of detail, in scope and in how they can be used. However, and more importantly, the maps do also complement each other. Based on synergies in the two maps, and lessons learned, we will define strategies for the main Avenue stakeholders.

5.1 City governments

The current pilots of AVENUE provided important insights into how to proceed in the future to support the testing as well as the deployment of automated vehicles for public transport.

As experienced in Copenhagen, the cities could work in collaboration with key stakeholders to update the homologation guidelines for automated vehicles technology. The guidelines must be adapted to the novelty of innovation while keeping the citizens' safety in mind. For instance, the Automated and Electric Vehicles (AEV) Act in the UK focuses on the roll-out of these vehicles and preparing the infrastructure and liability insurance for "the biggest transport revolution in a century" (Department for Transport, 2018). Moreover, the legal framework is only one component of a long-term plan for integrating mobility innovation, specifically the shared automated vehicle, within the city and the existing transportation ecosystem. Running the automated minibuses in public areas must go beyond the testing phase to the actual roll-out to serve the city for the long run (Eden et al., 2017) and filling real social mobility needs. The long-term planning ensures constant investment and development of the technology and the services which could provide funding support for the PTOs. To achieve that, the city government should commit to involving key stakeholders and especially the citizens; they could devote citizens forums, participatory workshops, or living labs. These initiatives engage the people to become active participants in the innovation process and in urban policy planning (Björgvinsson et al., 2010).

Furthermore, future deployment and their impacts must be present in the mobility master plan and future transportation agenda. The SUMP guidelines could provide reliable support on how to manage automated vehicles to benefit all stakeholders. The emphasis should also be put on promoting sustainable active modes of transport such as walking and biking. Thus, the introduction of an automated minibus should be targeted to support active mobility and reduce the use of unsustainable individual transport. Moreover, the responsibility lies in the hands of city planners to ensure that the infrastructure is adequate for the circulation of the automated minibuses but that it remains in line with sustainable urban planning. The automated minibuses could be a game-changing agent in terms of creating place-making and improving the quality of life in urban areas (Sime, 1986; Vleugel and Bal, 2017).

Finally, collaboration with other cities lays the ground for a network of support. Membership in cooperative networks could accelerate adaptation planning for AV roll-out. The benefits of networking between cities were explained in (Heikkinen et al., 2020) research on climate change adaptation for networks such as the C40 Cities Climate Leadership Group and the Global Covenant of Mayors. A similar consortium to AVENUE could be beneficial for deploying the automated minibuses for public transport. An alternative could be to integrate AVENUE projects in the focus of C40 cities to support their sustainable mobility policies.

5.2 Transport Operators

The PTOs in AVENUE prepared for the pilots by researching the existing public transport offer in the area, the cities agendas and goals, and AV's potential technological trends. All of that built a solid foundation for the testing of the automated minibus. However, a more detailed assessment of the regulatory framework, such as the existing homologation conditions for Copenhagen, or the feasibility of on-demand public transportation in Luxembourg, could have further reinforced the project. This showcases the importance of cooperating with key stakeholders such as the local policymakers and government. The regulations' analysis could have provided further insights about the city's mobility strategy, infrastructure restrictions, and transportation demand management, e.g. if there is pull and push policies: no car zones, road pricing (TUMI, 2011).

Furthermore, the PTOs should work more with the citizens. The use of surveys or workshops could help them understand more the needs of the users before defining a test area or in the testing areas. Thus, they will provide the service to meet demand rather than only to test the services of the automated minibus.

Such collaborations with other stakeholders provide a holistic vision of needed services, whether to focus on connectivity services such as Wi-Fi on board of the vehicles or more on the public transport services. It also promotes private-public partnerships. Moreover, the operators could work with civil society to better ensure that the automated minibuses for public transport services are sustainable. The automated minibuses should support public transport but also not compete with active modes of transport like walking and biking. The NGOs' recommendations could support smooth deployment operation, increase the acceptability of the automated minibuses, and promote the services. Even more, the PTOs could focus on the integration of the automated minibuses within the transportation ecosystem. In the future, they could collaborate more with software and MaaS operators to better implement one platform where passengers could select the on-demand automated minibuses for public transport and book the entire trip with one ticket. This could ensure the proper integration of these vehicles.

5.3 MaaS stakeholders

The MaaS provider is a role that could be occupied by private, public, or both transport operators. The recommendation for the MaaS stakeholder is to focus on providing integrated customer-centric data to the passengers. Public and private transport operators should work together as one integrator for MaaS services to define the standards for sharing data between all key stakeholders. The access of the PTOs to transport regulations and transport authorities makes it easier to offer a range of public transport services on a MaaS platform quicker, yet the business competitiveness and profit-driven model of private

operators could help the MaaS market to grow faster (Kamargianni and Matyas, 2017). Thus, the collaboration between both sides could help develop the MaaS services.

To better incorporate the automated minibuses in the transportation ecosystem, data sharing should be open and fair and API a pre-requisite to enable interoperability. The results of the Avenue social impact assessment show that the acceptance to use data is high among (potential) users, and fears regarding data misuse are low (Korbee et al., 2021). The transparency of data exchange will foster trust and cooperation with all the stakeholders. Further, the information, ticketing and billing to ride the automated minibus have to be integrated into the public transport system of cities and MaaS platforms. In a future mobility system, it is expected that the automated minibuses will be part of mobility hubs, which will integrate all the means of transport. Consequently, the services' quality will be improved, and the impacts of automated minibuses for public transport will be beneficial to cities, citizens, and private and public partners (Pickford and Chung, 2019). The collaboration between private and public transport operators under the care of public authorities leads to a unified platform for MaaS. This partnership supports transport demand management, fill mobility gaps, and reduces externalities.

5.4 Citizens and Civil Society

The deployment of automated minibuses in public transport entails a promise to revolutionize our mobility and enable people-centric-mobility as recommended by UITP and the EU. Not only does it aim to enhance access to mobility, it also intends to redefine how we use different mobility systems. It is, for instance, aimed for that citizens will no longer focus on owning vehicles but focus on using them. As this socio-technological transition has a lot of implications for citizens, they, therefore, have to be actively involved in it. Hence, it is recommended that citizens (whether or not they are users of public transportation and/or automated minibuses) actively engage in fora such as citizen dialogues. Equally important is the creation of spaces for dialogue, public discussion and living labs for interactions of citizens and the technologies and innovations. All in all, the urban transportation system as envisioned by AVENUE (and the MaaS-type of systems) claim to be a user-centred system.

This active involvement is not only required for citizens; an important role is reserved for civil society organisations. Environmental NGOs have currently not taken a clear position in this debate but stress the need for better studies to be able to assess the environmental implications. This is an important role that should be continued.

6 Conclusions

The AVENUE project aims to demonstrate the use of automated minibuses in public transport. The stakeholder analysis presented in this deliverable aimed to provide insight into the social setting in which the automated minibuses will operate. The social-environmental assessment consists of a multitude of organisations, networks, and institutions. Each of these stakeholders has their own set of expectations and their own specific role. Based on the conducted stakeholder analysis, we can draw conclusions on three levels. The first set of conclusions can be drawn concerning the main actors and the level playing field of the deployment of automated minibuses. The second set of conclusions can be drawn on how stakeholders currently assess the development of deploying automated minibuses in public transport systems. The third set of conclusion focuses on how AVENUE partners can increase the success of the deployment of automated minibuses in public transport through a specific stakeholder approach.

6.1 Automated minibuses in public transport

Deploying automated minibuses in the public transport system takes place in a complex stakeholder environment. The stakeholder maps show that a plurality of stakeholders involved does not share similar goals and expectations. Furthermore, developing a system in which the automated minibuses provide an on-demand, door-to-door service creates an entanglement with the mobility system in general, as it is a service that competes with private taxi services and personal use of cars. This does also result in an altered level playing field; the division between public and private transport is diluting.

6.2 Stakeholder positions

The interviewed stakeholders picture the future outlook for automated vehicles in very different ways, meaning that each stakeholder is focusing on different issues to be addressed with the implementation of automated vehicles. Additional to different topics that stakeholders have in mind, they also have different attitudes towards the same topic. A good illustration of that is the future role of bus drivers in a system where automated vehicles will be applied. While the bus drivers themselves picture their current responsibilities as job enrichment (they expect to take over more ambiguous tasks), others perceive the job of bus drivers as not required for the operation of automated minibuses.

The development of fully automated vehicles has also resulted in a renewal of the mobility industry, which is still ongoing. Stakeholders like manufacturers have so far always played a leading role in market competition, and as they will not like to give up this position easily, they try to steer into one direction. Classical OEMs used to be market leaders in the automotive industry, but with the increasing extent of automation, new competitors drop into this market. Another point to consider here is the investment-linked with fully automated driving. To support investments, it is desirable that policies and regulations that in support of this new technology are in place. That would give manufacturers, at least to some extent, security about their investment. Introducing a legal framework supporting this innovative technology, does present a dilemma for governments as they should keep needs and wishes of society and citizen in mind. In addition, there is a discrepancy in pace between technology development (fast and dynamic) and legal framework development (slow and long term).

Prior to scaling up the deployment of fully automated vehicles, some barriers need to be solved. These barriers are not only of technological nature but do especially address legal and social issues. To find solutions for barriers is not in the response of manufacturers and software developers alone, as they will not possess sufficient resources. Especially, social acceptance can become a great threat for putting automated minibuses in place. Another fact to be considered when analysing stakeholders is to take a look at the resource equipment each stakeholder group has. In fact, each stakeholder group is rich in more or less similar resources, differing in quantity. Additionally, many interviewees raised the missing legislation and regulation for implementing automated driving and claimed that governments partly fail to put appropriate regulations in place.

6.3 AVENUE stakeholder strategies

To stimulate a successful integration of automated minibuses in the public transport system, partners of the AVENUE project can/should include new stakeholders in its network. Stakeholders that are currently under-represented are civil society organisations, such as driver unions, and environmental NGOs and citizens associations. These actors are crucial in a user-centred urban mobility system. Another group that is not represented in the AVENUE consortium are the city governments. These governmental bodies are crucial stakeholders in public transportation, as they define the requirements of the public transport network in their cities. The PTOs are the service providers. An example that shows the importance of the city government is the refusal of the city of Luxembourg to allow an on-demand, door-to-door service to be offered as a public transport service. The third group of actors that are recommended to be included or connected with (more prominent) in the AVENUE consortium are the partners deploying existing modes of transport that the automated minibuses will be connected to. We do, therefore, conclude that the AVENUE consortium should focus on:

- creating stronger cooperation between city government, PTOs and software developers to develop common strategies to deploy automated minibuses which serves general interest. The deployment should become an integral part of the city goals for mobility, as well as for the concession process for public transport services. Cooperation or non-synchrony are key factors to success.
- developing tools for citizens participation and inclusion in the debate beyond a user vision.
- stimulating more interaction and exchange between scientific research institutes, and policymakers and decisions makers.

Last but not least, a user-centric system (as is envisioned in the AVENUE vision) requires a user-centric approach/human-centric approach, more than technology development. This means, for instance, that the selection of lines/services that will be deployed depends on real social mobility needs rather than technological possibilities. Bottom-up strategies, such as living labs and citizens forums, enable more participatory approaches, debates and dynamic interaction between society and innovations. Moreover, automated vehicles combined with a MaaS open new opportunities to fulfil the best the mobility needs and help to develop people centric transport policies which serves general interest. This could raise acceptance of citizen for innovation.

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Appendix A: Topic list

Key topics:

- Role of interviewee in organization
- Introduction of organization
- Perception on automated mobility
- Perception on automated minibuses integrated in public transport
- Barriers, risks, obstacles and solutions
- Resources
- Information behaviour
- Relation to other stakeholders

Guideline:

- To provide respondents a maximum level of openness the guidelines determines the topics in detail but does not determine accurate direct questions.
- At the start of the interview, we ask for personal introduction & attitudes, in the remaining of the interview, we are interested in the perceptions, goals, resources etc. of the organization.

General Introduction **about 5 min.**

- Introduction to AVENUE (EU project, aim to demonstrate the usefulness of integrating automated minibuses in public transport, role of HS-PF, goal of stakeholder analysis, methodology of qualitative interviews)
- Data protection declarations
- Request for audio recording
- Use of citations for reporting
- Introduction of the interviewer

I. Warm-Up **about 5 min.**

Aim: Introduction of the **interviewee**

- Professional background, professional career
  as technical, economic, political, social, psychological background
- Current areas of responsibilities

II. Involvement, Attitudes, Expected Trends regarding mobility and automated mobility

about 10 to 20 min

Aim: Identifying the interviewee's role within his/her organization with regard to automated vehicles. Understanding the role and interests of the organization.

How would you describe the role, the specific interests, strategic goals or even responsibilities of your organization with regard to introducing and establishing automated public vehicles (minibuses in the first place) in your community/city?

With regard to your own person but as well with regard to your professional tasks, what do you think about mobility in general, public transport and finally automated vehicles in special?

CHECKLIST

- Description of organization (public, private, civil society)
- automated mobility involvement concerning e-mobility, automated vehicles (core objective of organization; affair of their heart, are they open-minded, neutral, enthusiastic or skeptical)
- Future trends, developments concerning mobility in general: multimodal integrated mobility on demand and ticketing
- Expectations towards different target groups, attractive market segments, application fields
- Customers of organization? Value they are proposing to add.
- End Users of automated vehicles (e.g. general people, scholars/commuters, tourists, shoppers, weekenders &'night owls')

III. Perception on automated minibuses/pilot **about 10 to 20 min.**

Aim: Involvement and perception on integration of automated minibuses in public transport

Now I'd like to go into more details concerning automated vehicles especially automated minibuses. You may know there will be a pilot in your city. What do you know about this pilot so far?

(If respondents are not yet involved, some prepared background information is given).

IV. Perceived barriers, risks, obstacles and solutions **about 10 to 15 min**

Aim: Identifying the barriers and obstacles that the interviewee's organization perceives, and the solutions proposed to overcome these barriers

Which upcoming barriers and obstacles regarding automated public transports does your organization foresee?

Checklist:

- Formal regulations (policies, rules, etc.)
- Cooperation with other actors
- Social acceptance

- Improve technology
- Desired automation
- control and monitoring levels
- Level of acceptance of different service and business models
- Reduce environmental impact
- Public vs. private mobility
- Security

V. Resources of interviewee's organization about 10 to 15 min.

Aim: Identify the resources that the interviewee's organization possess to resources

What resources does your organization possess that help to reach to the solutions proposed, what resources are missing?

Checklist:

- Financial resources
- Institutional resources
- Technical resources
- Social resources

VI. Identification of other Stakeholders, information behaviour about 10 to 15 min.

Aim: Identifying important stakeholders

What other stakeholders/organizations does your organization cooperate with, depend on, or have regular interaction with?

Which of these stakeholders are most crucial for enabling automated public transportation and why?

Checklist:

- Customers
- Partners for cooperation
- Stakeholders that they depend on for their success
- Public organizations, private companies, civil society organizations
- Opponents and supporters of AVENUE goals
- New competitors (Google, Apple, Uber, etc.)

VII. Information behaviour about 5 to 10 min.

Aim: Identifying relevant sources for information

What sources of formal and informal information does your organization rely upon?

Checklist:

- Formal and informal information

- Social networking
- Interaction with other stakeholders
- Important influencers
- Working groups, personal network

VIII. Wrap Up – Final Self-Reflection about 5 to 10 min.

Aim: Invite interviewee to address to topics that we have not yet touched upon

Thanks for your time and the information provided. Are there any themes/issues regarding automated public transport that you would like to discuss with us?

MANY THANKS FOR THIS INTERVIEW!