AVENUE

Automated Vehicles to Evolve to a New Urban Experience

DELIVERABLE 8.9

Social impact assessment

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Acronyms

CATI	Computer Assisted Telephone Interview
EC	European Commission
SUMP	Sustainable Urban Mobility Plan
PRM	People with Reduced Mobility
PTO	Public Transport Operators
WP	Work Package
AV	Automated Vehicle
AM	Automated minibuses

Executive Summary

An important aspect of the AVENUE project is the socio-economic and environmental evaluation (WP8) It consists of an Environmental Impact Assessment (T8.1), an Economic Impact Assessment (T8.2), a Social Impact Assessment (T8.3) and a Sustainability Assessment (T8.4). This deliverable presents the AVENUE social impact assessment. The AVENUE Social Impact Assessment focuses on the social impacts of the deployment of automated minibuses in the four official AVENUE cities, Luxembourg, Copenhagen, Geneva and Lyon. The primary aim is to understand whether the introduction of automated minibuses in the public transport system will result in a changed mobility behaviour, which corresponds to the following research question: What is the social impact of automated public transport systems, and how does this contribute to a changed mobility behaviour? To answer this research question, six studies have been conducted:

- A qualitative study focused on the mobility needs in a prospective replicator site
- A qualitative study focused on the mobility needs, mobility gaps expectations on automated minibuses in the pilot site Nordhavn, in Copenhagen, Denmark.
- A qualitative study on experiences of the safety operators.
- A quantitative, representative study focussed on mobility behaviour, attitudes on automated minibuses and social acceptances of automated minibuses in the four AVENUE cities. This study was conducted twice; as zero measurement in 2019 and in 2021
- A study focused on the user experiences of passengers of the automated minibus service in four pilot sites; Nordhavn (Copenhagen), Sion (Switzerland), Esch (Luxembourg) and Slagelse (Copenhagen).
- A study on social media content about automated minibuses.

These results are presented following six main themes 1) Mobility attitudes and behaviour; 2) Mobility needs; 3) Attitudes and acceptance toward automated minibuses, 4) Target groups; 5) changes in mobility behaviour and 6) User experiences.

HERE: Include final conclusions

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 the 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 has 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. 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.

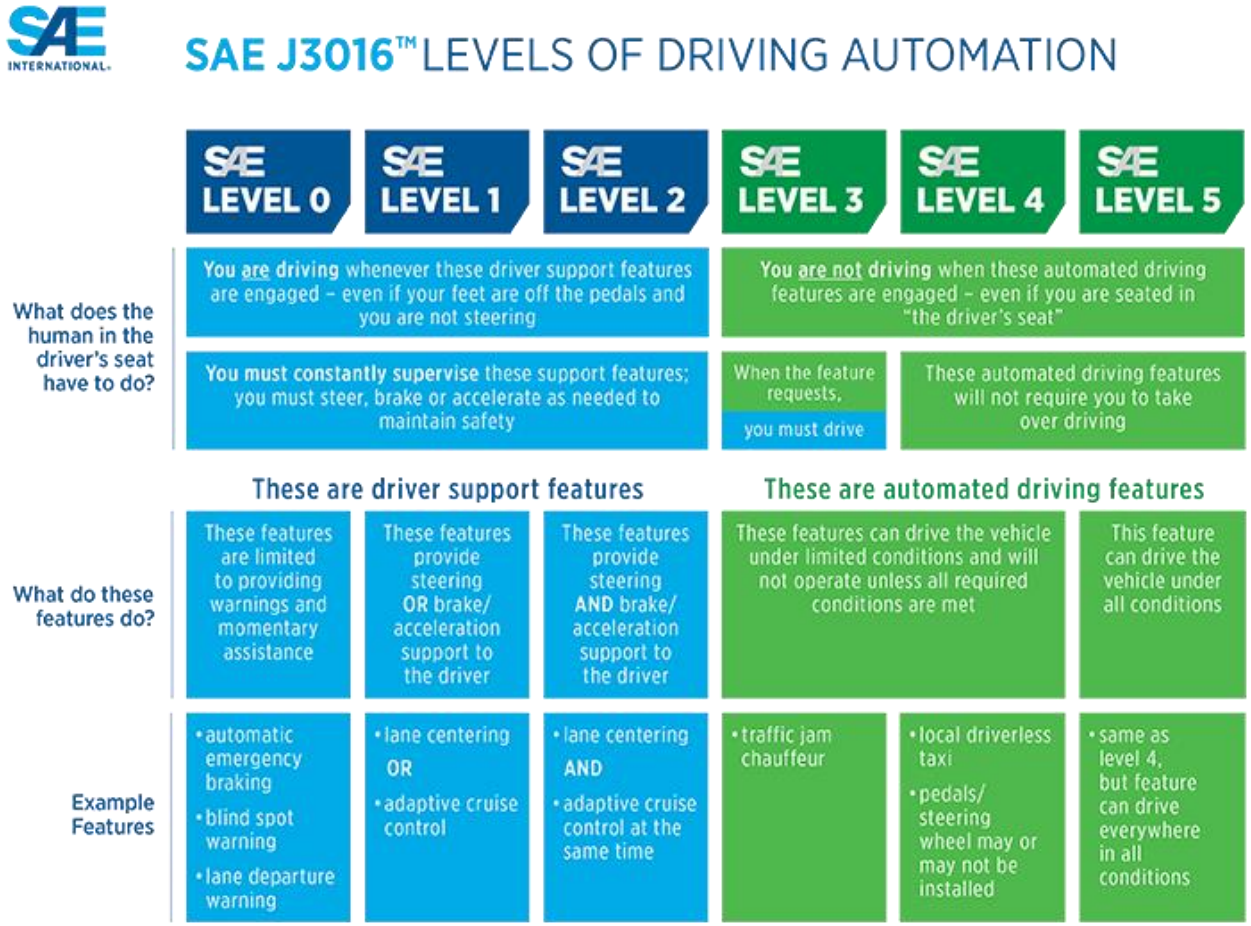


Figure 1.1 Levels of driving automation

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 of 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 takes into account 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 minibuses. . Table 2 provides and overview of the AVENUE sites and OODs.

	Summary of AVENUE operating sites demonstrators						
	TPG		Holo		Keolis	Sales-Lentz	
	Geneva		Copenhagen	Oslo	Lyon	Luxembourg	
Site	Meyrin	Belle-Idée	Nordhavn	Ormøya	ParcOL	Pfaffental	Contern
Funding	TPG	EU + TPG	EU + Holo	EU + Holo	EU + Keolis	EU + SLA	EU + SLA
Start date of project	August 2017	May 2018	May 2017	August 2019	May 2017	June 2018	June 2018
Start date of trial	July 2018	June 2020	September 2020	December 2019	November 2019	September 2018	September 2018
Type of route	Fixed circular line	Area	Fixed circular line	Fixed circular line	Fixed circular line	Fixed circular line	Fixed circular line
Level of on-demand service*	Fixed route / Fixed stops	Flexible route / On-demand stops	Fixed route / Fixed stops	Fixed route / Fixed stops	Fixed route/Fixed stops	Fixed route / Fixed stops	Fixed route / Fixed stops
Route length	2,1 km	38 hectares	1,3 km	1,6 km	1,3 km	1,2 km	2,3 km
Road environment	Open road	Semi-private	Open road	Open road	Open road	Public road	Public road
Type of traffic	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed	Mixed
Speed limit	30 km/h	30 km/h	30 km/h	30 km/h	8 to 10 km/h	30 km/h	50 km/h
Roundabouts	Yes	Yes	No	No	Yes	No	No
Traffic lights	No	No	No	No	Yes	Yes	Yes
Type of service	Fixed line	On demand	Fixed line	Fixed line	Fixed line	Fixed line	Fixed line
Concession	Line (circular)	Area	Line (circular)	Line (circular)	Line (circular)	Line (circular)	Line (circular)
Number of stops	4	> 35	6	6	2	4	2
Type of bus stop	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed	Fixed
Bus stop infrastructure	Yes	Sometimes, mostly not	Yes	Yes	Yes	Yes	Yes
Number of vehicles	1	3-4	1	2	2	2	1
Timetable	Fixed	On demand	Fixed	Fixed	Fixed	Fixed	Fixed
Operation hours	Monday-Friday (5 days)	Sunday-Saturday (7 days)	Monday-Friday (5 days)	Monday-Sunday (7 days)	Monday-Saturday (6 days)	Tuesday & Thursday Saturday, Sunday & every public holiday	Monday - Friday
Timeframe weekdays	06:30 – 08:30 / 16:00 – 18:15	07:00 – 19:00	10:00 – 18:00	7:30 – 21:30	08:30 – 19:30	12:00 – 20h00	7:00 – 9:00 16:00 – 19:00
Timeframe weekends	No service	07:00 – 19:00	No service	9:00 – 18:00	08:30 – 19:30	10:00 – 21:00	No Service
Depot	400 meters distance	On site	800 meters distance	200 meters distance	On site	On site	On site
Driverless service	No	2021	No	No	No	No	No
Drive area type/ODD	B-Roads	Minor roads/parking	B-Roads/minor roads	B-Roads	B-Roads	B-Roads	B-Roads/parking
Drive area geo/ODD	Straight lines/plane	Straight lines/ plane	Straight lines/ plane	Curves/slopes	Straight Lines/ plane	Straight lines/ plane	Straight lines/ plane
Lane specification/ODD	Traffic lane	Traffic lane	Traffic lane	Traffic lane	Traffic lane	Traffic lane	Traffic lane
Drive area signs/ODD	Regulatory	Regulatory	Regulatory, Warning	Regulatory	Regulatory	Regulatory	Regulatory
Drive area surface/ODD	Standard surface, Speedbumps	Standard surface, Speedbumps	Standard surface Speedbumps, Roadworks	Frequent Ice, Snow	Standard surface, Potholes	Standard surface	Standard surface

Table 2: Summary of AVENUE operating site (+ODD components)

1.3 Scope and aim of the social impact assessment study

This deliverable presents the final results of the AVENUE social impact assessment. The aim of the social impact assessment is to study mobility needs, attitudes toward automated minibuses, user experience, user acceptance and potential changes in mobility behaviour in the use of public transport systems. Chapte 2 details the structure of the AVENUE social impact assessment, and presents the studies conducted. Chapter 3 presents that mobility behaviour and attitudes on mobility of the citizens of the four AVENUE cities. Chapter presents the results of a qualitative studies into the mobility needs and mobility gaps as perceived by citizens in Singen (Germany) and Nordhavn (Copenhagen). It furthermore discusses the expectations of the citizens of introducing an automated minibus service. Chapter 5 presents expectations, attitudes and acceptance of automated minibuses in the four AVENUE cities. This chapter presents results from the 2021 representative, quantitative survey among citizens of the AVENUE cities. Hereafter, chapter 6 will focus on specific target groups. First it presents target groups based on perception of risks and benefits of on AM. Hereafter, an analysis is made between PRM and non-PRM users, and between citizens living in urban or rural areas. n chapter 7, and analysis is made on changes in mobility behaviour, attitudes and perceptions on AM. User experiences are presented in chapter 8. This AVENUE social impact assessment is finalized with conclusions in chapter 9.

2 AVENUE social impact assessment

In this chapter we will introduce the AVENUE social impact assessment, starting with an introduction of the main themes guiding this assessment. Hereafter, we will introduce the studies that have been conducted and will be presented in this deliverable.

2.1 Introduction

Public support is of crucial importance for a successful implementation of the AVENUE automated minibus service system. Elements that are important for the creation of public support are: safety, comfort, technology trustworthiness, effectiveness, accessibility and price (Kyriakidis et al. 2015; Nordhoff et al. 2018b; Bernauer and Wicki 2018; Litman 2019). A study shows that potential users are supportive of this new technology (Nordhoff et al. 2018a). To increase its acceptance, the new technology should be introduced to the public as soon as possible, while simultaneously being further advanced and pushed to high-quality level (Salonen and Haavisto 2019). Furthermore, visual assessments (e.g. lights, signals) and government support increase acceptance (Wicki and Bernauer 2018).

In the AVENUE social impact assessment, we focus on the social impact of the deployment of automated minibuses in the AVENUE cities Luxembourg, Copenhagen, Geneva, Lyon (demonstrator cities), Sion and Esch (replicator cities). In addition, the needs and expectations in a town without automated minibuses (Singen) were investigated. The primary aim is to understand whether the introduction of automated minibuses in the public transport system will result in a changed mobility behaviour, which corresponds to the following research question:

What is the social impact of automated public transport systems, and how does this contribute to a changed mobility behaviour?

To change mobility behaviour of citizens in the AVENUE cities by introducing automated minibuses requires a need for new mobility services, social acceptance of automated mobility services by the society as well as a positive user experience. These aspects are interrelated, but nevertheless should be distinguished, as citizens might be accepting the new technology in general but might not be willing to use it due to unsatisfactory or even negative user experiences. Or, people that are reluctant to the new technology will start using it due to positive user experiences (Shackel 2009; Tullis, T. & Albert, A. 2013). These three concepts correspond to the first three research questions that guide the social impact assessment:

1. What are mobility needs of citizens, and can an automated minibus service provide in this need?
2. What is the social acceptance of automated public transport systems in the AVENUE cities?
    - Are there differences between specific target groups, and if so, which ones?
    - What is the acceptability and accessibility of automated public transport systems for people with reduced mobility (PRM)?
    - How are automated vehicles discussed in social media, and what lessons can we learn for AVENUE?
3. What is the user experience of automated shuttles in the AVENUE cities?

These questions will be answered via a combination of observation and qualitative as well as quantitative interview techniques. These techniques will be adapted from classic methods used in user experience design and evaluation such as usability testing or contextual enquiry. In addition to the classic methods used to answer research questions 1 to 4, we aim to gain insights in the role of social media in the acceptance of automated public transport. Gaining insights from the contents of social media could provide other indicators about the social acceptance of automated minibuses.

2.2 Research approach

To answer the research questions, we designed and conducted 6 studies (see Table 2.1):

- A qualitative study focused on the mobility needs, mobility gaps and the question whether automated minibuses can fulfil these mobility gaps in a prospective replicator site in Singen, Germany.
- A qualitative study focused on the mobility needs, mobility gaps and the question whether automated minibuses can fulfil these mobility gaps in the pilot site Nordhavn, in Copenhagen, Denmark.
- A qualitative study took the perspective of the safety operators. Their own experiences with the automated minibus, their observations and interaction with the users provided input on the AVENUE user experiences.
- A quantitative study focussed on mobility behaviour, attitudes on automated minibuses and social acceptances of automated minibuses in the four AVENUE cities. This study was conducted in 2019, as a zero measurement, and repeated in 2021.
- A study focused on the user experiences of passengers of the automated minibus service in four pilot sites; Nordhavn (Copenhagen), Sion (Switzerland), Esch (Luxembourg) and Slagelse (Copenhagen).
- A study on social media content about automated minibuses. This should also contribute to understand the social acceptance of automated minibuses.

The study on the experiences of PRM has been conducted as part of AVENUE WP2, its results do however also feed into this deliverable. Table 2.1 provides an overview of the details of the studies. In this final deliverable the results are not presented study by study, but are structured according to content-related topics. This means that the results are brought together according to themes from the various studies. The methods applied in these different studies are discussed below.

Table 2.1 Overview studies conducted for the social impact assessment

OBJECTIVE	MOBILITY NEEDS, MOBILITY GAPS		SOCIAL ACCEPTANCE	USER EXPERIENCES			SOCIAL MEDIA
STUDY	Mobility needs, mobility gaps and expectations of automated minibuses	Mobility behaviour at pilot site level	Expectations, attitudes and acceptance of automated minibuses	User experience of actual users	Experiences of safety operators	Accessibility of automated public transport for PRM	Social media monitoring
TARGET GROUP	Citizens	Residents of pilot site	Potential users, households	Users of the automated minibus	Safety operators	People with Reduced Mobility	Comments of social media users
METHOD	Qualitative interviews	Qualitative, longitudinal study interviews	Quantitative, online survey	Quantitative, online questionnaires	Qualitative interviews	Qualitative interviews	Media analysis
SAMPLE SIZE	n= 12	n=8	2019: n= 981 2021: n=1816	Copenhagen (Nordhavn): n = 68 Sion: n=44 Esch: n=… Copenhagen (Slagelse): n=xx	n=6	n=58 (part of WP2)	n=781
CHAPTER IN DELIVERABLE	4	4, 8	5, 6, 7	8	7	7	7

2.2.1 Qualitative survey to investigate needs

This study was conducted to get an initial understanding about the current situation, problems and needs regarding the mobility of the citizens of a location that would qualify for an automated minibus service. Singen was selected because it was discussed as a potential replicator city. Additionally, the study aimed to analyse their expectations and concerns on future mobility solutions like the automated minibus, which was evaluated more detailed. The needs should be investigated before citizens had the opportunity to become familiar with the AMs. A qualitative research approach was selected to gain insights on how the current mobility situation is perceived and the expectations towards automated minibus services. Furthermore, the goal was to understand which needs exist, to what extent these needs are already met or where is a gap that should be closed by improvement and finally – whether the AM has the potentials to close these gaps. Qualitative, semi-structured interviews were conducted with citizens of Singen. The interviews were structured by a guideline, that is included in appendix C. The sample design followed the principle of conscious selection; the target group of the study were the citizens or regular visitors of Singen. An equal distribution of women and men, different age groups and public transport users versus non-public transport users was required. A requirement set by the AVENUE project, is the inclusion of people with reduced mobility (PRM), this could be people travelling with baby carriages, wheelchairs, or walking aids (Brosius et al. 2012).

Recruiting of respondents was conducted via distributing the request on several social media platforms, community websites of Wilferdingen-Singen and Remchingen or invitation by mail to known contact persons. In order to collect the right sample, an online screening questionnaire was conducted. This questionnaire covered the following issues: gender, age, PRM, place of residence, mobility behaviour, perceived mobility gaps, satisfaction with the public transport and current traffic situation. 46 respondents answered these screening questions. 12 persons fulfilled the quota criteria (see conscious selection) and were willing to take part in the survey (see Table 2.2). For qualitative studies it is common to have smaller samples but to select the sample consciously by theoretically based criteria (Brosius et al. 2012).

Table 2.2 Sample structure Singen study

Gender	• Women: n=7 • Men: n=5
Age	• Between 16-29 years: n=1 • Between 30-60 years: n=8 • 61 years or older: n=3
PRM	• Baby carriages and stroller: n=1
Place of Residence	• Singen: n=10 • Wilferdingen: n=2 (but regularly/very often in Singen due to work)
Duration	• between 60 min and 90 min

The interviews were analysed using qualitative content analysis. Qualitative content analysis is a method for analysing and reducing text meaning and is particularly suitable for comparing different texts (Mayring

2015). The aim is to create a category system that structures the text material and filters out those aspects that are relevant for answering the research question. The category system can be developed either inductive, deductive or mixed. With the inductive approach, the categories are derived directly from the material, whereas in the deductive approach they are already defined in advance. Mixed means, for example, that the main categories are determined inductively, but the subcategories are worked out inductively. The category system of the operator interviews was mainly created in an inductive manner. However, aspects of the mixed way are included, as the guideline already gives a first structure of the content and indications for the main categories.

2.2.2 Longitudinal survey to investigate among residents of Nordhavn, Copenhagen

The goal of the longitudinal study was to gain insights about mobility needs of citizens living near an AVENUE pilot site, to gain insights in their satisfaction with the current mobility situation in Copenhagen, perceptions and assessment of automated minibuses and how these could fulfil their mobility needs. The study focused on the residents of Copenhagen living next to Nordhavn as the automated minibus operated in this area during the survey. This should ensure that the participants are confronted regularly with the automated e-minibuses and ideally were using it already so that they had better insights to form an opinion.

The defined timeframe for the longitudinal survey was two months. Respondents were invited to take part in this study through flyers distributed in the area, through a Facebook-group of residents, and through the qualitive survey conducted in 2019. All interested respondents were given a screener survey, to check to what extent they fit to the relevant criteria and were then invited to take part in the longitudinal survey. Finally, eight persons took part over the whole timeframe. A detailed description of the sample is shown in

Table **2.3**.

Data collection was separated into different steps: a first explorative interview to get to know the participant as a person and their behaviour regarding mobility. The participants should explain if and how they would imagine the integration of the automated minibuses in their mobility behaviour in Copenhagen. Those respondents that already used the automated minibuses, were asked to reflect on their experience.

To analyse the change in attitude, the participants received six online – surveys from “Questback/Unipark” per e-mail, once a week. The questions are mainly closed questions with predefined answering possibilities for better comparison. The questionnaires were separated into two main topics, one being behaviour regarding mobility and preferred modes of transportation and the other one being about the autonomous e-minibus, their experiences with them, advantages and disadvantages and willingness to use them in the future. After the six surveys, a final explorative interview was carried out which was focused on the changes compared to the first guided interview and the development during the surveys. Linking the

surveys to the final guided interview helps quantifying changes and investigating them in the interview. At the end of the data collection there are two guided interviews and six surveys for every participant.
The interviews were analysed using qualitative content analysis, following the same produced as the qualitative study in Singen (section 2.2.1).

Table 2.3: Sampling size (n = 8) and relevant criteria

Criteria	Characteristics	Sampling size
Residence	○ Participant lives in Copenhagen, Nordhavn	n = 2
	○ Participant lives in Copenhagen, not Nordhavn – but travels there frequently (for work or other activities)	n = 6
Nationality	○ Danish	n = 3
	○ International	n = 5
Gender	○ Male	n = 6
	○ Female	n = 2
Age	○ 18 – 30 years	n = 2
	○ 31 – 50 years	n = 5
	○ > 50 years	n = 1
Household	○ Single – household	n = 5
	○ Couple with children	n = 1
	○ Couple without children	n = 2
Current mobility situation in Copenhagen	○ Own car	n = 1
	○ Bicycle	n = 5
	○ Metro and s-train	n = 8
	○ Bus	n = 5
	○ Car-Sharing	n = 2
	○ Taxi	n = 3
	○ Walking	n = 8
Restrictions in mobility	○ Without restrictions	n = 6
	○ With restrictions	n = 2
Personal interests	○ Environmental consciousness, sustainability	n = 5
	○ Special interest in innovations	n = 6
	○ Travelling, new experiences	n = 8
	○ Self-fulfilment, career	n = 5
	○ Friends, family	n = 7
	○ Sports and health	n = 4
Education	○ Vocational education	n = 1
	○ Bachelor's degree	n = 7
	○ Bachelor´s and master's degree	n = 3
Employment sector	○ IT, Software	n = 3
	○ Transportation industry	n = 2
	○ Journalism	n = 1
	○ Health management	n = 1
	○ Sustainable energy supply	n = 2

2.2.3 Qualitative interview with safety operators to investigate their experiences and perceptions

Safety operators are employees of the Public Transport Operators (PTOs) working in the automated minibuses. The automated minibuses are meant to drive without representatives of the PTOs, but the presence of a person that can interfere and control the minibus is still a requirement by law for all test-sites of the AVENUE project. The safety operators are in a daily interaction with the users and collect numerous valuable observations on user behaviour as well as on the interaction of the users with the automated minibuses. In this study we aimed to gain insights on the observations of the safety operators, more specifically on the following topics:

- Self-image and responsibilities of the safety operators;
- General perception on test sites and automated minibuses in practice
- Observations about user profiles, behaviours, questions, conversations, and critical situations.

A qualitative approach was selected to gain deep and comprehensive understanding of the perceptions and insights on the experiences of the safety operators. The data were collected through semi-structured guided interviews. The semi-structured interviews were structured by a guideline. Due to the flexibility of the method, it is possible to generate new information that is particularly important to the interviewee. Aspects that are irrelevant for the interviewee are only briefly or not addressed at all. Thus, the interviewer adapts to the interviewee to explore his or her point of view as intensively as possible (Jandura et al. 2011). The guideline used in this study was an adapted guideline that has been used for the AVENUE stakeholder analysis (Fournier et al.; Nemoto et al. 2019). The results of the study presented in this chapter, were also integrated in the AVENUE stakeholder analysis.

The interviews were conducted between February and March 2020 via telephone or video call. The interviewees were selected with the support of the Public Transport Organisations (PTOs). A total of eight safety operators from Geneva, Lyon, Luxembourg and Oslo could be recruited. One interview was conducted as a double interview – two safety operators were interviewed at once – which brings a total of 7 interviews. Three interviews were conducted in English and French respectively, one in German. Each interview lasted around an hour. The interviews were recorded with an audio device and transcribed afterwards. In total 60 pages of interview material are available.

Table 2.4 Sample description

ID	City / TPO	Sex	Working experience as safety operator at the time of the interviews
I1	Oslo / Amobility	Male	Approx. 3 months
I2	Oslo / Amobility	Female	Approx. 5 months
I3	Oslo / Amobility	Male	Approx. 2 months
I4	Lyon / Keolis	Male	Approx. 6 months
I5	Lyon / Keolis	Male Male	Approx. 4 months Approx. 4 months
I6	Genf / TPG	Female	Approx. 18 months
I7	Luxemburg / Sales-Lentz	Male	Approx. 18 months

The interviews were analysed using qualitative content analysis, following the same produced as the qualitative study in Singen (section 2.2.1)

2.2.4 Quantitative survey among potential users in AVENUE cities

To gain insights in mobility behaviour, attitudes toward automated minibuses, and acceptance of automated minibuses in the AVENUE cities, a large-scale, representative survey was conducted in the four AVENUE cities. To be able to assess changes in mobility behaviour, changes in attitudes toward automated minibuses and as well as changes in acceptance of automated minibuses this survey was conducted in 2019, and repeated in 2021. The design of the survey, as well as the questions asked, were

This study is a quantitative study based on a fully structured questionnaire. A standardised questionnaire, with closed questions leads to a better comparability of the results as well as an increased objectivity of implementation and evaluation (Brosius et al. 2012). A three-step approach was followed in developing the questionnaire. First, the main parameters and indictors were assessed based on theoretical insights and literature (as discussed in section 2). Second, a repository of questions used in previous questionnaires on automated driving was created (based on (Keolis Downer 2018; Woehr 2016; Kilian-Yasin et al. 2016; Bernauer and Wicki 2018; Schoettle and Sivak 2014b)). The questions were grouped according to our main parameters and indicators. Where necessary, additional questions were formulated. Third, experts, such as public transport operators in the cities of focus, provided feedback on the questions. The final questionnaire consisted of 28 questions – a full list of questions is added in appendix A.

For the majority of the questions, we applied a 5-point Likert scale (Brosius et al. 2012). Only the endpoints are named with (1) describing the negative configuration e.g., “do not agree at all” or “not important at all” and (5) describing the positive form e.g., “agree completely” or “very important”. To not overstrain respondents, an additional answer option (6) “I can´t judge” or “I don´t know” was added in specific questions. To avoid cancelling none of the questions were set as mandatory.

The survey was conducted in all four AVENUE demonstrator cities; Copenhagen, Geneva, Lyon and Luxembourg. Conducting the questionnaire in four different European cities, consequently meant that translations had to be made from English into French, German, Danish and Luxembourgish. Great care was taken to keep the different versions compatible and consistent. In Copenhagen, respondents were able to choose between Danish (default language) and English. In Geneva, respondents were able to choose between French (default language), German or English. In Luxembourg, the respondents were able to choose between Luxembourgish (default language), French, German and English. In Lyon, the survey was only available in French. The questionnaire was programmed using Questback/Unipark.

The survey was conducted twice; in 2019 as a zero measurement, and in 2021 as a control measurement. The data collection procedure was different between these two rounds.

In 2019, we combined two methods for data collection. In Copenhagen, Geneva and Luxembourg, the data was collected through online surveys. The survey was distributed through internet and social media of the local partners. In Lyon, a computer assisted telephone interview (CATI) was conducted. The CATI survey conducted in Lyon was part of a larger, regular "barometer" study commissioned by Keolis. The relevant raw data from the CATI survey were provided by Keolis for evaluation.
In 2021, the data was collected through online surveys. The invitation to the survey was distributed through a sample bought from Respondi. Great care was taken that the sample was representative; based on gender and age distribution.

Data cleaning and sample structure
In 2019, records from respondents who completed the survey by clicking through the questions in less than 200 seconds or did not answer any of the questions were removed. As a result, 21 surveys from Geneva and 5 from Copenhagen were removed. Respondents who started the survey but did not finish it completely are included in the analysis, as well as respondents who did not answer continuously to all the questions. This is explained by the wish to achieve as much data as possible. Finally, 978 records remained, divided over the four cities. The structure of the sample is diverse; we reached all age groups, female and male potential users, employees as well as students, households with or without children (see Table 2.5).
In 2021, a total of 3995 respondents were invited to participate in the survey. The first question of the survey assessed the geographic limit of the sample. This geographical limit is set within a radius of 30 km around the city centre. This eliminated 1925 respondents from the sample. We checked the validity of the remaining responses via postcode areas. The data cleaning procedure consisted of three steps:

1. Deleting of records that took too long to respond; all records that required over 10,000 seconds were removed from the sample. As a result, 4 records were deleted.
2. Deleting of records that answered the survey too quickly; all records that required less than 300 seconds were removed. As a result, 182 records were deleted.
3. Deleting records that provided inconstant answers. In this procedure, we aggregated 40 control variables, and deleted records that provided the same answer for at least 30 questions. Based on this procedure, 68 responses were deleted.

Finally, 1816 records remained. The structure of the sample is diverse; we reached all age groups, female and male potential users, employees as well as students, households with or without children (see Table 2.5). With our geographical limit set at a radius of 30 kilometres from the city centre, our parent population consists of about 2 million residents. Recognized calculators for sample sizes in this case recommend sample sizes of about n=1000.

Data analysis
The statistical program SPSS was used for data analysis. After an initial descriptive analysis, a factor analysis was carried out to reduce the number of perceived advantages and disadvantages of automated minibuses. This was followed by a hierarchical cluster analysis to identify different typologies of respondents according to these perceived advantages and disadvantages. The details of this analysis are presented and discussed in chapter 6.

Table 2.5 Sample structure

	2019	2021
Total respondents	978	1816
City	Lyon: 654	Lyon: 501
	Copenhagen: 127	Copenhagen: 491
	Geneva: 170	Geneva: 284
	Luxembourg: 27	Luxembourg: 540
Age	40% younger than 36 years	25% younger than 36 years
	60% older than 36 years	75% older than 36 years
Sex	52% male	47% male
	48% female	53% female
		<1% other/unknown
Occupation	62% employee	55% employee
	18% student	6% student
	9% self-employed	6% self-employed
	11% other	24% retired
		7% other
		1% on maternity or paternity leave
		1% on sick leave
Education	57% tertiary	41% tertiary
	38% secondary	51% secondary
	5% primary	6% primary
		2% no education
Household composition	40% have children in household	37% have children in household
	57 % do not have children in household	62% do not have children in household
	3% refused to answer	1% refused to answer
Own private car	30 % none	16% none
	44% one car	45% one car
	26% more than one car	39% more than one car
Most frequently used transport system	24% own car	59% own car
	10% bus	7% bus
	14% train etc.	4% train
	32% bike	13% bike
	5% walking	13% walking
	15% other means of transport	10% other means of transport
Reduced mobility		2% use a walking stick/aid
		1% use a walking frame
		1% use a wheelchair
		1% have a guide dog

2.2.5 Qualitative survey to investigate user experiences

To gain insights into the experiences of people that use the automated minibuses and to examine the usability of the new service, a well-recognized instrument is a user survey (see also deliverable 8.8; (Korbee et al. 2019)). In a user survey, people reflect on their experience when using the automated minibus and evaluate their usability. evaluate their usability. The users experienced the automated minibus in a real natural situation. They were not specifically asked to do so for the survey. It was their own decision to use the service.

The user survey has been conducted online, using Questback software (for an example, see Figure 2.1). Passengers were given a leaflet with brief information and with a link to the online survey by the safety operators (see Figure 2.2). As the questionnaire could also be filled out via mobile devices passengers could choose whether they wanted to complete the questionnaire during their ride or later on after their ride.

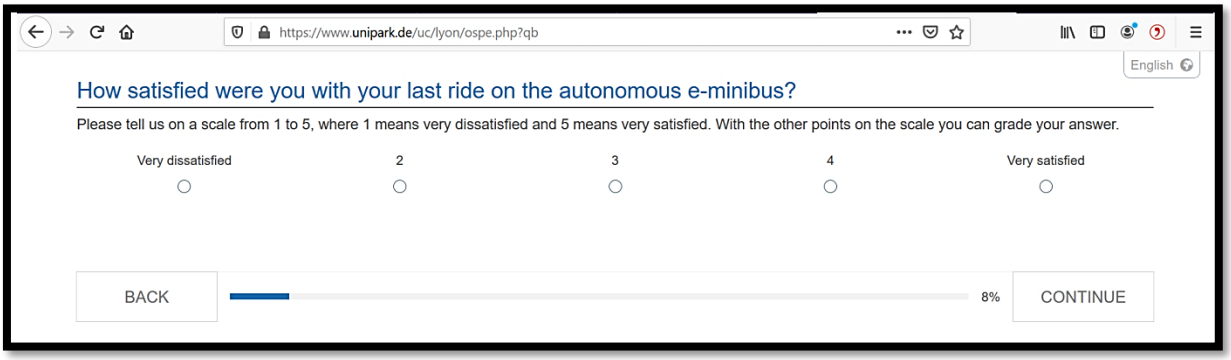


Figure 2.1 Example of question lay-out in Unipark

In Copenhagen, the distribution of the flyers started on Monday, August 24th 2020, and continued to December 1st 2020. The survey was open for respondents until December 15th 2021 to allow users to provide feedback sometime after receiving the invitation flyer. This is a total of 13 weeks. We see a relatively even distribution of respondents throughout this period. In total 58 respondents completed the entire survey, and 68 answered the questionnaire at least up to and including the question about overall satisfaction with their last ride. For the analysis, we also included the answers of participants that dropped out later in the questionnaire.

Figure 2.2 Invitation flyer to survey as distributed

The demographic structure of the users is heterogenous: young age groups as well as elderly people, male and female (male being somewhat overrepresented with 67%), students (7%) as well as (self-) employees (about 50%) and retired (29%). The user survey has primarily reached first users (94%). Only four respondents stated to have already used the automated minibus several times. More than two thirds of the respondents state that the usage was not driven by any specific occasion.

Table 2.6 Sample structure

	Copenhagen	***Sion***
Total respondents	*N=58 (FN – 10 respondents did not complete the questionnaire up to demography)*	*N=44 (FN – 9 respondents did not complete the questionnaire up to demography)*
Age	16 to 25 years: 5%	16 to 25 years: 71%
	26 to 35 years: 21%	26 to 35 years: 17%
	36 to 45 years: 10%	36 to 45 years: 0%
	46 to 55 years: 10%	46 to 55 years: 6%
	56 to 65 years: 21%	56 to 65 years: 0%
	66 to 75 years: 28%	66 to 75 years: 6%
	76 years and older: 5%	76 years and older: 0%
Sex	67% male	34% male
	31% female	66% female
	2% unknown/others	
Occupation	36% employee	9% employee
	7% student	85% student
	16% self-employed	0% self-employed
	29% retired	6% retired
	10% other	
Household composition	71% have children in household	6% have children in household
	28 % do not have children in household	91% do not have children in household
	1% refused to answer	3% refused to answer
Experience	94% first experience	89% first experience
	4%: 1 to 2 times	11% had previous experience
	2%: more than 11 times	

2.2.6 Social media analysis

The objective of the social media analysis was to offer an insight regarding the monitoring of comments from readers/users present on dematerialized versions of traditional media as well as on different social networks such as *Twitter, Facebook, Instagram,* and *Linkedin.* We were also be interested in comments posted on the video sharing platform *Youtube* and on community sites such as *Reddit* or *Quora*. The aim is not only to focus on comments related to the *AVENUE* project, but also to include all those related to automated public transportation in general. We also conducted a reflection based on the analysis of these contributions, which should help to determine where it is necessary to emphasize and shape communication strategies accordingly, which can be tailored to the channel or geographic context. Paying attention to these comments, particularly the more critical ones, should help to better identify consumers' demands, needs and fears and to reflect on what could be undertaken to better meet their wishes/demands. Some of these criticisms are precisely elements that the *AVENUE Project* is intended to solve, so it would be unfair to attribute all these flaws to it, but this remains a good way to quantify the need for these changes.

Table 2.7 Count of the sources referenced across this monitoring (total and by channel)

No. of sources	* on approx. 60,000 researched
Total	**781**
Conventional press	141
Youtube	96
Reddit	25
Quora	6
Facebook	99
Twitter	300
Linkedin	39
Instagram	75

The database, in its current form, contains 5,500 comments from about 800 sources. The sample seems numerically large enough to have a satisfactory level of significance, the representativeness is also very good, the panel being geographically diverse, based on a large number of channels and sources and very diversified in terms of their audience. As far as traditional media are concerned, the sources came from ten different countries: Germany, France, Denmark, Sweden, Switzerland, Great Britain, Austria, the United States, Luxembourg and Japan. The sources were sometimes found through the search engine of the different social networks or through *Google'*s search engine for the traditional press. The keywords (or *#* and *@*) used were: *automated*, *driverless*, *selfdriving in* combination with *shuttle*, *bus, public transport* (and their equivalents in different languages) but also the names of private and public operators that offer this type of service such as *Zoom*, *Keolis*, *Sales-Lentz group*, *TPG, RATP, Holo* etc.. The names of automated vehicles (*Olli, Arma, Aurrigo* etc.) or their manufacturers (*Navya, Aurrigo, Localmotors* etc.) and companies associated with these technologies (*Easymile*, *Bestmile*) were also used for these searches. Other sources have sometimes been found from one thing to another (hypertext links).

2.3 Cross-cutting themes for the social impact study

This deliverable is structured around the studies that provide insights on the three central topics for the social impact assessment (mobility needs, social acceptance of automated minibuses and user experiences). There are, however, some themes that cross-cut these studies. Four important themes require a word of introduction; the effect of the COVID 19 pandemic, the on-demand services, the relation to the sustainable urban mobility plans and digital illiteracy

Firstly, the effect on of the COVID-19 pandemic on public transport in general and automated minibuses in particular. The COVID-19 pandemic has direct consequences on the AVENUE project, as the majority of the operations endured a halting of the operations. Some pilots were able to restart their operations as of October 2020 with restrictions (such as a limitation of the number of passengers and requirement of protection masks), while others were not able to restart. For the social impact assessment, this meant that there was only limited opportunity to study user experiences or to conduct face-to-face interviews with residents of the pilot project areas. This has resulted in delays, and in cancellation of some user surveys.

The COVID-19 pandemic also impacts mobility behaviour, and attitudes on mobility in general; mobility demand is decreasing, due to lock-downs and home-office requirements. Furthermore, the demand for public transport is decreasing, as people rather opt for corona-safe mobility systems, such as a private car, or cycling. In the user surveys (presented in chapter 8), we included questions on the effects of COVID-19. A first indicator based on the study in Copenhagen shows is that COVID-19 influences the mobility patterns of about 50% of the users. The study also shows that that trust in automated minibuses is at a comparable level to trust in other public transportation systems.

Secondly, the on-demand system, as a key aspect of the AVENUE project, is a topic that is included in all studies. First results show that willingness to use the automated minibuses increases if an on-demand service is provided and that people are only interested in changing their mobility system if it provides additional temporal and spatial flexibility. Hence, the results so far point to the significance of an on-demand service for the success of the automated minibus services operation.

The European Commission (EC) introduced the concept of Sustainable Urban Mobility Plan (SUMP) aiming a ‘new planning paradigm’ in mobility, which comprehends a shift from planning for motorised roads and infrastructure to planning for people (Arsenio et al. 2016). Since 2013 the SUMP’s approach has been widely recognised, targeting sustainable and integrative planning processes to deal with the complexity and dynamicity of urban mobility (Eltis 2020). Hence, it embraces new modes of transport, e.g., micro-mobility, automated and connected vehicles, and new concepts as Mobility as a Service (MaaS), shared mobility and so on. The concept of SUMP comprehends the integration of all modes of transport, public and private, motorised and non-motorised and a long-term planning vision. It targets to improve the mobility accessibility, sustainability and citizens’ well-being (European Commission 2013). Automated minibuses are expected to have an impact an urban mobility, and could therefore become an important mode of transport to be considered in SUMP strategies and long-term vision. The results of this social impact study could feed into recommendations to improve or update the relevant SUMPs, for instance

through integrating insights on the mobility needs and gaps (Chapter 4), through defining the potential of the integrating automated minibuses in the public transport through the expectations and attitudes of potential users (Chapter 5, 6) and through the experiences of actual users, and their willingness to change modes of transport (Chapter 7).

2.4 Structure of this deliverable

The structure of this deliverable follows the logic of the research questions. Chapter 3 presents that mobility behaviour and attitudes on mobility of the citizens of the four AVENUE cities. Chapter presents the results of a qualitative studies into the mobility needs and mobility gaps as perceived by citizens in Singen (Germany) and Nordhavn (Copenhagen). It furthermore discusses the expectations of the citizens of introducing an automated minibus service. Chapter 5 presents expectations, attitudes and acceptance of automated minibuses in the four AVENUE cities. This chapter presents results from the 2021 representative, quantitative survey among citizens of the AVENUE cities. Hereafter, chapter 6 will focus on specific target groups. First it presents target groups based on perception of risks and benefits of on AM. Hereafter, an analysis is made between PRM and non-PRM users, and between citizens living in urban or rural areas. n chapter 7, and analysis is made on changes in mobility behaviour, attitudes and perceptions on AM. User experiences are presented in chapter 8. This AVENUE social impact assessment is finalized with conclusions in chapter 9.

3 Mobility behaviour and attitudes toward mobility in the AVENUE pilot cities

This chapter presents the mobility behaviour and attitudes toward mobility of the citizens of the four AVENUE pilot cities. The results are based on the final representative survey (for methodology see 2.2.4). This chapter is built around five blocks; current mobility preferences (3.1), actual mobility use and an analysis of gaps between attitudes (preferences) and actual mobility behaviour (use) (3.2). Finally, we focus on the groups that have the highest potential to substitute the use of their own car to AM (*bus preference & regular car use*).

3.1 Current mobility preferences

The analysis regarding the preferred transport system shows that the own car is the most preferred transport system for participants from all cities (53%), before public transportation (15%), walking (13%), and biking (13%) (Table 3.1).

Table 3.1 Preferred transport system*[1]

	Copenhagen (n=491)	Geneva (n=284)	Luxembourg (n=540)	Lyon (n=501)	Overall (n=1816)
Car	43%	30%	72%	56%	53%
Train	5%	9%	5%	2%	4%
Bus	5%	18%	5%	4%	7%
Bike	29%	9%	5%	6%	13%
Walking	10%	18%	8%	18%	13%
Other means of transport	9%	16%	6%	13%	10%

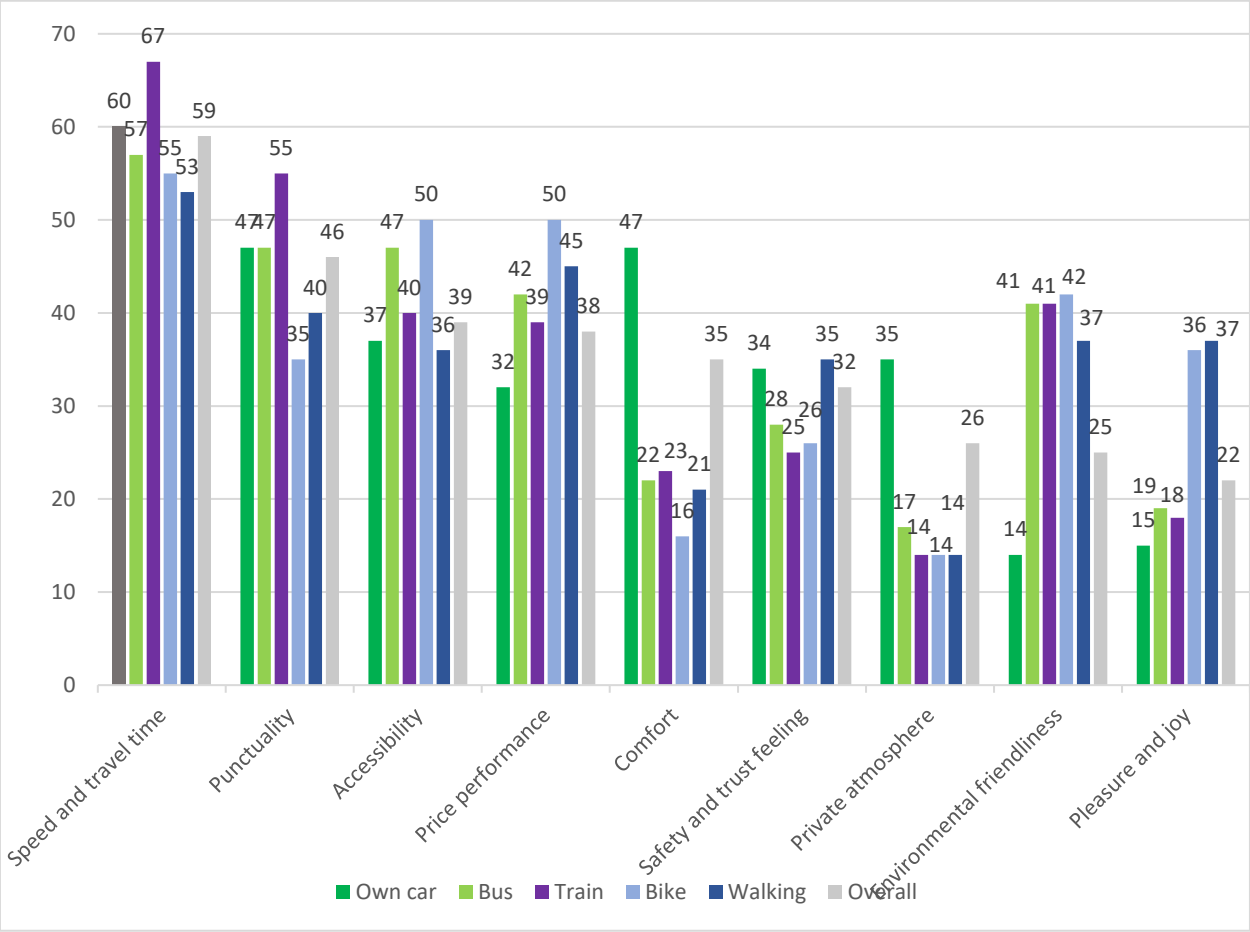
*[1] Statistical dependence between city and preferred transport system, (Chi-Square(33) = 457.645, $p < .001$)

Nevertheless, there are very significant differences between the cities:

- In Copenhagen using the bike as preferred mode of transportation is three to four times higher than in the other cities (29% in Copenhagen compared to 9% in Geneva, 5% in Luxembourg, 6% in Lyon). This makes it the second preferred transport system after the own car (43%) and even before bus and train (10%).
- In Geneva, comparable to Copenhagen the preference of car is lower than in Luxembourg or Lyon. Geneva is the city with highest preference for buses. Preference for buses is three times higher than in the other cities.
- Especially in Luxembourg the preference for the own car is very strong, with 72% of participants indicating the own car as their preferred mode of transportation. Public transportation was second with 11%, while walking (8%) and biking (5%) were mentioned less frequently.
- The preferences in Lyon picture more or less the preferences of Luxembourg, high preference for car (56%), but low preferences for public transport (10%).

In order to find out about the reasons behind the selection of the preferred transport system, respondents were asked to rate the importance of nine factors in selecting the preferred means of transport on a scale of 1 (most important) to 10 (least important). The most important factors for selecting the preferred means of transport for participants were speed and travel time, which received a ranking between 1 and 3 from 59% of respondents. Other important factors were punctuality and comfort. Further important factors were also accessibility, price performance, and safety and trust feeling. Least important to respondents were the factors private atmosphere, environmental friendliness, and pleasure and joy, see Figure 3.1.

Figure 3.1 Importance of factors in selecting preferred means of transport, divided by groups that prefer car, bus, train, bike and walking (in %, n=1816)



Subdivided by the preferred mode of transport, we see many differences in importance of aspects (see Table 3.2). The most striking difference is the importance giving by comfort; 47% of respondents that prefer to use the car, consider this important (which received a ranking between 1 and 3), compared to 16% of the respondents that prefer to use the bike. The respondents that prefer to use the bike or walking, grant higher importance to the factor 'pleasure and joy' compared to the other groups. A majority (59%) of respondents that prefer to use the car, do not find 'environmental friendliness' important in their decision (see also ... They rank the importance of 'environmental friendliness' significantly lower than those preferring other means of transport.

Table 3.2 Importance of factors in selecting preferred means of transport, divided by groups that prefer car, bus, train, bike and walking (in %, n=1816)

		Preferred mode of transport											
Mean[1]	Top box 1-3 (important)	Own car (n=968)		Bus (n=120)		Train (n=80)		Bike (n=227)		Walking (n=237)		Total[2] (n=1814)	
	Low box 7-9 (not important)												
Comfort*[1]		4.0	47	5.4	22	4.9	23	5.6	16	5.2	21	4.6	35
			16		39		19		36		31		23
Accessibility*[2]		4.9	37	4.2	47	4.4	40	4.1	50	4.8	36	4.7	39
			35		24		24		20		33		32
Safety and trust feeling		4.8	34	4.7	28	5.0	25	5.2	26	4.8	35	4.8	32
			28		22		25		31		28		27
Speed and travel time*[3]		3.3	60	3.7	57	3.1	67	3.7	55	3.8	53	3.4	59
			10		11		9		16		19		12
Pleasure and joy *[4]		6.0	15	5.9	19	5.7	18	4.9	36	5.0	37	5.7	22
			44		48		47		38		40		42
Punctuality *[5]		4.0	47	3.9	47	3.7	55	4.4	35	4.4	40	4.1	46
			16		13		12		19		20		17
Price performance *[6]		5.2	32	4.2	42	4.8	39	4.1	50	4.4	45	5.7	38
			38		24		31		22		25		31
Environmental friendliness *[7]		6.5	14	4.7	41	5.0	41	4.4	42	4.6	37	5.7	25
			59		29		43		21		25		45
Private atmosphere*[8]		4.9	35	6.8	17	6.7	14	6.4	14	6.6	14	5.7	26
			31		66		64		56		60		44

[1] Means: 1: is most important criteria, 9 is least important criteria. Hence, the higher the mean, the least important the criteria scores.

[2] In this overview we only included the main preferred modes of transport. The overall score is calculated over all respondents.

*[1] Importance of comfort differed statistically significant for the different transport systems, $F(4, 295) = 42.914$, $p < .001$, Car<Bus, Train, Bike, Walking; Train<Bike (0.025)

*[2] Importance of accessibility differed statistically significant for the different transport systems, $F(4, 304) = 5.602$, $p < .001$, Bike<Car, Walking (0.036); Bus< Car

Importance of safety and trust feeling differed not statistically significant for the different transport systems

*[3] Importance of speed and travel time differed statistically significant for the different transport systems, $F(4, 305) = 3.950$, $p=.004$,

Car<Walking (0.016), Train<Walking (0.050)

*[4] Importance of pleasure and joy differed statistically significant for the different transport systems, $F(4, 275) = 11.261$, $p<.001$, Bike<Car, Bus; Walking<Car, Bus

*[5] Importance of punctuality differed statistically significant for the different transport systems, $F(4, 1507) = 3.663$, $p=.006$,

*[6] Importance of price performance differed statistically significant for the different transport systems, $F(4, 1490) = 11.029$, $p<.001$,

Bus<Car, Bike<Car, Walking<Car

*[7] Importance of environmental friendliness differed statistically significant for the different transport systems, $F(4, 279) = 53.197$, $p<.001$, Bus<Car, Train<Car, Bike<Car, Walking<Car

*[8] Importance of private atmosphere differed statistically significant for the different transport systems, $F(4, 1425) = 37.126$, $p<.001$,
Car<Bus, Train, Bike, Walking
*[7] Importance of environmental friendliness differed statistically significant for the different transport systems, $F(4, 279) = 53.197$, $p<.001$, Bus<Car, Train<Car, Bike<Car, Walking<Car
*[8] Importance of private atmosphere differed statistically significant for the different transport systems, $F(4, 1425) = 37.126$, $p<.001$,
Car<Bus, Train, Bike, Walking

In the remainder of this section, the groups are discussed, focussing on the importance of the factors, differences in demographics, and distance to work. The supporting figures and tables, can be found at the end of this section.

3.1.1 Respondents that prefer to use a car

Respondents that prefer to use the car find the following aspects important in selecting the car as preferred mode of transport: comfort, speed and travel time and punctuality (Table 3.2 Importance of factors in selecting preferred means of transport, divided by groups that prefer car, bus, train, bike and walking (in %, n=1816)). The least important factors by this group are pleasure and joy and environmental friendliness. Hence, respondents that prefer to use the car, can be characterised as focussing on functional, individual needs, rather than additional experiences or influences.

Car preference is highest in Luxembourg (72%) and lowest in Copenhagen. This is also reflected by the fact that Luxembourg has the 'most cars per inhabitant in the EU'. In 2019, Luxembourg had 681 passenger cars per 1000 inhabitants. These numbers are lower for France (482), and Denmark (455) (Eurostat, 2021[1]). In Geneva, 78% of the households have a car (Montfort, De Faveri et Bisso 2019))[2] Lower car preference in Copenhagen could be caused by the fact that Demark has a very strong bicycle infrastructure and a relatively good public transport system (Thorhauge et al., 2020[3]). Distance travelled to work does not seem to influence the preference for car, as this is evenly distributed among the travel distances (Figure 3.2).

Respondents that prefer to use the car can be found across all age groups, with no overrepresentation of any age group, compared to the overall sample. The gender ratio (52% female vs 48 male) also follows the overall gender ratio (53% female vs 47% male). People with reduced mobility prefer the car as much as the overall sample. Only a very small proportion (1.4%) of respondents that do not own a car, indicate that the car is still their preferred mode of transport (See tables Appendix B)

Respondents that prefer to use the car, are less satisfied (44%) with the public transportation offer in their local area, compared to the other groups (66%) (Figure 3.3). Furthermore, about half of this group, thinks that flexibility of public transport systems should be improved, both in terms of frequency, and the number of stops (Table 3.4Table 3.3)

[1] https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=road_eqs_carhab&lang=en
[2] Microrecensements mobilité et transports (MRMT): https://www.bfs.admin.ch/bfs/de/home/statistiken/mobilitaet-verkehr/personenverkehr/verkehrsverhalten.html
[3] *Link to article, DOI:* 10.1016/j.tra.2020.06.016

In this study, we did not check for the effects of the physical/geographic/topographic outline of cities, as an indicator for car preference.

Table 3.3 Items in public transport that should be improved, according to the different groups of mobility preferences. Shown are the percentages that indicate that an item should be improved

	Car (n=968)	Bus (120)	Train (n=80)	Bike (n=227)	Walking (n=237)	Overall (n=1816[1])
Environmental friendliness	30	41	48	55	47	37
Public transport should become on-demand	30	30	23	19	25	27
Entertainment	11	19	6	11	10	11
Flexibility by an increase of locations to get on the public transport system	48	38	53	40	38	44
Flexibility by an increase of frequency of public transport	49	53	48	46	47	48
Additional services, to bridge the distance between home and bus, tram and train station	41	33	29	26	24	36

[1] This table only shows the % of respondents that prefer car, bus, train, bike or walking. Other preferences are excluded in the table, but are integrated in the % for overall

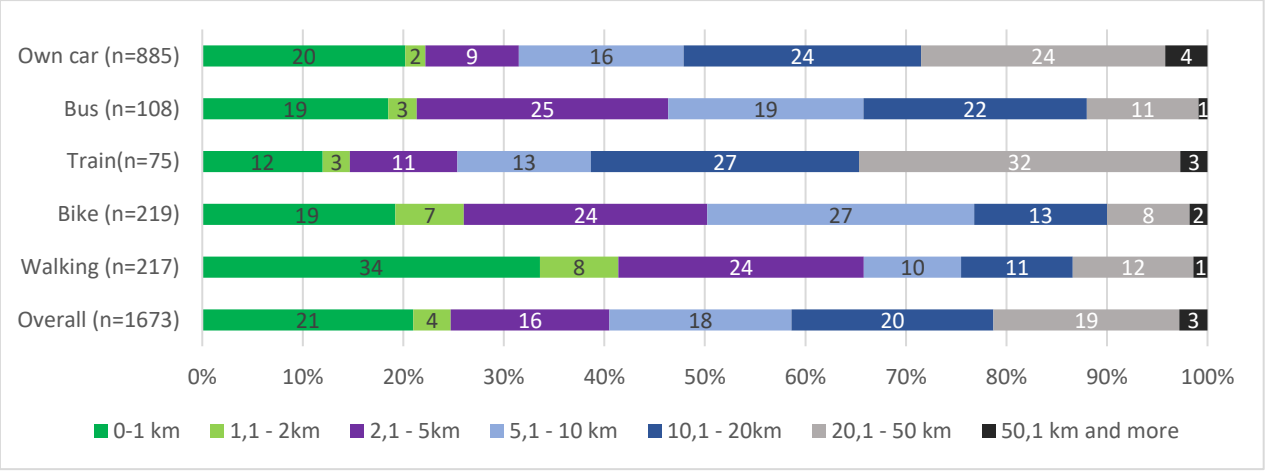


Figure 3.2 Effect on distance travelled to preferred mode of transport (in %):

Table 3.4 Effect on distance travelled to preferred mode of transport (mean values)

Table XXX

	Own car (n=885)	Bus (n=108)	Train (n=75)	Bike (n=219)	Walking (n=217)	Overall (n=1673)
Mean value*[1]	4.1	3.6	4.5	3.4	3.0	3.8

*[1] travelled distance differed statistically significant for the different transport systems, $F(4, 302) = 23.515$, $p < .001$,
Train>bus, bike, Walking
Walking< car, bus (0.015),
Own car> bus (0.024), bike

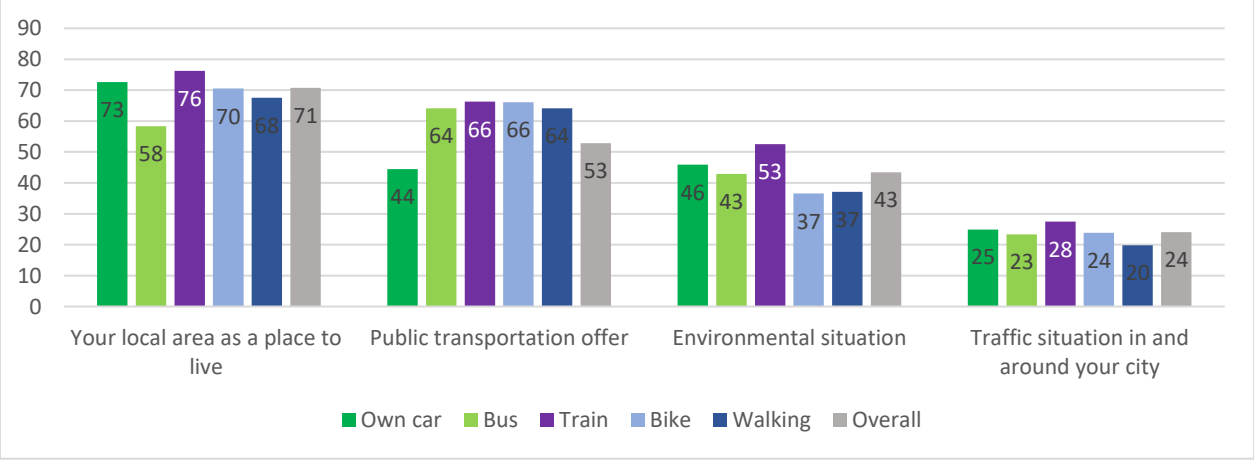
3.1.2 Respondents that prefer to use the bus

Respondents that prefer to use the bus (7% of the total sample) find the following aspects important in selecting the bus as preferred mode of transport speed and travel time, punctuality, price performance and accessibility. Least important are private atmosphere and comfort (Table 3.2). The group that prefers to use the bus, could therefore be characterised as being focussed on basic, functional needs, and find basic needs such as accessibility and price more important than 'additional' needs, such as comfort and price performance.

Respondents that prefer to use the bus can be found across all age groups, with a slight overrepresentation of the younger age groups (15% of the 16-25 year olds, compared to 8% in total sample; and 20% of the 26-35 year olds, compared to 17% in the total sample) and an slight underrepresentation of the middle-aged groups (11% of the 46-55 year olds, compared to 20% in total sample; and 18% of the 56-65 year olds, compared to 19% in the total sample)(See tables Appendix B). The gender ratio (64% female vs 36 male) shows an overrepresentation of female respondents in the group that prefers to use the bus compared to the overall gender ratio (53% female vs 47% male). People with reduced mobility prefer the bus more (14%) compared to the overall sample (7%). Respondents that do not own a car are overrepresented (19%) in the group that selected the bus as their preferred mode of transport. The majority (66%) of respondents that prefers to use the bus, travels medium distances to work (between 2 and 20 km) (See tables Appendix B).

Respondents that prefer to use the bus, indicate that flexibility in the sense of an increase frequency of public transport option should be improved, and to a lesser extend the locations to get on the public transport systems (See tables Appendix B). This group is, compared to the other groups, least satisfied about their local are as a place to live (see Figure 3.3). In Geneva, we see a relatively high number of bus preferences (18% compared to 7% overall). We therefore assume that public transport offer, and the city topography is a leading factor in the preference for buses.

Figure 3.3 Differences on how satisfied people are with their place to live/traffic situation/environmental situation/public transport offer on their preferred mode of transport (in %).



3.1.3 Respondents that prefer to use the train

Respondents that prefer to use the train (4%) find the following aspects important in selecting the train as preferred mode of transport; speed and travel time, and punctuality. Least important factors are private atmosphere and pleasure and joy (Table 3.2)Respondents that prefer to use the train can be found across all age groups, with a slight overrepresentation of the youngest and the oldest age groups (11% of the 16-25 year old's, compared to 8% in total sample, 8% of the 66-75 year old's, compared to 13% in total sample) and a slight overrepresentation of the middle-aged groups (23% of the 36045 year old's, compared to 19% of the total sample 24% of the 46-55 year old's, compared to 20% in total sample) (See tables Appendix B). The gender ratio (53% female vs 47% male) follows the overall gender ratio (53% female vs 47% male). The majority of this group (59%) travels longer distances to work.

3.1.4 Respondents that prefer to use the bike

Respondents that prefer to use the bike (13%) find the following aspects important in selecting the bike as preferred mode of transport: speed and travel time, accessibility, and price performance. The least important factors are comfort and private atmosphere (**Error! Reference source not found.**Table 3.2). With a large proportion of this group coming from Copenhagen, this is an indication that the results support the statement that "*in Copenhagen the bike is regarded as a time-efficient alternative to the car*" (Thorhauge et al., 2020[4])

Respondents that prefer to use the bike can be found across all age groups, with no overrepresentation of any age group, compared to the overall sample (See tables Appendix B). The gender ratio (47% female vs 53% male) shows a slight overrepresentation of male respondents compared to the overall gender ratio (53% female vs 47% male). Only a small part (1.3%) of persons with reduced mobility prefer the bike as much as the overall sample. Respondents that do not own a car are overrepresented (39%) in the group that indicate that the bike is their preferred mode of transport. Bike preference is found slightly less among the respondents that travel longer distances to work.

3.1.5 Respondents that prefer to walk

Respondents that prefer to walk find the following aspects important in selecting walking as preferred mode of transport; speed and travel time, punctuality and price performance. Least important factors are private atmosphere and comfort (Table 3.2). Respondents that prefer to walk can be found across all age groups, with no overrepresentation of any age group, compared to the overall sample (See tables Appendix B). The gender ratio (64% female vs 36% male) shows a slight overrepresentation of female respondents compared to the overall gender ratio (53% female vs 47% male). Respondents that do not own a car are overrepresented (32%) in the group that indicate that walking is their preferred mode of transport. Almost half of the respondents that prefer to walk (47%), think that the environmental friendliness and flexibility of public transport systems should be improved (Table 3.3)

[4] *Link to article, DOI:* 10.1016/j.tra.2020.06.016

3.2 Mobility use

As it may be expected that real use or behaviour may not fit to the preferences or attitudes towards different mobility systems, the usage was as well investigated. In addition to gaining insight in the preferred transport system, respondents were asked about the actual use of different transport systems. Five questions were asked to make that a full insight in the actual use was gained. As a first question regarding this topic, respondents were asked to indicate the frequency of use for specific means of transport (Table 3.5). To gain more specific insights, respondents were asked to indicate which means of transport they used for three specific occasions; going to work/study; going to the supermarket and; visiting friends and family. To avoid over-asking the respondents, a selection was made in the answering options, by only including those transport means that respondents indicated to use daily, weekly or monthly. For these occasions, respondents were also asked to indicate the average distance travelled for each occasion.

Table 3.5 Current use of transport (in %)

		Copenhagen (n=491)	Geneva (n=384)	Luxembourg (n=540)	Lyon (n=501)	Overall (n=1816)
Car*[1]	Daily users	34	23	64	48	45
	Weekly users	24	35	27	29	28
Bus*[2]	Daily users	5	24	5	7	9
	Weekly users	19	34	20	11	19
Train*[3]	Daily users	6	10	4	2	5
	Weekly users	16	20	10	3	11
Bike *[4]	Daily users	27	11	4	4	11
	Weekly users	22	13	11	14	15
Walking *[5]	Daily users	66	74	60	49	61
	Weekly users	22	18	23	29	24

*[1] Statistical dependence between City and Current use of car, (Chi-Square(12) = 318.080, $p < .001$)
*[2] Statistical dependence between City and Current use of bus, (Chi-Square(12) = 262.532, $p < .001$)
*[3] Statistical dependence between City and Current use of train, (Chi-Square(12) = 228.686, $p < .001$)
*[4] Statistical dependence between City and Current use of bike, (Chi-Square(12) = 245.906, $p < .001$)
*[5] Statistical dependence between City and Current use of walking, (Chi-Square(12) = 61.527, $p < .001$)

If one considers the relative frequency of use of the transport systems per city, a similar picture emerges as for the preferences. Highest usage of bikes in Copenhagen, highest usage of buses in Geneva and highest usage of cars in Luxembourg and Lyon. In absolute terms, however, there is an overall tendency that cars are actually used slightly less than would be expected based on preference, and public transport slightly more than would be expected. A mobility census in Geneva (between 2000-2015) confirms these numbers for Geneva. This survey shows that the average daily distance travelled is 36.8 km, of which 65% are travelled by car, and 24% are travelled by public transport (Montfort, De Faveri et Bisso 2019))[5] Data from Copenhagen (Christiansen et Baescu 2021) also confirm our results: modal split for bikes in Copenhagen is 25%, for car 36% and for public transport in general 15%). Official data about the mobility use in Lyon, also

[5] Microrecensements mobilité et transports (MRMT): https://www.bfs.admin.ch/bfs/de/home/statistiken/mobilitaet-verkehr/personenverkehr/verkehrsverhalten.html

confirms our results, with 42% of daily trips conducted by private car, 30% of daily trips by walking, and 13% by public transport (Sytral 2016).There are unfortunately no current figures available for Luxembourg.

Table 3.6 Occasions per transportation system (in %)

		Commuting to/from work	Going to supermarket	Visiting family and friends
Car[*1] [*2] [*3]	**Overall (n=1816)**	**45%**	**56%**	**58%**
	Copenhagen (n=491)	36	33	43
	Geneva (n=284)	29	41	41
	Luxembourg (n=540)	61	78	76
	Lyon (n=501)	48	64	61
Bus[*4] [*5] [*6]	**Overall (n=1816)**	**19%**	**9%**	**18%**
	Copenhagen (n=491)	14	6	3
	Geneva (n=284)	39	22	29
	Luxembourg (n=540)	18	5	10
	Lyon (n=501)	14	6	13
Train[*7] [*8] [*9]	**Overall (n=1816)**	**12%**	**3%**	**15%**
	Copenhagen (n=491)	16	2	25
	Geneva (n=284)	21	6	23
	Luxembourg (n=540)	11	3	7
	Lyon (n=501)	1	1	8
Bike[*10] [*11]	**Overall (n=1816)**	**9%**	**7%**	**11%**
	Copenhagen (n=491)	8	7	10
	Geneva (n=284)	16	9 12	13
	Luxembourg (n=540)	5	4	9
	Lyon (n=501)	9	6	11
Walking[*12] [*13] [*14]	**Overall (n=1816)**	**24%**	**40%**	**29%**
	Copenhagen (n=491)	23	65	33
	Geneva (n=284)	39	59	42
	Luxembourg (n=540)	13	10	14
	Lyon (n=501)	28	38	34

[*1] Statistical dependence between City and Commuting to/from work with car, (Chi-Square(3) = 101.548, $p < .001$)
[*2] Statistical dependence between City and Going to supermarket with car, (Chi-Square(3) = 253.360, $p < .001$)
[*3] Statistical dependence between City and Visiting family and friends with car, (Chi-Square(3) = 153.787, $p < .001$)

[*4] Statistical dependence between City and Commuting to/from work with Bus, (Chi-Square(3) = 88.422, $p < .001$)
[*5] Statistical dependence between City and Going to supermarket with Bus, (Chi-Square(3) = 81.821, $p < .001$)
[*6] Statistical dependence between City and Visiting family and friends with Bus, (Chi-Square(3) = 63.636, $p < .001$)

[*7] Statistical dependence between City and Commuting to/from work with train, (Chi-Square(3) = 57.016, $p < .001$)
[*8] Statistical dependence between City and Going to supermarket with train, (Chi-Square(3) = 13.860, $p = .003$)
[*9] Statistical dependence between City and Visiting family and friends with train, (Chi-Square(3) = 228.686, $p < .001$)

[*10] Statistical dependence between City and Commuting to/from work with bike, (Chi-Square(3) = 29.706, $p < .001$)
[*11] Statistical dependence between City and Going to supermarket with bike, (Chi-Square(3) = 16.473, $p = .001$)
No Statistical dependence between City and Visiting family and friends with bike

[*12] Statistical dependence between City and Commuting to/from work with walking, (Chi-Square(3) = 74.819, $p < .001$)
[*13] Statistical dependence between City and Going to supermarket with walking, (Chi-Square(3) = 370.168, $p < .001$)
[*14] Statistical dependence between City and Visiting family and friends with walking, (Chi-Square(3) = 95.382, $p < .001$)

Car is the most used means of transport for visiting family and friends (58%), for going to the supermarket (56%) or for commuting to/from work (45%). Especially for going to the supermarket train (3%) and bus (9%) are not seen as satisfying transport systems. Public transport does not meet the needs for physical relief especially in the case of transporting purchases or luggage or other things one may bring to friends and family. This is also confirmed by our qualitative investigation of needs[6].

The daily commute (travelling from home to work/study) is generally below 50 km. Only a small group (3%) travels more than 50 km to go to work/study. In Copenhagen and Lyon, the distance to work/study is somewhat lower compared to Geneva and Luxembourg. In Copenhagen or Geneva where distances to travel to work of max. 10km are dominating (69% max. 10km in Copenhagen, Geneva 69%) – bike or bus are more accepted. In Luxembourg where a majority of 56% has to travel longer distances car is clearly preferred. Lyon is something in between (see figure 3.4).

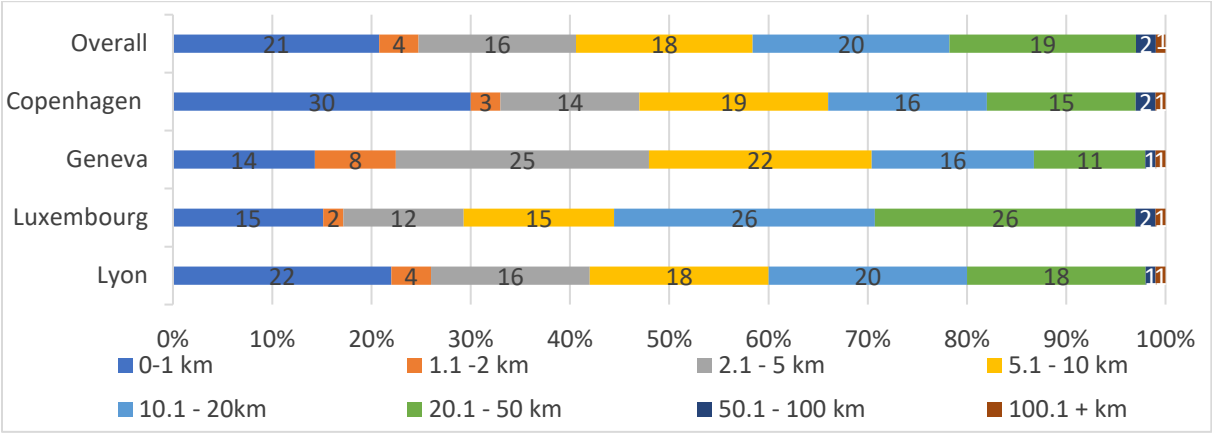


Figure 3.4 Distance between home/work per city (in %)

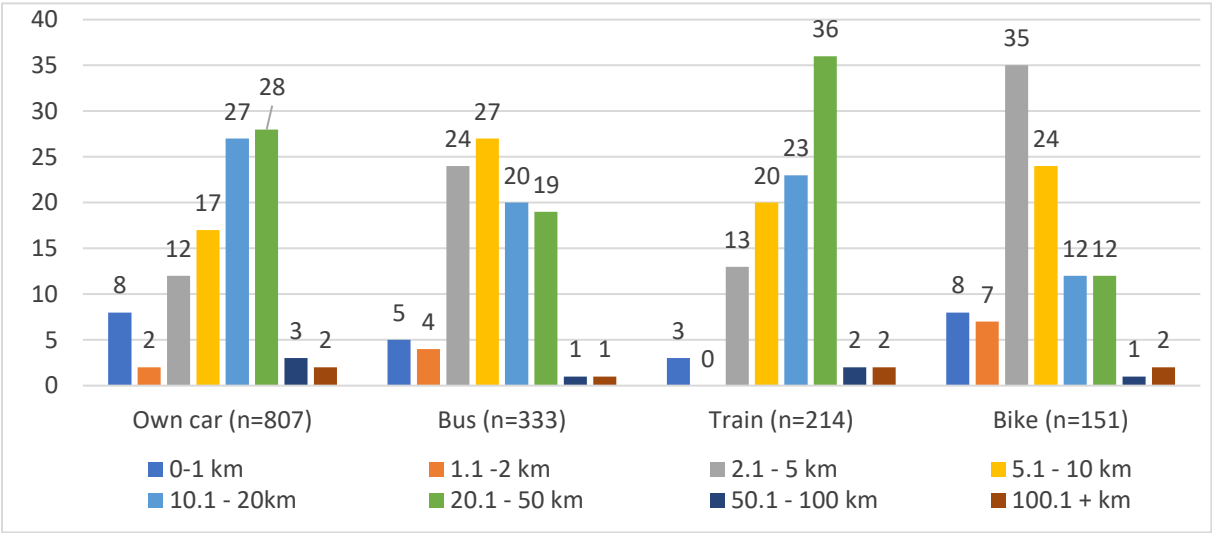


Figure 3.5 Distance travelled to work/study per means of transport (in %)

[6] Please see chapter 4 of this deliverable that is presenting the results of our qualitative study into the mobility needs, wishes and gaps in Singen.

In the remaining of this section, we divide the groups into car use, bus use, train use, bike use and walking. For each of these transportation means, we identify what respondents use this transport means for, whether there are differences between the users (demographics). In doing so, we can also analyse whether there are differences between the preferred mode of transport, and the actual use of transport (see Table 3.7). Through this analysis, we can gain insights in the attitude-behaviour gap, and gain insights into the reasons for these differences. We conclude this chapter by zooming into groups that are of interest to target AM services to.

Table 3.7 Comparing preferred mode of transport to actual use (daily & weekly)

Actual use of transport		Preferred mode of transport				
		Car (n=976)	Bus (n=119)	Train (n=80)	Bike (n=227)	Walking (n=237)
Car*[1]	Daily use	**73**	9	15	10	15
	Weekly use	**24**	34	34	31	33
Bus*[2]	Daily use	2	**54**	19	2	12
	Weekly use	11	**37**	38	23	29
Train*[3]	Daily use	2	11	**43**	5	5
	Weekly use	6	25	**39**	13	13
Bike *[4]	Daily use	2	3	10	**67**	3
	Weekly use	12	12	15	**26**	17
Walking *[5]	Daily use	47	78	75	75	**88**
	Weekly use	29	17	20	19	**9**

*[1] Statistical dependence between Preferred transport system and Current use of car, (Chi-Square(16) = 788.853, $p < .001$)
*[2] Statistical dependence between Preferred transport system and Current use of bus, (Chi-Square(16) =638.973, $p < .001$)
*[3] Statistical dependence between Preferred transport system and Current use of train, (Chi-Square(16) = 524.469, $p < .001$)
*[4] Statistical dependence between Preferred transport system and Current use of bike, (Chi-Square(16) =891.545, $p < .001$)
*[5] Statistical dependence between Preferred transport system and Current use of walking, (Chi-Square(16) = 212.398, $p < .001$)

3.2.1 Car use

A closer look into the use of a private car (Table 3.5), shows that almost three out of four respondents (73%) use a private car daily or at least weekly. The value is highest for Luxembourg where 91% use a private car daily or at least weekly. It is lowest for Geneva where only 57% of respondents use a private car daily or weekly. Across all four cities, only 22% never or rarely use a private car. The car is most often to go to the supermarket (58%). Visiting friends and family (56%) and commuting between home and work/study (45%). Here we see major differences between the cities; the car is used the least in Geneva (29% to go to work, and 41% to visit friends & family as well as going to the supermarket) and most often in Luxembourg. Except for Geneva, the car is the most used means of transportation for travelling between home and work/study. In Geneva, the most used transportation for this occasion is the bus, see Table 3.6. The distance travelled to work/study by car is between 20-50 km for 55% of respondents (see Figure 3.5).

When comparing respondents' actual and preferred mode of transport, the results show that 97% of those that indicate that the car is their preferred mode of transport, use the car on a daily or weekly bases. The group that prefers to use the bike, uses a private car regularly (10% daily; and 31% weekly), but to a lesser extent than overall use (45% daily and 28% weekly; Table 3.7These results show that for respondents that prefer to use the car, there are no obstacles to actually use it on a daily or weekly basis. However, for those

respondents that prefer public transport or active modes of transport (bike/walking), there are reasons why they are still using the car. These reasons could be a lack of adequate infrastructure for public transport of biking.

3.2.2 Bus use

The bus is the second most used transportation system, being used daily or at least weekly by 28%. In Geneva the bus is used on a daily or weekly basis by the highest share of people (58%), while it is lowest for Lyon (18%) (Table 3.5). The bus is used by roughly a fifth of the respondents as means to travel from/to work (19%), and to visit family and friends (18%). It is not used very often to go to/from the supermarket (9%). In line with the daily and weekly use of the bus, the percentages for these occasions are highest in Geneva. The bus is not used for the very short distances (0-2 km), but primarily for the intermediate distances; 51% of bus users, use the bus for distances between 2 and 10 km (Figure 3.5). When comparing respondents' actual and preferred mode of transport, the results show that 91% of those indicating the bus as their preferred mode of transport, use the bus on a daily or weekly basis. Respondents that indicate the train as their preferred means of transport, also show a high regular use of the bus (19% daily, and 38% weekly; Table 3.7).

3.2.3 Train use

The train is used daily or at least weekly only by 16%. Geneva is the city with the highest use (30% use it daily or at least weekly; Table 3.5) and Lyon has the lowest use of train (5%). The train is primarily used for medium to long distances: 59% of the train users, use it for distances between 20 and 50 km (Figure 3.5). A large majority (76%) that indicated that the train is their preferred mode of transport use the train to travel between home and work/study (Table 3.7). Hence, this group uses the train on a regular basis (43% daily and 39% at least weekly).

3.2.4 Bike use

The bike is the third most used means of transport in the four AVENUE cities. It is used daily or at least weekly by circa one fourth (26%) of respondents. This value is highest for Copenhagen, where almost half of the respondents use the bike at least weekly (48%), and lowest for Luxembourg (14%) (Table 3.5). This can be explained by a different need of physical relief (see Chapter 4). Copenhagen and Luxembourg differ strongly regarding topography. A majority of those respondents that indicate that they prefer the bike as means of transport, use the bike on a daily basis (67%) or at least weekly (26%) (Table 3.7)

A high percentage of bike use in Copenhagen, can be explained by the fact that Denmark is one of the world-leading countries in terms of bicycle infrastructure. A study by Thorhauge (2020)[7] shows that in Copenhagen, the bike is regarded as a time-efficient alternative to the car. This study also shows the importance of a good developed cycling culture and infrastructure for the use of bike. In countries where this is lacking, the bike does not play a relevant role as an alternative to car. In these settings (which can

[7] (Thorhauge et al., 2020: *Link to article, DOI:* 10.1016/j.tra.2020.06.016)

be related to Luxembourg, Geneva and Lyon) the car is regarded as the only solution to fulfil complex activity patterns, perceived mobility needs and the use of individual modes. Bike use can be stimulated in these countries for shorter distances, though investments in improving conditions for cycling, or can stimulate other individual modes, such as mopeds and motorcycles (Thorhauge et al., 2020).

3.3 Conclusion

Insights in mobility preferences and mobility behaviour are important to be able to assess the potential of automated minibuses. To be a successful and sustainable solution, the deployment of automated minibuses should reduce car use, and increase public transport use. Even more, to avoid rebound effects and to increase environmental impacts, AM services should not replace trips that are currently made by bike or walking (Huber et al., 2021 & Viere et al., 2022 environmental deliverable). Three groups are therefore important:

- Citizens that prefer to use the bus (as the public transport option closest related to the AM), but are currently using their own car on a regular basis. Apparently, there are reasons why these citizens use the car, rather than the bus.
- Citizens that prefer to use the bike, but are currently using their own car on a daily basis.

The group that prefers to use the bus, but is currently using the car on a daily basis and to travel from/to work/study, are potential users of the automated minibuses. If the AM services are designed to meet the needs of this group, it is very likely that this group will substitute the car with the AM. Elements of public transport that should be improved according to this group are an increase of flexibility by a frequency of public transport and to a lesser extent and additional services that bridge distances between home and bus, tram and train stations. As bus users can be characterised as being focussed on basic, functional needs, and find basic needs such as accessibility and price more important than 'additional' needs, such as comfort and price performance, it is expected that they will show a higher acceptance of automated minibus services, if these fulfil these basic, functional needs. Hence, the increase the acceptance of AM services, these should focus on offering a reliable, speedy means of transport.

The group that prefers to use the bike, but are now using the car on a daily basis or to travel to/from work, is also a potential group of AM users. As this group values the flexibility of an individual mode of transport, and thinks flexibility should be improved in public transport. This group regards environmental friendliness as the most important aspect to be improved in public transport systems. Improving these aspects, by adding AM services, could possibly reduce the amount of car use by this group of respondents.

Mobility behaviour and attitudes toward mobility, generally differ between the four Avenue cities. The effects of mobility preferences and mobility behaviour on attitudes toward automated minibuses, and willingness to use AM, is further discussed in chapter 5.

4 Mobility needs

4.1 Introduction

An important insight of the AVENUE project is that a citizen centric approach is needed. As the famous Leo Burnett[8] already mentioned: "Don't tell me how good you make it; tell me how good it makes me when I use it." (Leoburnett, 2021 [9]). Innovations can only succeed if they cover the right needs. This means that the focus is primarily on understanding the needs of citizens and on understanding how new mobility systems like the automated minibuses can be a credible solution to meet these needs.

Two qualitative studies were investigated to get deeper insights into citizens' needs: one in Singen, Germany and one in Copenhagen, Denmark. The studies were carried out as part of a research project[10] (Singen) and bachelor's thesis (Copenhagen)[11]. They were conducted to get an initial understanding about the current situation, problems and needs regarding the mobility of the citizens of Singen and Copenhagen (esp. in the area of Nordhavn). Especially for Nordhavn in Copenhagen the qualitative survey should investigate the current mobility situation in the test area and the needs of the citizens living next to the test area as well as to what extent the automated minibuses are seen to fill current mobility gaps. For this, the citizens were accompanied over a period of several months to understand if their needs and attitudes changed within a given timeframe.

4.1.1 Singen, Germany

Singen was chosen because additional sites had to be investigated for the Avenue project. Singen had been discussed as a possible location to extend to. Copenhagen was already chosen as test site. The village Singen is located in Germany, between the cities Karlsruhe and Pforzheim. It has a population about 3,800 inhabitants and is about 10 square kilometres big. In terms of topography, Singen has a big height difference. Due to this topography, the village is divided into "Unterdorf" (lower part) and "Oberdorf" (higher part). The majority of the shops as well as the train station are at the edge of the village in the "Unterdorf". The village is connected to major roads, such as the B 10, providing a direct link to the German highway A8. Additionally, there is the train station for the railway line (Interregio-Express Train) to

[8] Leo Burnett (1891 – 1871) was an American advertising executive. He was a pioneer in marketing and advertising, using dramatic realism in his work to build brand equity. Examples of this work are 'the Marlboro man', and Tony the Tiger (Kellogg's frosted flakes). The company he founded in 1935 is one of the largest agency networks, with activities spanning 69 countries.

[9] Website of Leo Burnett: www.leoburnett.it. Accessed on 21.02.2022

[10] Dony, Sophia, Liebhauser, Niklas et al. 2020. This research project was carried out in the scope of the AVENUE project, raw data (interview transcripts) were available for this chapter.

[11] Dony, Sophia, 2020. This BSc thesis was conducted in the scope of the AVENUE context, raw data (interview transcripts) were available for this chapter.

Karlsruhe/Aalen and the tramway (S5) to Pforzheim/Karlsruhe, as well as one bus stop, which connects different villages in the local community Remchingen and surroundings.

4.1.2 Nordhavn, Copenhagen

The Copenhagen pilot site is situated in an area of the city called Nordhavn. Nordhavn is an active industrial port that is undergoing a transformation – turning into Copenhagen's new international waterfront district offering residential and commercial buildings. When the development of Nordhavn is done, the area will house more than 40,000 residents and 40,000 employees. Nordhavn aims at being an eco-friendly neighbourhood and contributes to boosting Copenhagen's image as an environmental metropolis. Renewable energy and new types of energy, optimal use of resources, recycling of resources and sustainable transport will help make Nordhavn a model for sustainable development and sustainable design.

Currently, the Nordhavn area is serviced by a nearby S-train station (app. 1,1 km away) and bus stops located near the train station. There are however no buses or trains running directly in the area – creating a great opportunity for automated vehicles to function as a new public transport solution, connecting the area much better than it is today. In 2020 two new metro stations will have been built – opening in the periphery of the neighbourhoods.

The route is placed in the area called Århusgadekvarteret. This area was the first one finished and residents started moving there in 2015. Since then different squares and the harbour promenade and a rooftop gym have been evolved and taken into use. Furthermore, special attention has been on developing local retail, so today there are supermarkets, cafes, restaurants and different specialised retailers. There are several shared space areas on the route including a bathing zone. The route is a circle line around the area (blue line on the map below), making it easier to get around and to enter the area from outside Nordhavn. Our garage is located on the next peninsula close to Århusgadekvarteret (the red line in Figure 4.1).

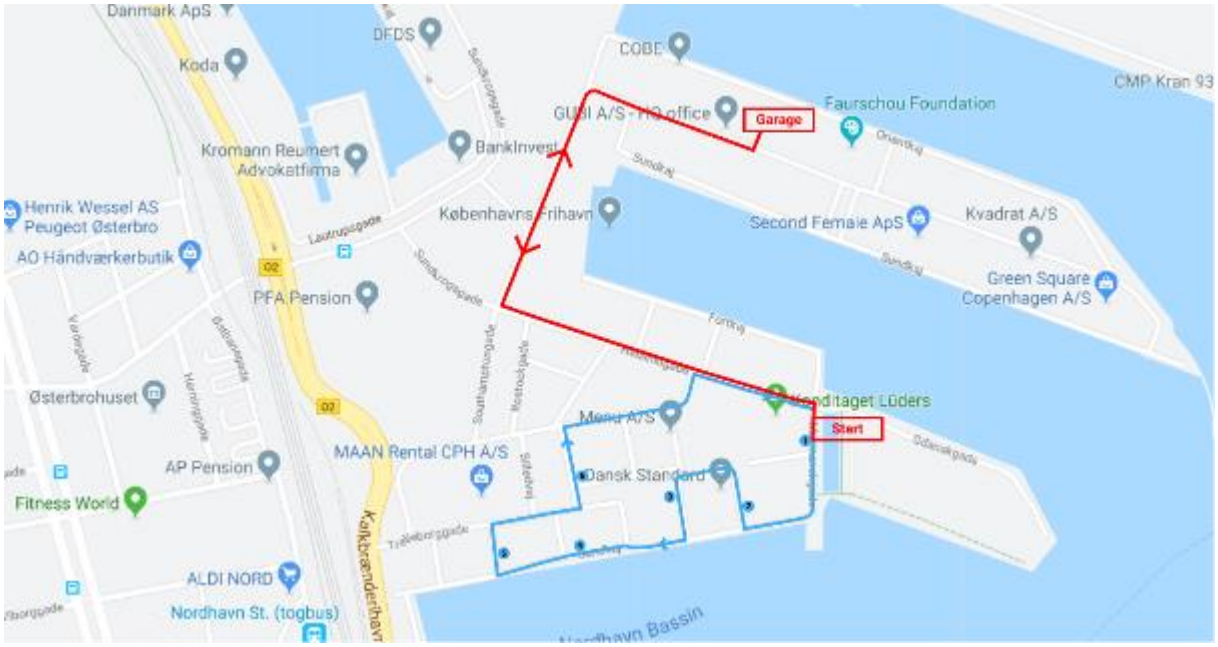


Figure 4.1 Pilot route in Nordhavn

The pilot route is in mixed traffic with cars, pedestrians, bicycles etc. The area is, in general, a low-speed area with 20-50 km/h speed limits on the route, and in the 50km/h limit areas, the recommended speed for cars is 30km/h. (reference: D7.8 Second iteration Copenhagen, large scale pilot use case demonstration report, April 2021)

4.1.3 Structure of this chapter

The details of the study design are presented in Chapter 2. This chapter starts with detailing the current mobility situation in Singen (4.2.1) and Copenhagen (4.2.2). Hereafter, the mobility needs are depicted. These mobility needs are extracted from the interviews. Through an analysis of the current mobility situation and the mobility needs (4.3), mobility gaps in Singen (4.4.1) and Copenhagen (4.4.2) are discerned. In section 4.5, an analysis was made on how an automated minibus service could fulfil the discerned mobility gaps. An overview of this structure is presented in Figure 4.2

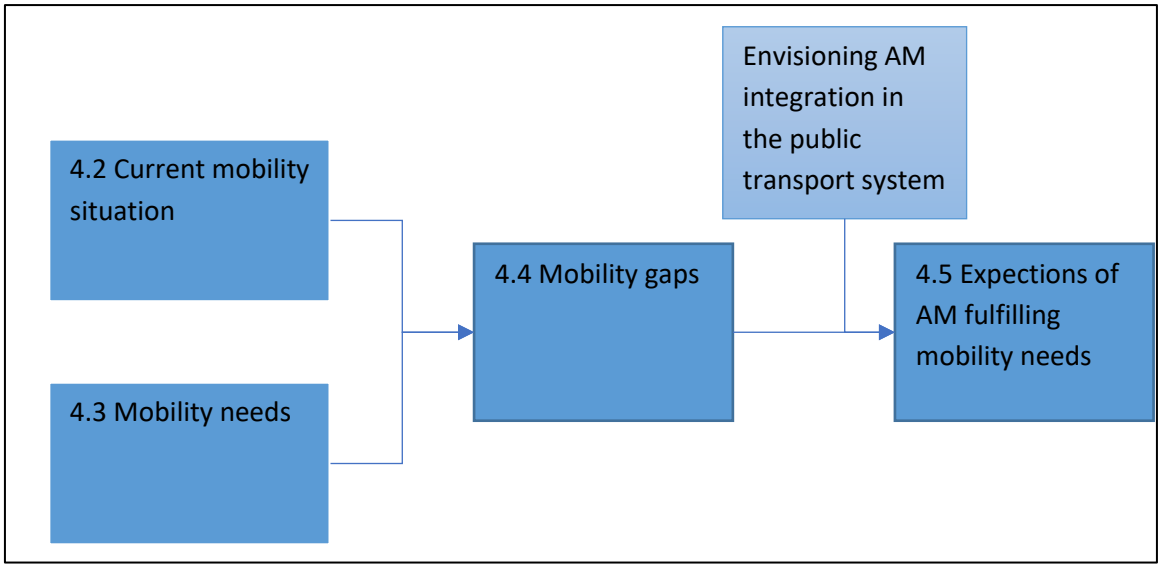


Figure 4.2 Flow of analysis

4.2 Current mobility situation

Before the results of the surveys are discussed in detail, the current mobility situation within Singen and Copenhagen is briefly analysed.

4.2.1 Current mobility situation in Singen

The screener questionnaire provided first insights on the mobility situation. About two thirds (62%, based on the total sample of n=46 who answered the screening questions) are not satisfied with the offer of public transportation in Singen and about every second is not satisfied with the current traffic situation. Especially the current offer of bus services is not satisfying. Cars are the most used transportation means with 33 people using the car at least regularly, train and bus are used less, rarely or only occasionally. 37

participants state that they never use the bus. The train is used rarely or occasionally by 31 participants. Walking and cycling are also common transportation means, with 30 people answering they walk at least regularly and 23 stating they use the bike at least regularly.

4.2.2 Current mobility situation in Copenhagen

In Copenhagen, public transportation consists of the metro, s-train, and buses. The participants use all of the public transportation options and especially the metro and s-train represent an essential part of their everyday mobility. Accordingly, they are the most common means of transportation for the respondents, together with walking and cycling. Participants voiced a strong affection for walking at the start of the study. Private cars were less attractive to the study members, sometimes even a strong aversion against its use was observed.

4.3 Mobility needs

According to (Schmitt and Altstötter-Gleich, 2010[12]), attitude is defined as the "degree to which a person likes or dislikes an object" (2010, S. 146). The attitude thus always refers to a specific attitude object. In the context of this study, the attitude object is the 'integration of automated minibuses', which is expressed by the perceived suitability of the automated minibuses to best meet the personal mobility needs. Therefore, the challenge is to understand which are the relevant needs. In the analysis and in presenting the results, we divide between the mobility needs, and the aspects that are required, or are in place to fulfill these needs. The latter are termed 'reliefs' (grey in Figure 4.3).

[12] Schmitt, M., Altstötter-Gleich, C. (2010). Differentielle Psychologie und Persönlichkeitspsychologie kompakt. Landau: Beltz Verlag Weinheim Basel

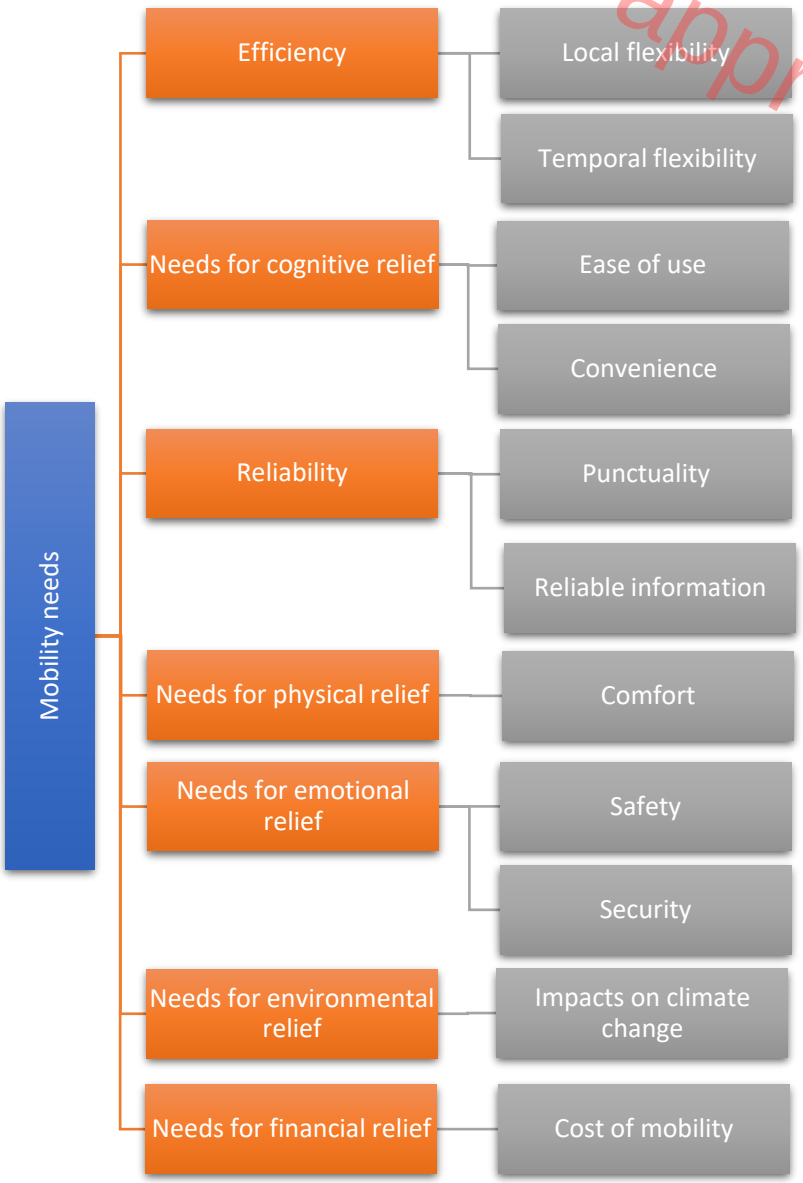


Figure 4.3 Mobility needs

Efficiency

The prime mobility need is efficiency. This means getting from A to B fast and without disturbances.

> *"When the purpose is to go somewhere, I prefer to take the s-train, because it brings me fast to my destination (...)." (Participant from Copenhagen, woman, age 40)*

To achieve efficiency, both local and temporal flexibility is required. This means that users can access and use the transport mode whenever and wherever they want. This provides a certain amount of freedom to the users:

> *"Yes, that is important to me, the freedom to do whatever I want and also to bring everything I like to, when I'm going to a special place." (Participant from Copenhagen, man without handicap, age 25*)

In Singen, interviewees express a need for the possibility to arrive at and depart from the station at any time to catch the scheduled train and to leave from the train station. Currently, this mobility need is not being met. The departures times, frequency as well as the bus stops are seen as impractical, e.g. because the stops are too far away. This makes the transportation by bus time intensive.

> *"The bus stop is so far from my house. Until I have walked to the bus stop, I may as well walk right down to the station. And the time does not fit, I would be either much too early or too late for the connection to the IRE at the station." (Participant from Singen)*

In Copenhagen, participants were satisfied with the local flexibility of the transportation system due to the closely interconnected network of stations that are quickly accessible from any location.

> *"I'm living in the inner-city, that means that all the different s-train lines stop at my station. That increases my mobility whatever place I need to go to." (Participant from Copenhagen, woman, age 47)*

The metro and s-train are also able to circumvent the traffic jams on the streets and enable a direct connection between two locations. This contributes to the satisfaction with freedom and flexibility.

> *"When I'm going to the inner-city, I really prefer to take the s-train, because of the traffic (...). So especially for longer distances I would prefer the s-train or the metro because of the speed." (Participant from Copenhagen, woman, age 47)*

However, the need for freedom is not always fulfilled fully, as the s-train and metro in Copenhagen have a lower frequency in certain areas or at certain times of the day, like at night. Concerning the bus network in Copenhagen, the advantages are seen in the accessibility of the bus stops. However, recently some bus lines and stations have been removed due to the extension of the metro. Therefore, some participants deplore longer driving times or worse accessibility of the bus stops.

> *"They have changed the bus routes also in my place. That means when I go out in the evening it gets more difficult to get there and back home." (Participant from Copenhagen, man with handicap, age 40)*

Due to the high traffic volume in Copenhagen, private cars, but also buses, are generally not perceived as flexible and efficient mobility options.

> "*In Copenhagen, I generally avoid to take the bus. Somehow the busses are little bit more inconvenient. They are stuck always in traffic and are slowly. Therefore I prefer the metro." (Participant from Copenhagen, man without handicap, age 40)*

Only one participant states that for him, the needs of freedom and convenience can be fulfilled by driving a car.

> "*And also, regarding the aspect of independence, that I'm not depending on the public transport paths. With the car I can reach the destinations which I would like to and with public transport only the offered one." (Participant from Copenhagen, man without handicap, age 25)*

4.3.1 Needs for cognitive relief

Cognitive needs are those mobility needs that require a reduction in stress and an increase in mental health. Various mobility options can fulfil these needs and offer a cognitive relief. An example hereof is not having to change the mode of transport various times when travelling from A to B and being able to travel spontaneously without having to plan every detail in advance

> *"I mean convenient in terms of not having to plan. When I decide to go from A to B, I can do it without planning. I can just do it. You can handle impulsive when move around. So when I have the idea to go there, I would just like to grap my things and go." (Participant from Copenhagen, man without handicap, age 40)*

A cognitive need expressed by the respondents is 'not having to find a parking spot at destination'. Public transportation can fulfil this need.

> *"With the public means of transport one can use the transit time productively, for example, to read bookmarked articles or video, (...). This is then no lost time and I can make valuable use of it." (Participant from Singen)*

Using bikes on the one hand contributes to cognitive relief because no planning is necessary, but on the other hand also may lead to other distressing problems. Esp. in Singen, when using the bicycle to reach the train station, bicycle thefts are a problem.

> *"I don't put my e-bike, which is a high value bike, there at a bicycle stand that is not really secured. If you look at the bike stand, there's always some bike without wheels or just the frame. So that doesn't really inspire confidence." (Participant from Singen)*

Generally, the public transportation system in Copenhagen is considered to have a relatively high flexibility implying a certain degree of cognitive relief. Nonetheless, some issues like the placement of the bus stops, the frequency and network of the public transportation system remain. Concerning cycling, on the one hand, the well-built cycling paths provide an alternative to the congested streets, therefore offering cognitive relief from the stress of driving a car. On the other hand, though, the situation is sometimes referred to as "cycling chaos" which may also add stress and minimizes the cognitive relief from cycling (see also section on safety).

4.3.2 Reliability

The need for reliability includes a need for punctuality of the mode of transport and sufficient information provision. To achieve a high level of efficiency, a high level of reliability of the respective means of transport is needed.

> *"I always ask myself, which is the fastest transport? There are two things I'm considering, firstly with which mode of transport I'm reaching my destination faster and also in time regarding the punctuality. So that I can trust it." (Participant from Copenhagen, man without handicap, age 55)*

In Singen, the need for reliability and punctuality is not fulfilled when it comes to the buses, as there are delays and an inadequate information policy. Therefore, the need for reliability can better be satisfied through using the car.

> *"Yes, when I go shopping now, I have stuff in my shopping bag, maybe it's refrigerated goods. And when does the next bus come now? Is it on time? This uncertainty is kind of stupid then." (Participant from Singen)*

The need for reliability is also judged to be met inadequately by the metro and s-train in Copenhagen. The trains do not always arrive on time due to disruptions, maintenance, or train failures. Therefore, the reliability is compromised having a negative impact on the freedom, flexibility and cognitive relief and in consequence efficiency offered by the public transportation system.

> *"Sometimes the metro had a lot of delays. This was very annoying when I had an appointment. So it is very important to me that it is on time (...) especially when having client visits." (Participant from Copenhagen, woman, age 47)*

4.3.3 Needs for physical relief

A third important mobility need is need for comfort. Comfort is conceptualised as physical needs, as it is often closely linked to the physical surroundings. This need is most present in Singen due to its topography (steep hills). Respondents in Singen state that there is a need for physical relief. The steep hilly roads can be easily overcome by car, but pose a problem if walking, using a bike, or travelling by bus. Problems with space for shopping bags, cleanliness and air conditioning are identified. This need for physical relief is especially strong, if larger purchases have to be transported.

> *"… And then there is again the question of how to get up the hill with the purchase? That's why I use the car again." (Participant from Singen)*

Beside the topography, further problems with physical relief when using the bicycle include bad road conditions (few bicycle paths, parked cars, detours through train tracks) and bad weather conditions. Thus, bicycles offer less physical relief compared to a car.

> *"(...) However, so especially in the upper part of of Singen it is rather unsuitable to ride the bike because the streets are very busy and the sidewalks are too narrow to use them." (Participant from Singen)*

> *"The weather has to play along, of course. If it's raining cats and dogs now, then I won't go shopping." (Participant from Singen talking about bicycle use)*

Still, the use of the bicycle was also associated with beneficial effect to the physical well-being, like the opportunity to exercise and providing fun to the cyclists.

In the Copenhagen study, three groups could be identified with varying needs for physical relief: 'men without handicap', 'men with handicap'[13] and 'women'. For men without handicap the need for comfort and physical relief is less pronounced, it plays a more significant role for women and men with handicap. For women, the need for physical relief encompasses reducing the strain when carrying shopping bags, protection against bad weather conditions and high hygiene standards. For men with handicap, the comfort mostly relates to a wish for physical relief due to the physical strain caused by their handicap.

> *"When I have those eye problems, I'm really limited in my mobility and it is hard to see what happens around me? So when I need to go somewhere, I call a taxi, which gives me the needed relief in this situation." (Participant from Copenhagen, man with handicap, age 40)*

Concerning the bus network in Copenhagen, it is considered to provide physical relief through the good accessibility of the stations, however, as mentioned previously, the reduction in bus lines and stations has led to a worse accessibility of the bus stops providing less physical relief.

4.3.4 Needs for emotional relief

The need for emotional relief is very complex. Among other aspects it means a sense of security. The mode of transport should offer a high degree of safety and security. A need for safety was reported in relation to returning home from the train station in Singen at night. The area around the train station (including the underpass) was described as particularly dangerous. Using a car is therefore seen as a means that guarantees emotional well-being. The safety concern was also mirrored in the survey in Copenhagen. The need for emotional comfort and security is not always fulfilled in public transport, due to the lower frequency of the s-trains and metro in certain areas or at certain times of the day. Especially female participants expressed the feeling of discomfort waiting for the trains at night.

> "*When it is really late in the night I never use busses to be honest. And also the trains are only every 20 minutes, so I do not feel comfortable waiting at the station or even being in the s-train." (Participant from Copenhagen, woman, age 40)*

In addition, not all participants in Copenhagen felt save when cycling. Some participants even describe the situation in Copenhagen as "cycling chaos" leading to a feeling of unsafety.

> *"In terms of road traffic accidents with others, the infrastructure is dedicating after the bike. So I'm feeling very safe riding my bike. And additional it is healthy to use the bicycle. I consider it also as a healthy lifestyle using my bike." (Participant from Copenhagen, man without handicap, age 55)*

[13] As no women with handicap participated in the study, only men can be considered. An example for a handicap may be knee or eye problems.

> *"I do not feel comfortable riding the bicycle here In Copenhagen. Couple of years ago I have fallen and had a drama. So I'm scared now." (Participant from Copenhagen, woman, age 40)*

Fun, entertainment or other emotional experiences while travelling are not a major need. This need is only required for long distances and is not relevant for the short distances and occasions.

The survey in Copenhagen was also impacted by the Covid-19 Pandemic. Hygiene and social distancing as part of the need for physical safety gained relevance for the survey participants who started using public transportation less. This change in mobility behaviour was reinforced by the call of the Danish government to use less public transportation. Therefore, individual transportation like the use of bicycles, cabs and walking increased as they fulfilled this hygiene need better.

4.3.5 Needs for environmental relief

Sustainability is another need but was not weighted the same by all respondents. Participants that are already very aware of environmental protection highly value this need.

> *"To be honest, the environmental aspect was not a reason for me. Or just like everyone tries to be a bit resource-conserving, but that wasn't really a motive for me." (Participant from Singen)*

> *"The environmental factor plays a lesser role." (Participant from Singen)*

> *"I think that question with environmentally friendly is something you think about, but in a general level, it is something you are striving to. But when it is come to the actual action in mobility, to come from A to B, suddenly the environmentally gets a second place and just want it to be easy." (Participant from Copenhagen, man without handicap, age 40)*

In Copenhagen, the need for sustainability is also not valued equally by all survey participants. The participants can be separated into two groups regarding their need for sustainability. On the one hand, there are 'engaged environmental advocates' who have a high involvement with topics of climate change and sustainability. On the other hand, there are 'environmental friends' who have a general awareness of climate change, but for whom sustainable mobility is less important.

The participants who showed a high concern for the environment criticize that the majority of buses in Copenhagen drive with fossil fuel. Otherwise, the public transportation system, especially the metro and s-train, is seen as sustainable and the group of participants with high concern for the environment express that in their opinion resources are efficiently utilized. Therefore, the current transportation system satisfies their need for sustainability.

> *"When using public transport, not only metro, compared to people who are driving their own car, you are reducing your own carbon footprint. So in this regard, it is better to use public transport than your own car. Therefore I see a high benefit in public transport." (Participant from Copenhagen, man without handicap, age 55)*

In terms of cycling, some participants express that their need for sustainability could also be satisfied by this mode of transportation as it contributes to the reduction of greenhouse gas emissions. For survey respondents who show high concern for the environment, the car does not fulfil the need for sustainability, due to its high greenhouse gas emissions.

4.3.6 Needs for financial relief

Price was not a mobility need from the point of view of the participants, if the price is reasonable for this mode of transportation.

> "*The costs are important when thinking of which mode of transport. But it is more that it should be a justified price, like when I get a high standard of service and good quality, I'm willing to pay more." (Participant from Copenhagen, man without handicap, age 55)*

In Singen, for example, the high bus-ticket prices were criticized. This shows that the current offer of public transportation in Singen does not satisfy the mobility needs of the citizens to justify the bus fares.

4.3.7 Summary mobility needs

In summary, there are six major mobility needs identified in the two studies. The seventh, the need for financial relief, is not a mobility need, but is connected to the other mobility needs. One of the most important mobility needs is efficiency. This means that transportation users have a need for a mode of transportation that provides local and temporal flexibility, so that they are free and flexible in their mobility and can move around the city in the most efficient way.

Connected to efficiency is also the need for cognitive relief since flexible transportation reduces stress for its users. Not having to plan one's trip in advance frees cognitive resources and thereby provides cognitive relief. To fulfil the need for cognitive relief, a transportation mode has to be easy and convenient to use. Furthermore, reliability is also a mobility need that contributes to fulfilling the need for cognitive relief and efficiency. Study participants indicate that the mode of transportation needs to be punctual, and that the information provided about the schedule needs to be reliable in order to satisfy their need for reliability. The need for comfort implies providing physical relief to the transportation users by making it comfortable for them to move around the city.

On an emotional level, there is also the need for emotional comfort and relief which relates to the means of transportation offering safety and security for the users.

Lastly, there is a need for sustainability and environmental relief. This need is most present for respondents with a high concern for the environment. They have a pronounced desire for sustainable mobility and demand for example that their mobility options have a minimum of greenhouse gas emissions. While the need for financial relief is not a mobility need in itself, it is connected to the previously mentioned mobility needs. Depending on whether the mobility needs of the participants are satisfied, the prices are evaluated as adequate or not.

The important mobility needs identified in the studies that are currently not (fully) met are local and temporal flexibility, punctuality, and comfort. These mobility gaps present in the current mobility situation will be detailed in the following section.

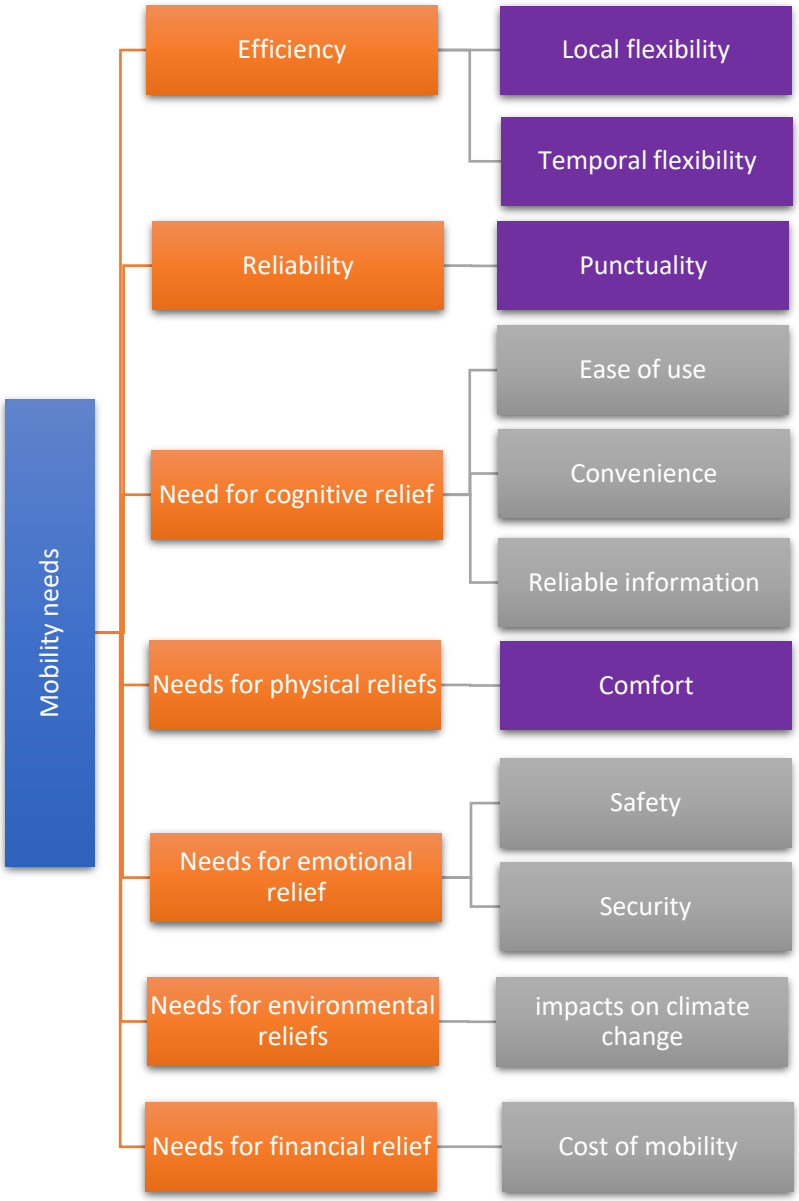


Figure 4.4 Summary mobility needs, as indicated by the respondents. Highlighted in purple are important mobility needs that are not, or only partially met by the current mobility situation

4.4 Mobility gaps

Mobility gaps arise when mobility needs are not, or not fully, satisfied. In this chapter the specific gaps as they were observed in Singen and in Copenhagen will be discussed.

4.4.1 Mobility gaps in Singen

Two major mobility gaps have become apparent. First, the first/last mile to/from the train station and second, going shopping especially without the availability of a car.

First and last mile (esp. from home to train station)

Specific mobility needs are to be fulfilled for the first and last mile**Error! Reference source not found.**. Currently, there are three options to reach the train station: by car, by bus or by bike. Reaching the train station by car, on the one hand, offers greater flexibility in terms of time than the bus, but time is lost again looking for a parking space. For reaching the train station by bus, you will have to overcome some problems, such as a lack of good and well-located bus stops, and inappropriate departure times for certain train connections. This results in an unsatisfied state of freedom and independence, and also efficiency and convenience in general. Additionally, the bus is criticized for its unreliability and delays. Furthermore, the bus has bad hygiene standards and no air conditioning.

Reaching the station by bike has certain disadvantages as well. At the train station there is a high risk of thefts, which hampers the residents to use theirs bicycles and put them there on the stands. Another disadvantage stated by the interviewees is the difference in elevation between the station and “Oberdorf”. In case of bad weather people like to switch to another mode of transport.

> *"What bothers me so much is the last mile (...) You have no good public good local public transport at all. It's more like a school bus service here in Singen.” (Participant from Singen)*
> *“Of course, this bothers a bit that the best way to get home from the station is still to be picked up.” (Participant from Singen)*

Shopping without the availability of a car

Alternative transportation means to the car to go shopping are using the bicycle and the bus. Both the bus and the bicycle are not satisfying the mobility needs in the situation of going shopping. Transporting larger purchases by bike is a problem especially when people live in the "Oberdorf". Also, in case of bad weather use of bicycle is not satisfying. In using the bus for shopping, problems occur by a lack of flexibility (due to the impractically located bus stations) and a lack of storage space. Additionally, the reliability and punctuality represent a problem when returning from shopping.

As a conclusion, we can state that there is a need for improvement in the mobility situation in Singen. There is an acute need for improvement by offers of public transport being more flexible and solving esp. the problem of bridging the last mile from home to train station.

4.4.2 Mobility gaps in Copenhagen

In Copenhagen public transportation consists of metro, s-train, and buses. Generally, the participants had a positive attitude towards the metro and s-train because they fulfilled their needs of efficiency, freedom, and relief. Though, participants were generally satisfied, the need for reliability and punctuality was not fully met by the metro and s-train. The gap between needs and the offered service is strongest for buses, smaller for metro or s-train. Due to the vast public transportation network in Copenhagen, there is no acute need to use a car in the city. In addition, the private car is also not seen to fulfil all mobility needs, especially concerning a relief for the environment.

The Copenhagen study did not indicate specific mobility gaps. However, there are occasions where mobility needs are not fulfilled by the transportation network. A first gap is notable in bus users; and is a result of changes in the public transport sector. Changes in the metro system resulted in cancellation of bus lines and bus stations. As a result, bus users developed a more negative attitude towards the bus and did not use it as much as before. This results in an unfulfilled need for physical relief and comfort for women and men with handicap. The non-users had a negative attitude from the beginning, complaining about long waiting times at the bus stations and difficulties reaching destinations or even the bus stations from their apartment. Their needs of efficiency, freedom, and relief were not fulfilled.
A second mobility gap results from the lack of local flexibility. The need for comfort concerning protection from bad weather conditions and transportation options at night was also not fully met. Especially the group ‘women’ has a need for better solutions in this regard, while ‘men’ only mentioned this need in case of extraordinarily bad weather.
A mobility need that was not fully met is the environmental friendliness of public transportation means. Participants that engaged in environmental protection activities, indicated that the buses are fossil-fuel-powered, so they did not see their need for sustainability fulfilled. Hence, this group of participants states a need for more environmentally friendly mobility.
The last mobility gap that was identified concerned bike use in Copenhagen. Although the bicycle is quite popular in Copenhagen, some respondents felt that there is a bicycle chaos in the city and that it is not safe.

4.5 Expectations towards automated minibuses

The studies also aimed to assess whether an automated minibus service could provide a solution for the mobility gaps within Singen and Copenhagen. In order to give the respondents in Singen a first impression about automated minibuses, a videoclip was shown. The reactions show that the automated shuttle service is perceived as a promising solution. It is expected to offer higher flexibility, to increase sustainability, and to be an advanced model of transportation. In general, it is seen to be an attractive “additional” solution but cannot completely replace other means of transport.

In Copenhagen, almost all participants state that the integration of automated minibuses could be an improvement for the (public) transport system. Hence, some unfulfilled needs of the participants regarding public transportation could partly be solved by the automated minibus.

Regarding the operation of the automated minibuses, participants envisioned three modes of operation; an on-demand, door-to-door service, a fixed route service with flexible departure times, and a fixed route service with a fixed time schedule. If operated as an on-demand, door-to-door service, respondents envisioned that this is supported by an application that provides all the necessary information and processes the payment. Information in the app should include the current location, the current route and the arrival time. Participants expect that this on -demand service would offer them the opportunity to be mobile at all times and reach various destinations in the city.

> *"It would be cool when you plug in your location in an application and then it says when the bus arrives. Then you go down to the street, it parks on the side and you enter." (Participant from Copenhagen, man without handicap, age 40)*

The respondents also reflected on the possibility that the AM service is offered as fixed routes, while the quantity of minibuses operating could be managed depending on the current demand. The buses should also connect to other public transportation systems in order to bridge the first/last mile.

> *"The routes must to make sense regards other public transport possibilities. So, for instance it should have a stop close by a station (...) it has to be linked up with all the other public transportation." (Participant from Copenhagen, woman, age 47)*

The last option "Fixed-Routes with time schedule" is regarded as very similar to the current system of public transportation, but with the minibuses there could be additional routes. This concept was the least preferred by all participants. Since the concept is similar to the current public transportation system, they assume that it will provide the least additional benefit to fulfil their mobility needs.

The next sections will provide more detailed results on how respondents perceive or envision how an automated minibus service could fulfil their mobility needs.

4.5.1 Expectations of flexibility

Respondents show a high expectation towards improved flexibility. Due to its small and compact appearance, the respondents assume that the automated minibus is able to reach many, even winding places. They therefore expect a better network of bus stops, resulting in higher local flexibility. Additionally, the automated minibus seems to have a modern technology and agile locomotion, which offers fast processes like the start and stop or the door opening. This results again in a fast mobility from A to B and finally in more temporal flexibility. Furthermore, the respondents associate the automated minibus with being modern, digital and innovative. Hence, they assume a connection to an app on their smartphones to have a fast order processing from anywhere. Having such a possibility to order the automated minibus from anywhere at any time again results in a local and temporal flexibility. For many, linking to an app is a suitable solution to realize an on-demand service, but also allows a good information policy including the waiting time forecasts, delays and the planned route.

In Copenhagen, participants had little personal experience with the automated buses, however, based on their knowledge about automated driving, they concluded that the buses will be able to drive wherever

they want, whenever they want but only for short to medium distances. This would help fulfilling their need for freedom, or more precisely flexibility in terms of time and space.

> *"I can imagine everything is integrated. The vehicle is parked somewhere nearby and you can order the vehicle by your smartphone. Then you can get into it and tip in the smartphone where you want to go and it just takes you there." (Participant from Copenhagen, man without handicap, age 40)*

Participants further assumed that the minibuses are able to drive without any human component. Due to the cost savings gained from the elimination of the human driver, they assume that a higher frequency of the minibuses (even at night) and an extension of the network to more remote locations will be possible with the minibus. This would further add to the satisfaction of temporal and local flexibility.

> *"You can integrate more vehicles with a higher frequency, because you do not need a driver and so the vehicles can drive all day and night without a stop (...)." (Participant from Copenhagen, man without handicap, age 37)*

> "*This would enable it to cover areas, which are not seen as financial visible at the moment to get very well connected. For example, for smaller areas outside of Copenhagen, where only every second hour a bus is arriving." (Participant from Copenhagen, man without handicap, age 40)*

Nevertheless, due to the assumed limited range of electric vehicles the participants see the added benefit of flexibility only when the buses operate within short or medium distances within the city. This is therefore a perceived barrier to achieve maximum local flexibility.

> *"I do not see driving a small electrical minibus 11km to the work (...)." (Participant from Copenhagen, man without handicap, age 37)*

In summary, participants concluded that the automated minibuses may be suitable for satisfying freedom needs by increasing local and temporal flexibility of public transport, in particular for short to medium distances within the city.

4.5.2 Expectations towards cognitive relief

Respondents expect that the automated minibus will reduce or eliminate general stress and energy needed to drive a car. As using a public transport service, such as the AM, eliminates the cognitive effort of having to find a parking spot, the expectation is that the AM will offer some cognitive relief in comparison to driving a car.

> *"One is significantly less stressed when using buses or trains at the destination. Driving a car is associated with stress and concentration. And sometimes you get annoyed." (Participant from Singen)*
>
> *"And you don't have to worry about anything, […] so insurance or maintenance costs of the car." (Participant from Singen)*

4.5.3 Expectations towards physical relief

In Singen, the potential for physical relief was seen primarily in comparison with bicycle use. The minibuses would be able to offer protection in bad weather conditions as well as making it easier to surmount the slopes and altitudes in Singen and facilitate the transportation of baggage (e.g., groceries).

Participants in Copenhagen do not see the need for more physical relief, as walking also contributes to the need for health. Therefore, participants do not want to eliminate walking altogether, but only in situations with high physical strain. Participants express that they expect to receive physical relief and convenience from the automated minibuses due to the increased flexibility. This physical relief is especially relevant for women and men with handicap, for example, when carrying heavy bags.

> *"I really do not like those heavy bags when going shopping or when I'm picking up a package. So, I would always prefer in this situation to get to public transport rather than walking with those heavy bags. So, this bus would be much more comfortable for me." (Participant from Copenhagen, woman, age 40)*

Women furthermore have expectations that automated minibuses would be able to fulfil their need for protection against bad weather conditions. For men this need only exists in extreme weather conditions (e.g., in winter), when they also indicate seeing the potential of the minibuses to fulfil their need for comfort.

4.5.4 Expectations towards emotional relief

Concerning the expectations regarding safety and security, the respondents, both in Singen and in Copenhagen, show a mixed picture. There are clear positive expectations, such as the reduction of accidents, but respondents also mention risks associated with the automated minibuses, such as unknown reactions of the AM in unforeseen situations.

The respondents in Singen associate the automated minibus with a low probability of accidents due to the preprogramed routes and its sensors.

> *"When you're sitting in a vehicle like this and you like to hand over some of the responsibility at the end, you just say, 'Okay, I trust the vehicle and those who made it.'" (Participant from Singen)*

> *"A bus is easier to steer. It follows the predefined routes." (Participant from Singen)*

With automated driving in general, respondents expect that there will be fewer accidents due to the stress relief for the driver, the communication between the vehicles as well as a reduced risk from unsafe drivers, e.g. older people. The most respondents assume human errors like the lack of concentration, stress or distraction as more likely than any technical errors of the software.

> *"Carelessness and personal characteristics of the driver no longer play a role." (Participant from Singen)*

Nevertheless, the test subjects are suspicious to the minibuses since the technology can also make wrong decisions. Especially one respondent, working in the IT industry, reflected on programming errors, which hampers the trust in the safety of the automated minibus.

> *"I know how many bugs there are in software and I know that there is no such thing as bug-free software." (Participant from Singen)*

Additionally, respondents expressed concerns related to unknown reaction of the automated minibus in unforeseen situations. This perceived risk could hamper the acceptance of automated minibuses by users.

> *"So, there's always something that happens that the technology didn't provide for." (Participant from Singen)*

Regarding the security there are some perceived expectations like better protection against attacks on the street especially on the way home at night. So, the automated minibus could offer a more secure last mile from the train station to their home.

> *"Exactly, so that would be nice not to have to walk home at night, but to be driven with, for example, such a shuttle." (Participant from Singen)*

In contrast, it has turned out that some fear attacks within the buses, especially when the automated minibus is driving without any human component. Furthermore, there are some concerns regarding the help for older people or people with reduced mobility when there is no human component available.

> *"I could see that as a disadvantage. It would have to already be designed in such a way that disabled people can use it." (Participant from Singen)*

So, the lack of a personal component in an automated minibus is seen as an obstacle for a secure feeling when using the bus. Therefore, a human component, like the supervisor inside the bus, could alleviate security concerns.

> *"Now when I think of certain situations that sometimes take place in public transportation, I think I think it's important to have someone you can turn to." (Participant from Singen)*

Due to the lack of a human component in automated driving, people also question who will be held responsible in case of an accident.

Respondents also expect a secure handling of their GPS data and app information, e.g. in terms of protection from third parties and abuse. Though, some participants are more relaxed about sharing their data.

> *"I already give away my data with so many apps anyway." (Participant from Singen*)

> *"Nevertheless, I want my data to be properly managed and secure." (Participant from Singen)*

In Copenhagen, the expectations whether minibuses can fulfill their need for safety vary depending on the time horizon. Regarding the need for safety (mainly accident prevention) the participants expressed doubts about the maturity of the current technology, although they were sure that in the near future with more development of the technology, they will feel safe using the automated vehicles.

> *"I see the benefit that when the technology works as supposed to, that you do not have a driver, who is tired or not vigilant about bikers. Those kind of accidents with bikers could be avoided with the new technology." (Participant from Copenhagen, woman, age 40)*

> *"I know how the software can be made and understand that at the current time the vehicle is not ready for the environment and you cannot plan and foresee all the situations and challenges which are happening in a city. So in the urban environment the technology has to improve a lot." (Participant from Copenhagen, man without handicap, age 37)*

Participants from Copenhagen had a positive attitude towards automated driving in general. The participants already had experiences with the fully automated metro in Copenhagen. The automated metro was evaluated as safe by the public transportation operators and the government, and the usage experience installed trust in the participants towards the safe integration of new technology in the transportation system (e.g., the integration of the minibuses).

During the pilot phase of the automated minibuses there is a supervisor on every minibus to ensure that everything is running smoothly. At the beginning all participants had a negative attitude towards this supervisor because they said that this would compromise the benefits of an automated vehicle (like the potential of maximum temporal flexibility).

> *"I definitely like to experience automated driving and not see a driver or this kind of supervisor within the bus. Otherwise it will lose the benefits of having a driverless bus." (Participant from Copenhagen, man with handicap, age 24)*

> *"Well, it is a vehicle, which does not need a driver and follow paths. Both in private and public sector there is no driver on board, who need to check things." (Participant from Copenhagen, man without handicap, age 47)*

In order to install a feeling of safety, participants preferred the presence of emergency buttons or call systems instead of a supervisor.

> "I*n case of small accidents, it would be helpful to have a button to a central technical team. Or when you have an emergency that you can press an alarm button." (Participant from Copenhagen, woman, age 47)*

During the study, the participants that actively used the automated minibuses changed their opinion as while using the bus, they encountered some problems that the supervisor was able to solve.

> *"As long as it is new technology and not fully tested in different situations, traffic areas, then there should be someone on board. Otherwise, when there is a problem like last week in my test drive, I would have felt lost without the person. So until the trust is fully there, there should be a supervisor." (Participant from Copenhagen, woman, age 47)*

The group of non-users, on the other hand, did not change their negative attitude towards the supervisor during the entire period of the study. Nevertheless, this merely negative attitude towards safety did not compromise the other positive opportunities that the participants were expecting.

Overall, the participants of the study were open towards the topic of automated mobility.

> *"It is very exciting, in fact, I like innovative things like that. So yes, the project sounds exciting and I think it has a potential for development and is a good concept for the future." (Participant from Copenhagen, woman, age 40)*

Two separate groups could be identified, one having a high involvement with the topic with more extended knowledge and more concrete ideas about what integration concepts could look like. The second group had a lower involvement with more vague ideas about the topic. Their ideas and knowledge increased through the study.

> *"During this couple of weeks and also now, I'm paying more attention if I see an article in the newspaper which is related to automated driving and then I'm more interested reading it." (Participant from Copenhagen, woman, age 40)*

Another expectation from women in Copenhagen concerning the emotional well-being and safety is that automated minibuses would be able to fulfill their need for safety at night, as they expect the vehicles to drive at a higher frequency, also at night.

4.5.5 Expectations towards relief for the environment

In addition to the positive expectations towards flexibility, positive environmental effects are expected. Some respondents mentioned the CO2 savings, no fossil fuels as well as the reduction in noise emission due to the electric drive of the automated minibus.

> *"I would definitely support that as a participant, that these CO2 emissions are minimized." (Participant from Singen)*

Other participants see the use of the minibus as an opportunity to do something for the environment and to have a clear conscience based on social desirability. For example, they could improve their ecological footprint in comparison to the use of the car and have a better conscience.

> *"So now also with e-mobility, there is of course the environmental thought as well." (Participant from Singen)*

But there are also some critical statements, regarding the use of genuine green electricity and better alternatives to lithium batteries such as hydrogen cells. Participants also express concerns about a rebound effect caused by the inefficient passenger transportation due to the small size of the automated minibus. As a larger fleet will be necessary for the transportation of the same number of people this may reduce the environmental friendliness of the minibus.

> *"I think there's a lot of hypocrisy involved. Especially when I think of the whole e-mobility, I think that most people are very little informed about the energy suppliers." (Participant from Singen*)

> *"I personally don't find electric vehicles attractive because of the whole battery issue." (Participant from Singen)*

However, environmental friendliness itself is not considered as a primary need for mobility. The need for relief for the environment often conflicts with other mobility needs. These other needs often take precedence over environmental friendliness. Therefore, the environmental benefits of the shuttles are seen as an additional consideration for its usage, but not as the decisive factor.

The participants of the study assumed the automated minibus to be managed and ordered by an app, to be driving without a driver and to be powered by electricity.
Regarding the need of sustainability, all participants had a very positive attitude towards the automated minibuses. They expected less CO_2-emissions and even considered less noise pollution, some also mentioned that the minibuses could lead to decreased use of private cars.

> *"I presume that those automated vehicles are charged by electric. So this is a high benefit, that it reduces the carbon footprint." (Participant from Copenhagen, man without handicap, age 55)*

> "*It seems that they are not making any noise. So it is really silent when they are driving around, which could also be a big opportunity regards the environment." (Participant from Copenhagen, man without handicap, age 37)*

In Copenhagen, respondents expect that through the integration of automated minibuses some residents will be motivated to substitute their use of car with the minibuses, thereby contributing to the satisfaction of their need for sustainability.

> *"The cars are polluting quiet a lot in the inner-city. So, if you could get more electric busses to the inner-city and reduce the cars, this would definitely reduce the pollution. And therefore I would definitely support this kind of transportation." (Participant from Copenhagen, woman, age 47)*

People with a high concern for the environment furthermore expect benefits through noise reduction and they are convinced that minibuses could satisfy their need for sustainability as a replacement for the fossil fuel-powered buses. While the group of 'environmental friends' also expect benefits for sustainability, this

is not their principal motivator to use minibuses. For this group, the fulfillment of the temporal flexibility need is a more important motivator why they would consider using the minibuses.

4.5.6 Expectations toward financial relief

Respondents stated that they are willing to pay a higher price compared to currently used means of transportation, under the condition that the automated minibus service is a real improvement in terms of temporal and local flexibility and there is a connection to an app for fast ordering and efficient routing

> *"I think that the price could be higher. If I have the added value of being able to call it when I want to and it drives me there." (Participant from Singen)*

This shows that if it succeeds to raise awareness of the needs that are also still unmet by the car, the added value that new mobility systems can offer would also be valued materially. Nevertheless, a critical cost factor still arises from the need for safety, which can only be fully met through a safety operator inside the vehicle.

4.5.7 Summary of expectations toward automated minibuses

Overall, the respondents see opportunities for the AM to fulfil mobility needs. Using an automated minibus service could result in a cognitive relief, as it will omit the stress from driving a car and finding a parking spot. Further elevation of cognitive reliefs could be envisioned if the AM service is complemented with an (app) service that would provide information about time tables and integrate other means of transport as well. The envisioned additional flexibility that an AM service could bring, is seen as the most important contribution to fulfilling mobility needs. In Singen, due to it topography, an AM service is seen as a possibility for physical relief. This relief is not apparent in Copenhagen. Respondent still see quite a bit of uncertainties about risks and benefits of the AM regarding safety and security, therefore an AM service is not regarded as causing emotional relief. The AM could result in fulfilling a relief for the environment. However, qualities of the AM that would fulfil this need, are perceived as conflicting with other mobility needs, mostly flexibility, see also Figure 4.5.

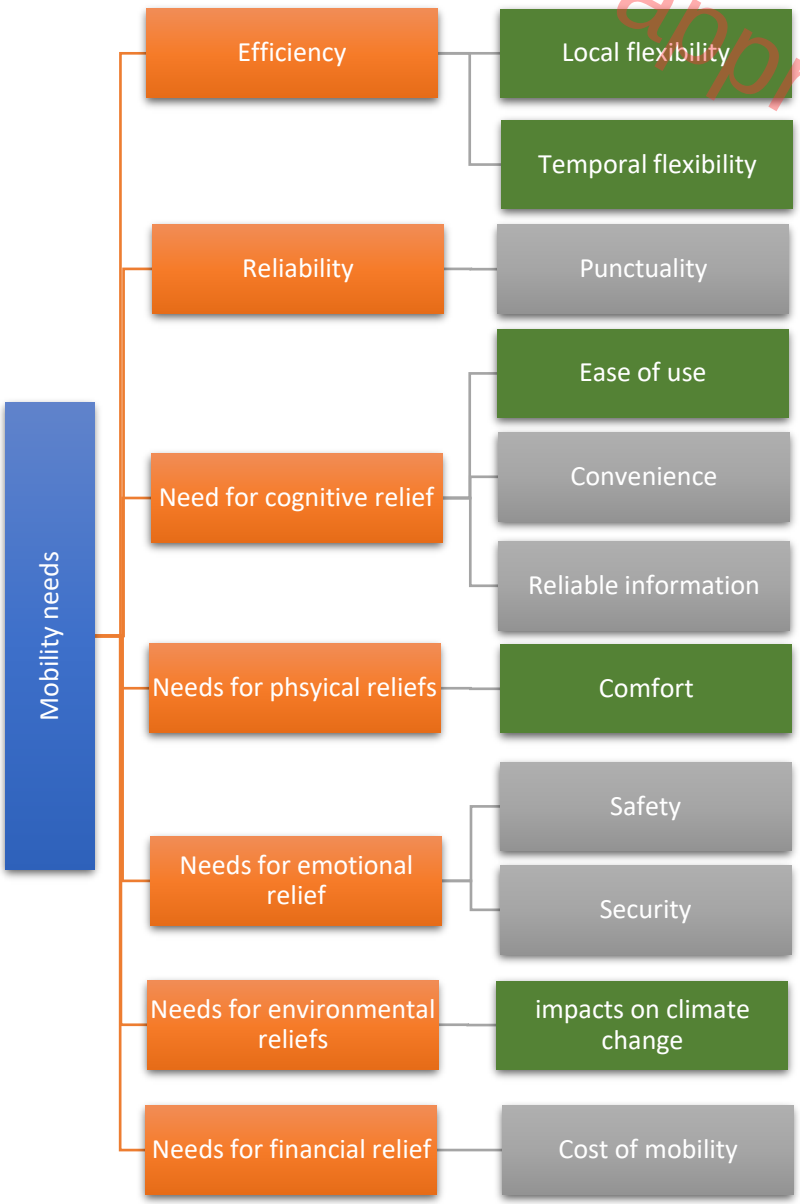


Figure 4.5 Expectations of the automated minibus in fulfilling mobility needs (mobility needs highlighted in green those that respondents can envision the automated minibus to contribute to)

4.6 Conclusions

This chapter centralised the mobility needs of potential users of AM, starting with the current mobility situation. In Singen, the current offer of public transportation is not satisfactory, and walking or cycling are not an optimal solution to replace public transport or the car. This results in mobility gaps, such as the first-and-last mile to/from the train station. The automated minibus service is perceived as a solution for the current mobility gaps in public transport offers, as it is expected to increased temporal and local flexibility. However, the automated minibus service is primarily perceived as an attractive “additional” solution, which cannot replace existing means of transport entirely.

The results clearly show at temporal flexibility is prioritized over local flexibility. This means that respondents are willing to accept an additional distance to the nearest bus stop, but are less willing to accept additional waiting time. A more detailed analysis of the requirements for an on-demand service is required in further research, as it is not yet clear what an acceptable distance between home and the pick-point (physical or virtual bus stop) is; and what is perceived as an acceptable waiting time.

An automated minibus service could be a mobility solution in locations with an acute need for improved public transport. It can be expected that the willingness to test the new service is high. Potential users do not expect that an automated minibus service will be a complete substitution of all current mobility options; it is not foreseen that the service will replace the use private car or bicycle entirely, but there is potential to substitute the current bus system. Under the condition that the service will include additional services, is of higher quality than the current service and is a real improvement in terms of temporal and local flexibility, respondents are willing to pay a higher price for the service.

Safety is a very important basic need and essential for a positive attitude towards the minibuses. This is also highly influenced by the trust that the population has in the government and transport operators, so joint campaigns ensuring the safety of those vehicles can help. Despite the need for physical relief, participants also express a need for health in mobility. This implies that there is not always a demand for door-to-door mobility. The first and last mile walking is preferred by the respondents if they do not have substantial mobility limitations. The project should take this into consideration when positioning the automated minibuses in the public transport system.

A conclusion of this study is that there is limited knowledge and personal experience with automated minibuses among the participants. This shows the necessity to raise awareness and interest for the pilot line. Regarding the importance of personal experience with the automated minibuses, installing more pilot lines could help. The feedback for the current pilot lines was, that it does not really benefit the residents' daily mobility. When considering future test routes, the routes should considerably expand the current mobility offer. One example for a promising test route would be a connection between a shopping district and a residential area where there is a high number of residents with limited mobility.

5 Attitudes and acceptance of automated minibuses

This chapter presents the attitudes and acceptance of citizens of the four AVENUE pilot cities. The results are based on the final representative survey (for methodology see section 2.2.4). This chapter is built around five blocks; general attitudes on local situation (5.1), the awareness on automated minibuses (5.2), the willingness to use the AM services (5.3), perceived advantages and concerns of using AM services (5.4) and the expectations and requirements of the AM services (5.5).

5.1 General attitudes on local situation

In the survey, the respondents were asked to rate their satisfaction with four aspects of life quality in their city on a scale of 1 (very dissatisfied) to 5 (very satisfied) (see Table 5.1). In general, satisfaction with life situation seems to be high in the pilot cities (Table 5.1). Respondents report a high satisfaction with their local area as a place to live (3.9). Focusing on specific elements provides a different picture; they are not fully satisfied with the public transport offer (3.5), satisfaction even being lower for Luxembourg and Lyon (3.3). There is a general dissatisfaction with the local environmental situation (3.3) and the local traffic situation (2.7) and 76% of survey respondents were not satisfied with the situation (rating of 3 or even worse).

Table 5.1 Satisfaction with local situation

		Copenhagen (n=491)	Geneva (n=284)	Luxembourg (n=540)	Lyon (n=501)	Overall (n=1816)
Satisfaction with your local area as place to live*1	Mean value[1]	4.0	3.8	4.0	3.7	3.9
	Satisfied[2]	75%	65%	74%	65%	71%
Satisfaction with current traffic situation in and around your city*2	Mean value[1]	3.1	2.7	2.5	2.7	2.7
	Satisfied[2]	66%	47%	41%	49%	51%
Satisfaction with public transportation offer*3	Mean value[1]	3.7	3.8	3.3	3.3	3.5
	Satisfied[2]	62%	65%	45%	47%	53%
Satisfaction with environmental situation in your city*4	Mean value[1]	3.2	3.5	3.4	3.3	3.3
	Satisfied[2]	31%	49%	49%	45%	43%

[1]Mean values on factor variables (higher values mean higher satisfaction, where 1= lowest, 5=highest)

[2] The percentages represented here, are those respondents that are satisfied or very satisfied (topbox 4-5).

*[1] Satisfaction with place to live differed statistically significant for the different cities, $F(3, 898) = 10.162$, $p < .001$, Lyon<Copenhagen, Luxembourg; Geneva<Copenhagen, Luxembourg (all very significant)

*[2] Satisfaction with current traffic situation differed statistically significant for the different cities, $F(3, 888) = 27.685$, $p < .001$, Luxembourg<Copenhagen, Lyon; Geneva<Copenhagen; Lyon<Copenhagen (all very significant)

*[3] Satisfaction with public transportation offer differed statistically significant for the different cities, $F(3, 916) = 22.770$, $p < .001$, Luxembourg<Copenhagen, Geneva; Lyon< Copenhagen, Geneva (all very significant)

[*4] Satisfaction with environmental situation differed statistically significant for the different cities, $F(3, 888) = 7.069$, $p < .001$, Copenhagen<Geneva, Luxembourg (all very significant)

Concerning the values of the participants, the analysis revealed that family and friends, as well as, health, being environmental-friendly are the top four priorities in the lives of the respondents (Table 5.2**Error! Reference source not found.**). The rating of the items was done on a scale of 1 (not important at all) to 5 (very important). Aspects like climate protection, work, and making new experiences were of medium importance, while politics was least important to respondents. Although average is not highest for being environmental-friendly and climate protection these are important topics for a majority (76% and 65% rated the respective items at 4 or higher). In Luxembourg in particular, where cars are used more frequently, sensitivity to environmental friendliness (93%) and climate protection (71%) is even higher.

Table 5.2 Importance of different aspects of life

		Copenhagen (n=491)	Geneva (n=384)	Luxembourg (n=540)	Lyon (n=540)	Overall (n=1816)
Family[*1]	Mean value[1]	4.4	4.5	4.6	4.5	4.5
	important [2]	65%	86%	92%	89%	89%
Health[*2]	Mean value[1]	4.4	4.5	4.2	4.6	4.4
	important [2]	87%	90%	80%	93%	88%
Being environmental-friendly [*3]	Mean value[1]	3.6	4.1	4.6	4.1	4.1
	important, in % [2]	57%	77%	93%	76%	76%
Friends[*4]	Mean value[1]	4.0	4.2	4.3	4.1	4.2
	important, in % [2]	77%	80%	84%	79%	80%
Climate protection[*5]	Mean value[1]	3.5	3.9	3.9	3.9	3.8
	important, in % [2]	55%	68%	71%	66%	65%
Work[*6]	Mean value[1]	3.1	3.8	4.0	3.5	3.6
	important[2]	45%	64%	72%	56%	59%
Making new experiences[*7]	Mean value[1]	3.6	3.8	3.6	3.4	3.6
	important, in % [2]	57%	60%	56%	47%	55%
Politics[*8]	Mean value[1]	3.2	3.0	3.2	2.8	3.0
	important, in % [2]	37%	35%	39%	24%	34%

[1]Mean values on factor variables (higher values mean higher satisfaction, where 1= lowest, 5=highest)

[2] The percentages represented here, are those respondents that are satisfied or very satisfied.

[*1] Importance of familiy differed statistically significant for the different cities, $F(3, 887) = 8.140$, $p < .001$,

[*2] Importance of health differed statistically significant for the different cities, $F(3, 900) = 22.382$, $p < .001$,

[*3] Importance of being environmental friendly differed statistically significant for the different cities, $F(3, 915) = 51.652$, $p < .001$,

[*4] Importance of friends differed statistically significant for the different cities, $F(3, 899) = 6.428$, $p < .001$,

[*5] Importance of climate protection differed statistically significant for the different cities, $F(3, 902) = 15.780$, $p < .001$,

[*6] Importance of work differed statistically significant for the different cities, $F(3, 915) = 51.652$, $p < .001$,

[*7] Importance of making new experience differed statistically significant for the different cities, $F(3, 906) = 9.989$, $p < .001$,

[*8] Importance of politics differed statistically significant for the different cities, $F(3, 890) = 14.717$, $p < .001$,

Respondents were asked to indicate what aspect they perceive that should be improved in public transport. The top three items (price performance, flexibility by an increase of locations and of frequency of public transport offers and speed & travel time, Figure 5.1) result in improving efficiency. Efficiency was identified as a general mobility need in our need assessment (see chapter 4). When looking in detail at the individual cities, price performance was ranked first as the most important area of improvements by respondents in Copenhagen, Geneva, and Lyon, where it was the aspect named most often (74%, 72%, and 58%, respectively). This aspect was not rated highly by participants from Luxembourg, where only 9% of respondents saw it as an aspect that should be improved. This is most probably due to the fact, that public transport is free in Luxembourg. In contrast, in Luxembourg the most frequently named aspect was flexibility by an increase of frequency of public transport offers (58%). As an exception among the four cities, in Lyon safety and trust feeling was named the second most often after price flexibility; 56% of the respondents in Lyon saw it as an area of improvement compared to only 37% overall.

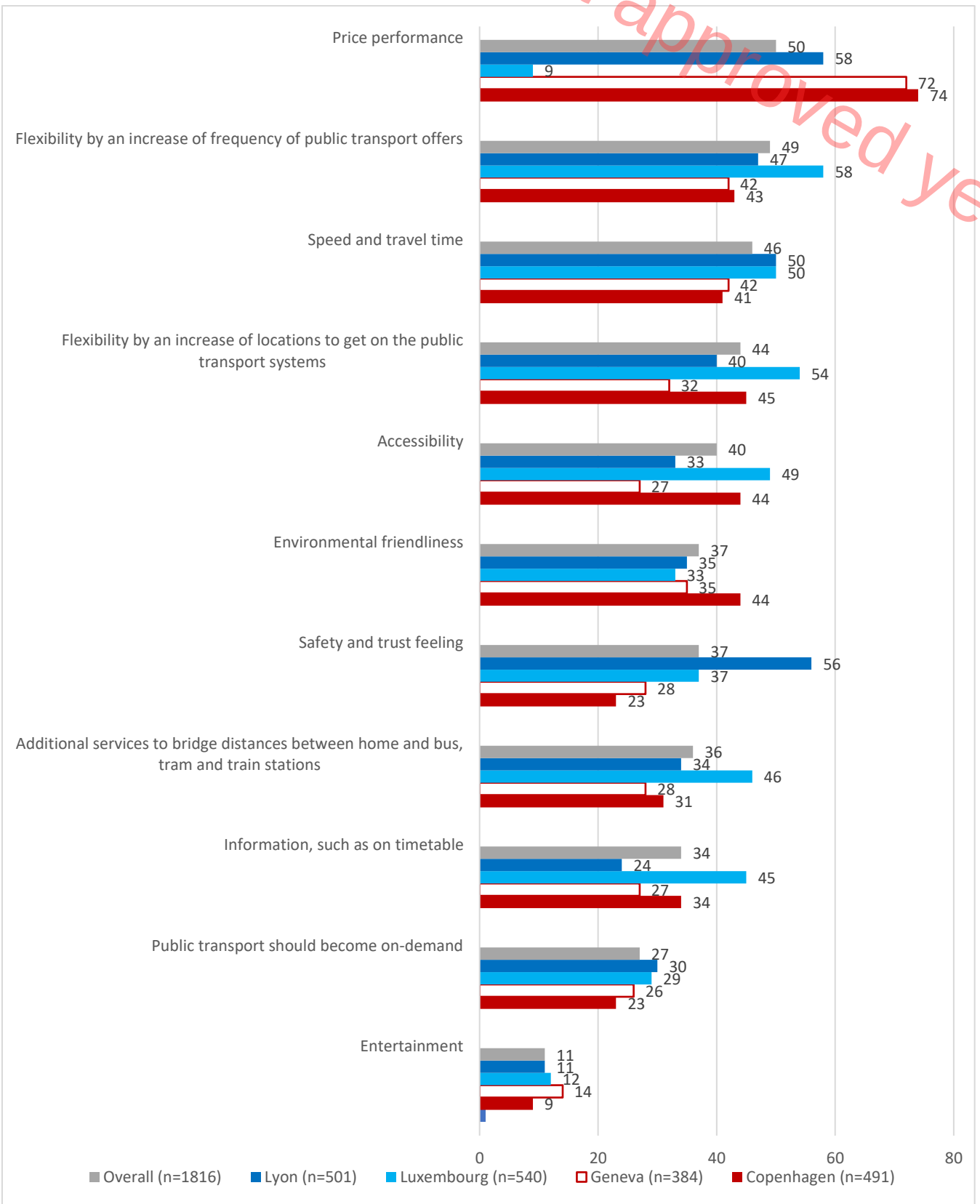


Figure 5.1 Aspects selected for improvement of public transport systems (Shown are topbox 1-3: most important aspects, in %)

5.2 Awareness and Acceptance of automated minibuses

A slim majority of our respondents (55%) was aware of the existence of automated minibuses, prior to conducting our survey. The awareness of AM is highest in Luxembourg (72%) and lowest in Copenhagen (40%). There is a wide range of information sources: newspaper (37%), radio/tv (50%), internet (33%), social media (15%) or seen on the test site (22%). Only a small number (7% overall) of respondents has already used the AM service (Table 5.2). That could be because of the fact, that the automated minibuses only drove on a very small area of the cities and in addition the Corona pandemic reduced the willingness to use public transport in general.

Table 5.2 Awareness of automated shuttles

		Copenhagen (n=491)	Geneva (n=284)	Luxembourg (n=540)	Lyon (n=501)	Overall (n=1816)
Awareness of automated shuttles[*1]	No.	197	141	387	278	1003
	% of total	40%	50%	72%	56%	55%
Experience with automated shuttles	No.	21	22	40	43	126
	% of total	4%	8%	8%	8%	7%

[*1]Statistical dependence between city and awareness of AM, (Chi-Square(3) = 107.917, $p < .001$)
No Statistical dependence between city and experience with AM

Before continuing the survey, respondents were provided with some key facts of the AM, see Figure 5.2.

"Automated minibuses are small electrically powered buses for up to 15 people that operate in public transport systems and drive autonomously, i.e. without an active driver"

Figure 5.2 Information presented to the respondents of the survey

5.3 Willingness to use the AM services

To gain insight in the acceptance of citizens to use the automated minibus services, we asked respondents to reflect on their willingness to use the AM. The consensus in academic literature (see amongst others:

Nordhoff et al., 2021) is that in general, there is a high acceptance and willingness to use AM. This was also shown by the results of the 2019 survey (see Korbee et al., 2020[14]). Therefore, in the 2021 survey, we asked for willingness to use the AM in three different scenarios of deployment to gather a more differentiated picture about willingness to use:

- The AM service as part of a seamless, intermodal trip
- The AM offering a service that bridges the first and last mile
- The AM offering an on-demand, door to door service

The respondents were provided with information of these three scenarios of deployment, prior to the questions, see Figure 5.2.

Textbox 5.1: explanation provided to the respondents on the three AM modes of deployment:

The automated minibuses can provide a service that is not based on a fixed timetable. The automated minibus comes at a time requested by you, to a location specified by you. This location can be the nearest bus stop, or even your doorstep.
This is called an on-demand, door-to-door service.

The automated minibuses can be integrated in the public transport system to bridge the distance between your place of departure or destination to a public transport station.

This is called a service that bridges the first and last mile.

The automated minibuses service can be integrated in a system together with other means of transportation. This means that you can easily combine a trip with the automated minibus with a trip on the train, bus or taxi. As the automated minibuses will operate on-demand, the system will allow you to plan your trip seamlessly.

This is called a seamless, intermodal trip.

Figure 5.3 Explanation provided to the respondents on the three AM Modes of deployment

The willingness to use is generally high. Regardless of the scenario, more than 50 percent “would be willing” or even be “very willing” to use AM, even two-thirds 63% if an on-demand service is offered (see Figure 5.4). The willingness to use the automated minibuses as on demand service is high in all four cities, highest in Geneva, where a generally higher usage of buses is observed (see mobility behaviour in chapter 3). On the other hand, it is lowest in Copenhagen. In Copenhagen, potential users assume that AM is most suitable for short to max. medium distances. Here, however, the bicycles offer a good alternative due to the topography.

[14] second iteration AVENUE social impact assessment

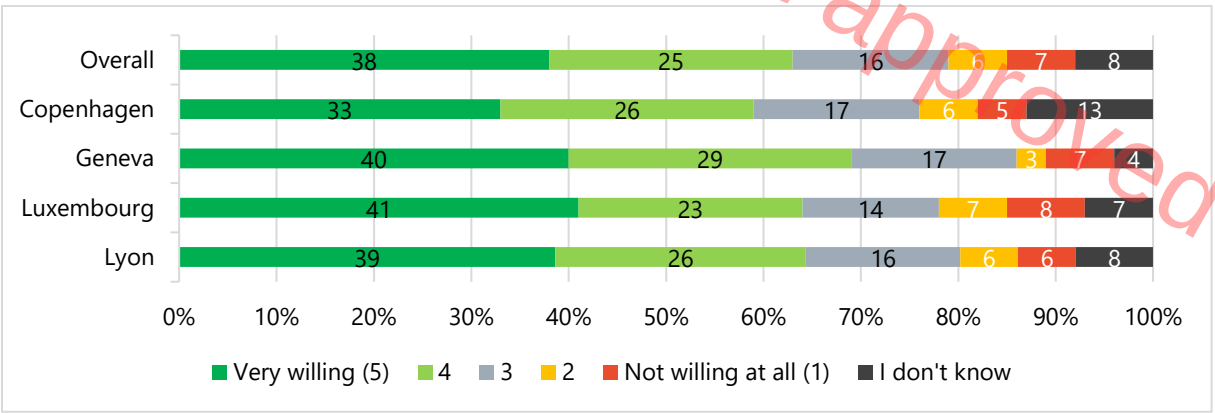


Figure 5.4 Willingness to use automated minibus per city if the automated minibus offers an on-demand, door-to-door service (in %; n=1816)

Table 5.3 willingness to use the automated minibus per city (means)

	Copenhagen (n=428)	Geneva (n=272)	Luxembourg (n=502)	Lyon (n=461)	Overall (n=1663)
Mean value*[1]	3.9	4.0	3.9	3.9	3.9

*[1] Willingness to use automated minibus if the automated minibus offers an on-demand, door-to-door service differed not statistically significant for the different cities

The willingness to use the automated minibuses as service that bridges the first and last mile is high as well in all four cities, again highest in Geneva, where a generally higher usage of buses is observed (see chapter 3 on mobility behaviour) followed by Lyon. On the other hand, it is lower in Copenhagen and Luxembourg but differences are only partly significant (Table 5.4).

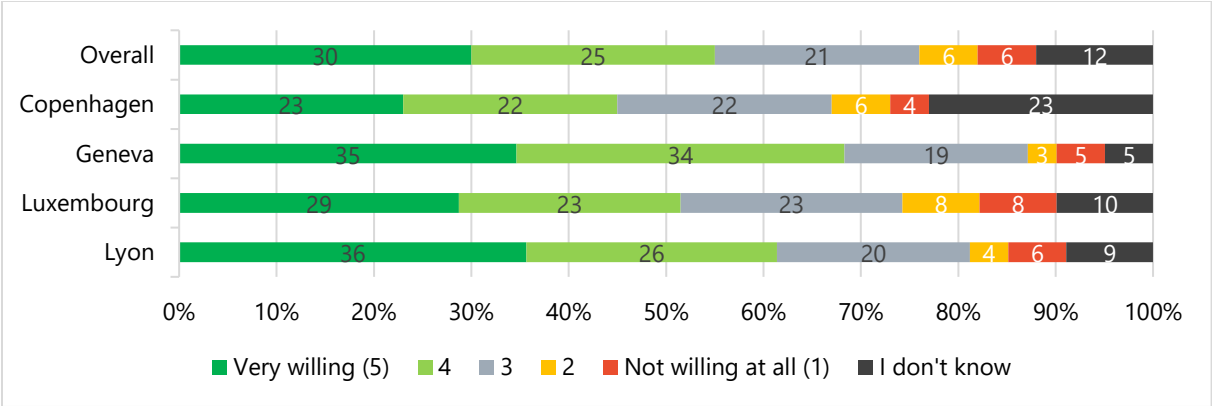


Figure 5.5 Willingness to use automated minibus per city if the automated minibus offers a service that bridges the first and last mile (in %, n = 1816)

Table 5.4 Willingness to use the automated minibus (means)

	Copenhagen (n=376)	Geneva (n=270)	Luxembourg (n=486)	Lyon (n=457)	Overall (n=1589)
Mean value*[1]	3.7	4.0	3.6	3.9	3.8

*1 Willingness to use automated minibus if the automated minibus offers a service that bridges the first and last mile differed statistically significant for the different cities, $F(3, 819) = 7.693$, $p < .001$,
All groups were different from each other (all very significant), except of Copenhagen to Luxembourg and Lyon, Lyon to Geneva

Comparable effects can be observed if the service is offered as part of a seamless trip, see Table 5.5 and Figure 5.6.

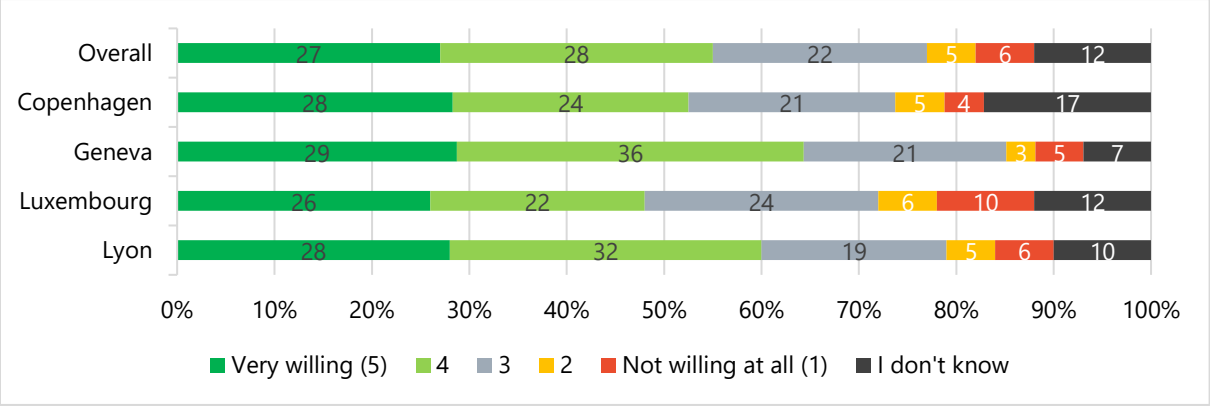


Figure 5.6 Willingness to use automated minibus per city if the automated minibus is part of a seamless, intermodal trip (in %, n = 1816)

Table 5.5Willingness to use an automated minibus if the automated minibus is part of a seamless, intermodal trip (means)

	Copenhagen (n=409)	Geneva (n=262)	Luxembourg (n=474)	Lyon (n=449)	Overall (n=1594)
Mean value*1	3.8	3.9	3.5	3.8	3.7

*1 Willingness to use automated minibus if the automated minibus is part of a seamless, intermodal trip differed statistically significant for the different cities, $F(3, 819) = 6.849$, $p < .001$,
Luxembourg<Copenhagen, Geneva, Lyon (all very significant)

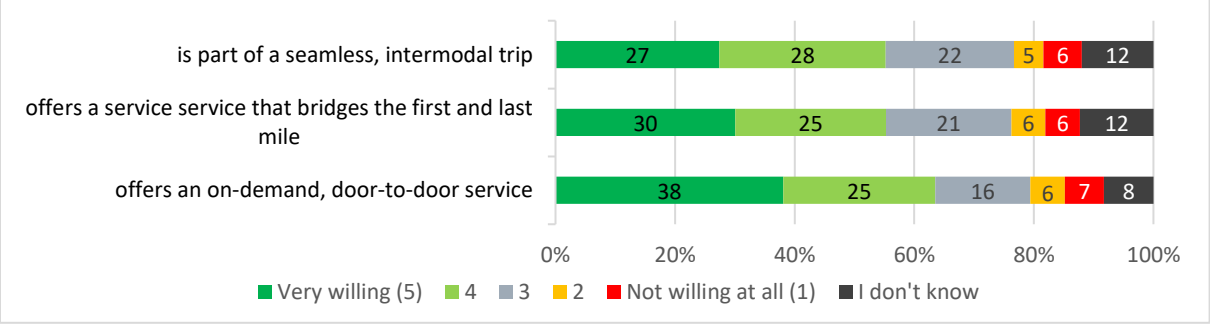


Figure 5.7 Willingness to use the automated minibus if the automated minibus… (in %; n=1816)

In addition to the willingness to use, the respondents were also asked to reflect on their willingness to reduce the use of their own car. As we are only interested to know the willingness to reduce the use of car

of respondents that actually own a car, the results omit those that do not own a car. Hence, the presented figures have a slightly lower base, as 1526 out of the 1816 respondents own a car. The willingness to even reduce the use of one's own car is generally high in all scenarios. If the service is offered on-demand even more than 50 percent would be “willing to reduce use of own car”. This number slightly increased in Lyon from 56 percent in 2019 to 63 percent in 2021 (see for more details section 7.2).

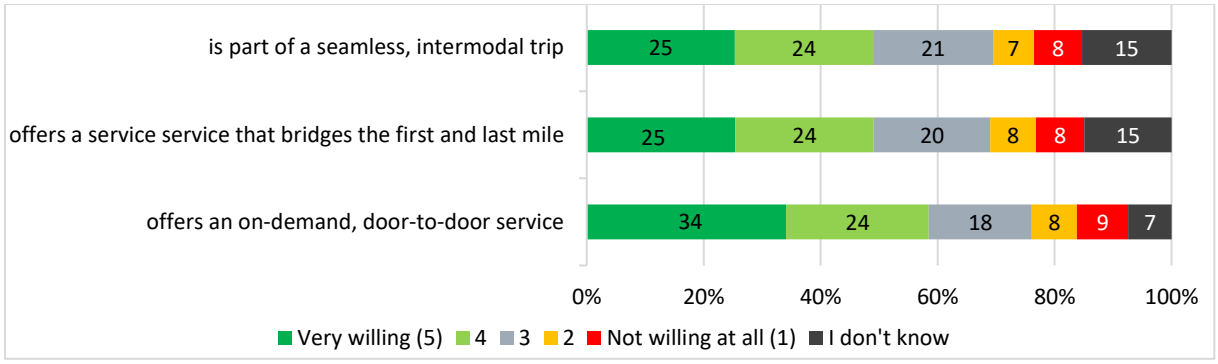


Figure 5.8 Willingness to reduce the use of your own car, if the automated minibus… (in %; overall n=1526*)

Similarly, to the previous question, respondents were asked to reflect on their willingness to give up the use of their car. About 50% „would be willing” to give up the use of own car, in case of on-demand service.

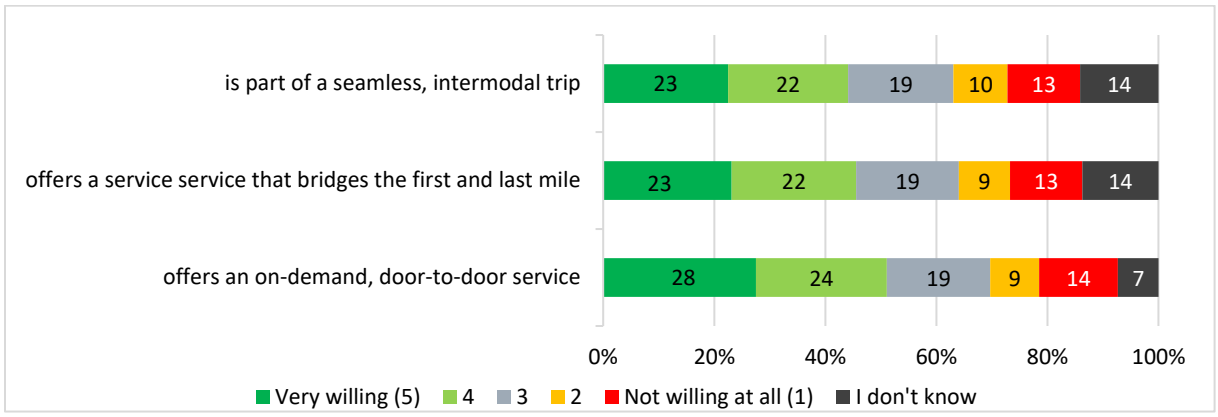


Figure 5.9 Willingness to give up the use of your own car, if the automated minibus… … (in %; overall n=1526)

And finally, the respondents were asked to reflect on their willingness to increase use of public transport if AM offers an on-demand service. At least 50% „would be willing” to increase use of public transport if the AM offers an on-demand service.

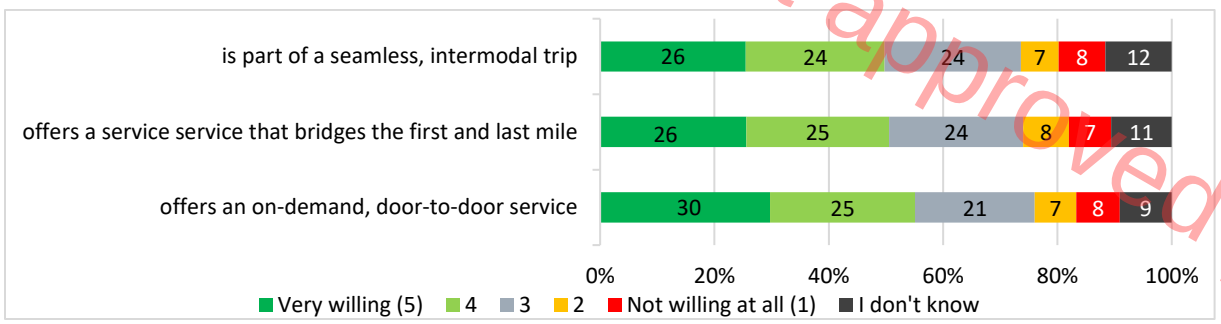
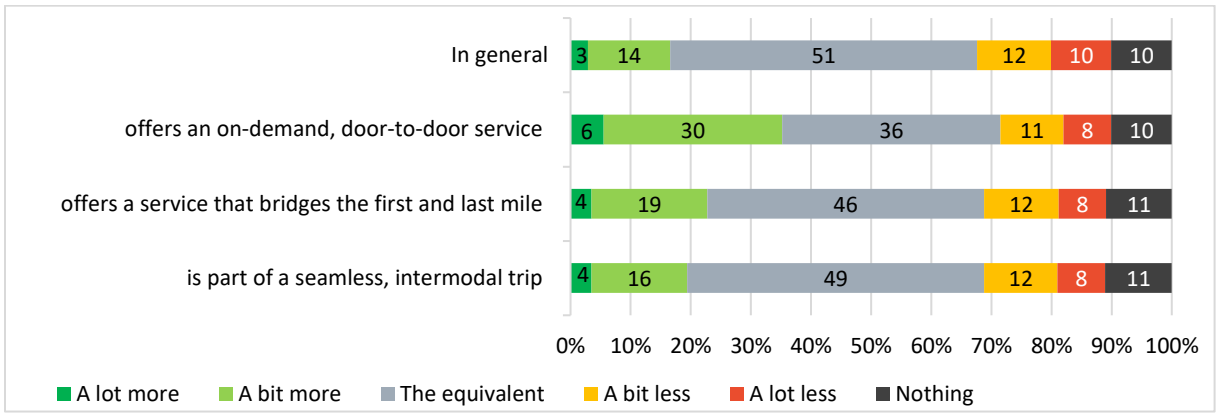


Figure 5.10 Willingness to increase the use of public transport systems (including current offers), if the automated minibus… (in %; overall n=1816)

Very important is the insight that in the past potential users were not really be willing to pay more for the automated minibuses. In general, this is still low – see Figure 5.11. In 2021 about 6% are very willing and 30 % are willing to pay at least a bit more if the service would be on-demand door to door. The automated minibus is not perceived as a truly inspiring innovation (see 2-factor model, Herzberg [15]), but rather as a service that eliminates existing deficiencies in terms of efficiency and flexibility (hygiene factor), i.e. only reduces the currently existing dissatisfaction. This could explain why one is not willing to pay more. The subjective benchmark could even be that one has the feeling of paying too much for the current, rather unsatisfactory service.



* This question was not asked in Luxembourg, as Luxembourg offers free public transport: n=1273

Figure 5.11 Willingness to pay to use the automated minibus, if the automated minibus… (in %; overall n = 1273)

In addition to the different scenarios the respondents were asked to select a mobility option they would prefer in a specific situation in which they want to get from point A to point B, see Figure 5.12. The options vary in terms of flexibility and duration, costs and environmental friendliness. As shown in the yellow boxes 45% prefer a faster option, being not the most expensive. As shown in the green box 26% prefer an environmentally friendly solution at very low costs, even if this means that the travel time is longer, see Figure 5.12. And on the left you can see that 28% choose a service that integrates the automated minibus. That seems to be mainly driven by the travel time no longer than 15 minutes.

[15] Frederick Herzberg: *One more time: how do you motivate employees?* In: *Harvard Business Review.* 46, 1, 1968, S. 53–62.

The fastest but also most expensive options are Robotaxi and Taxi. These options are only chosen by around 2 %.

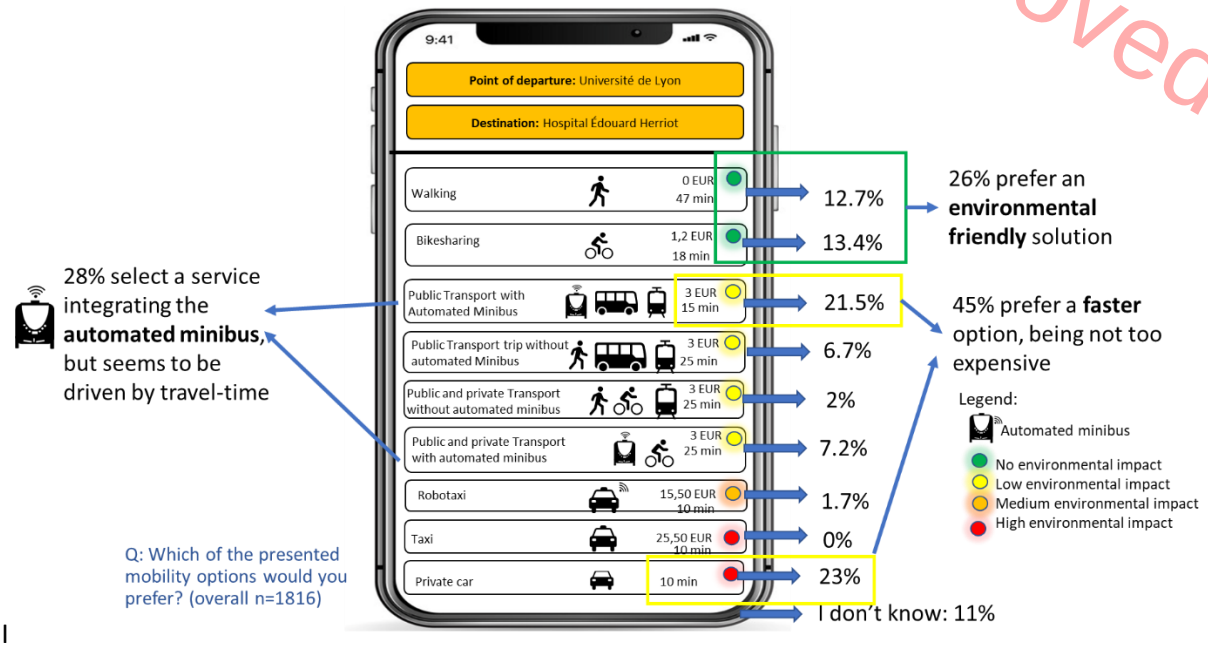


Figure 5.12 Preference for mobility options

When explicitly asked which needs drove their preference the following can be seen: AMs can fulfil the need for flexibility in a similar way to one's own car, as the first three columns show, but AM is cheaper and more environmentally friendly than the own car – see the two middle columns. And the columns on the right show that the need to move faster and more comfortably is better met by AM than by walking / cycling. Hence, an option that includes AM has the potential to replace one's own car, but also to increase the use of public transport (Table 5.6)

Table 5.6 Needs driving the preference for different transportation modes

	Flexibility departure times	Flexibility locations to start trip	Accessi-bility	Environ-mental friend-liness	Price	Speed/ travel time	Comfort	Private atmosphere
Walking+biking (n=488)	83%	73%	79%	75%	78%	63%	53%	56%
AM (n=521)	88%	84%	84%	74%	70%	78%	72%	45%
Car (n=417)	85,9%	80,0%	85%	30,8%	48,3%	82,9%	80%	73,4%

5.4 Advantages and concerns

Important questions in the survey are the question related to perceived advantages (Figure 5.13) and perceived concerns regarding the use of automated minibus. A general impression is that the respondents have a positive perception on the benefits of automated minibuses. About two thirds expect the automated minibuses to ("agree" or "fully agree") provide enhanced freedom for people with reduced mobility (64%), will increase flexibility by an increase of locations to start and stop (64%), increase flexibility by an increase of frequency of public transport offers (63%) and also be used as a transport offer for routes that are less popular (59%) or may be successfully integrated in the public transport (57%) and be booked on demand in the future (52%).

A high level of willingness to use thus is linked to the condition that the automated minibuses really offer this greater flexibility. As shown in the above chapter the willingness to integrate the automated minibuses into one's mobility behaviour and to reduce or give up use of one's own car is strongly dependant on how far it will offer the same flexibility as one's own car. A customer centred service of automated minibuses therefore has primarily to offer a higher level of flexibility than current public transport offers do.

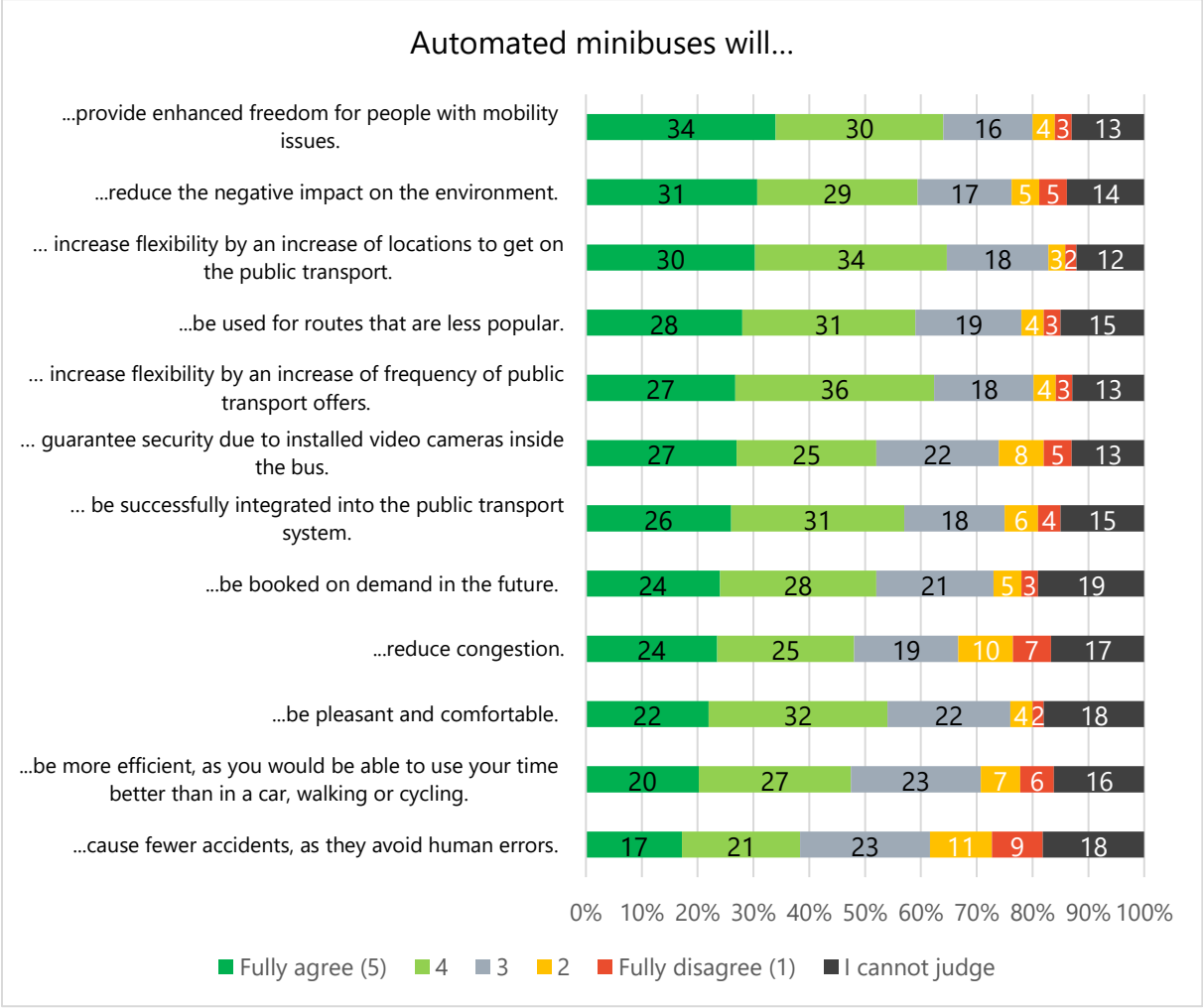


Figure 5.13 Perceived advantages of automated minibuses

Additionally, a positive impact on environment is expected: reduce the negative impact on environment (60%) and reduce congestion (49%). Also, a pleasant and comfortable journey (54%) with guaranteed security due to installed video cameras inside the buses expected (52%) by every second respondent. More cautious are the positive expectations regarding the question if the automated minibus will really cause fewer accidents by avoiding human errors.

On the perceived concerns we see a slightly more differentiated picture. Respondents show a high agreement with concerns regarding the functioning of the automated minibus (this includes the interaction with motorized (49%) and non-motorized traffic (46%), its reaction to unforeseen situations (54%) and issues of liability in the case of an accident (44%).

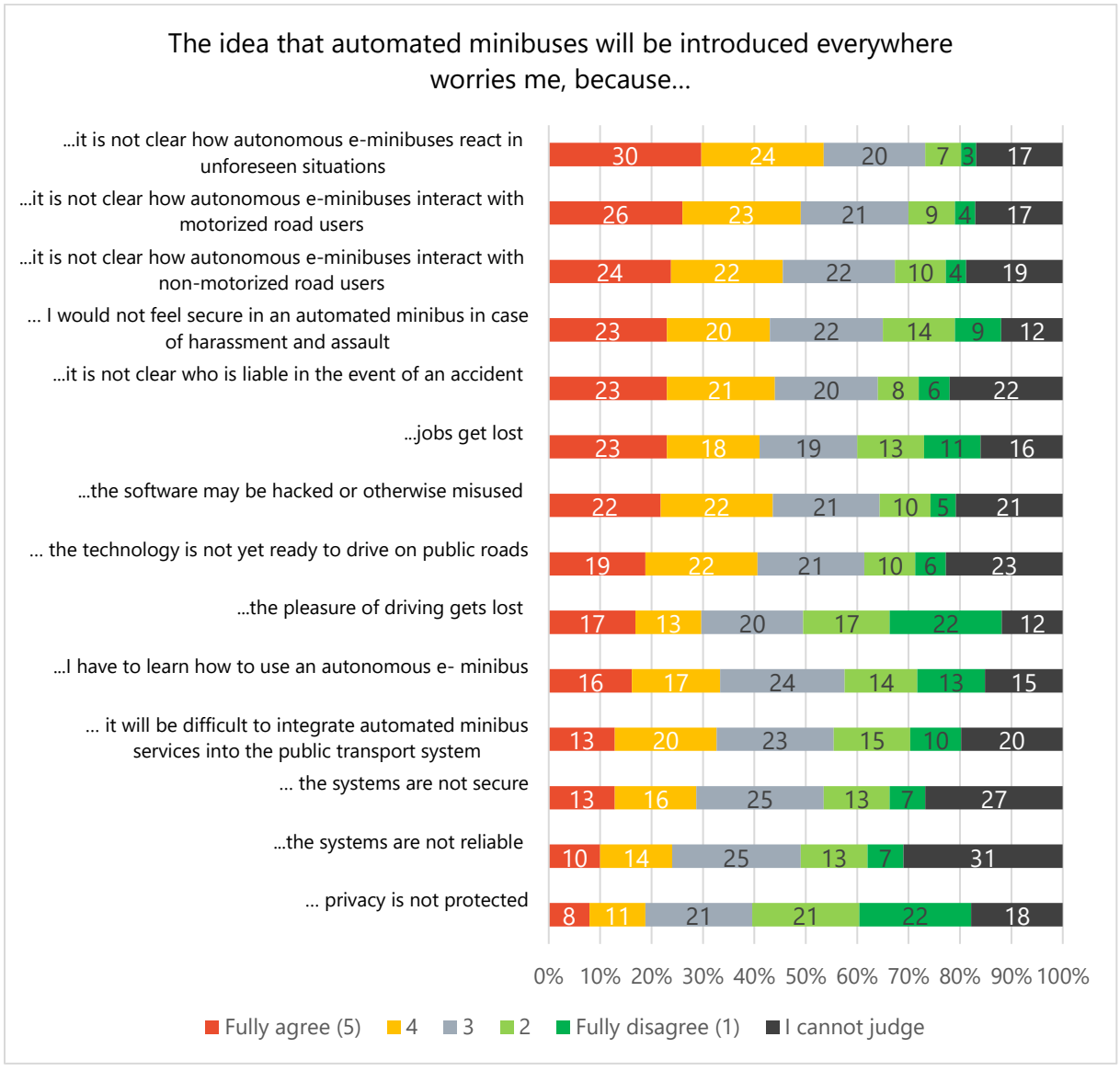


Figure 5.14 Perceived concerns over automated minibuses (in %; overall n=1816)

Respondents are also concerned that the software may be hacked. 44 % agree, that this could happen, 43% would not feel secure in case of harassment and assault and 41% also fear that the technology may not be ready to drive. Also 41% fear that jobs may get lost. Nevertheless, there seems to be a general trust in "the system". Only a small part of the respondents fears that the system may not be secure (29%) or is not reliable (24%).

As many respondents still think it is unclear how the automated minibuses react in critical situations, thus, for the majority the presence of a safety driver is still important. Additionally, expected services are an app to organize the journey and in-vehicle information (also see chapter 4 "Expectations towards cognitive relief").

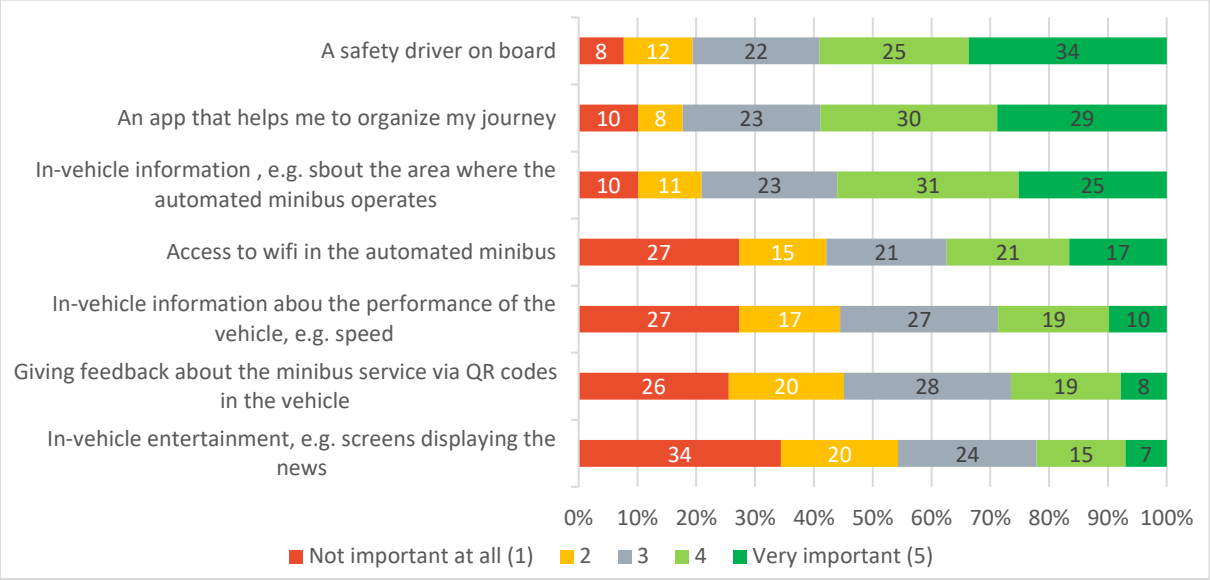


Figure 5.15 Importance of services in using the automated minibus (in %; overall n=1816)

5.5 Conclusions

Although, a slim majority already knows about the automated minibuses and pilots in their cities, only few citizens are already experienced with them. The willingness to use is generally high. Regardless of different scenario (AM service as part of a seamless, intermodal trip, AM offering a service that bridges the first and last mile or AM offering an on-demand, door to door service), more than 50 percent "would be willing" or even be "very willing" to use AM, even more if an on-demand service is offered.

Competing with other forms of mobility (using own car, using traditional public transport, biking etc.), options varying in terms of flexibility and duration, costs and environmental friendliness about every fourth choose a service that integrates the automated minibus.

Positive expectations towards an enhanced freedom for people with reduced mobility but also enhanced flexibility for all citizens or potential users by an increase of locations to start and stop and by an increase of frequency of public transport offers, an offer for routes that are less popular, a successful integration in the public transport and the option to book on demand are the main drivers for willingness to use in the future.

As long as it is not really clear for many of the citizens how the automated minibuses may interact with other motorized or non-motorized traffic members a supervisor is still expected to be very important.

6 Target Groups

This chapter will focus on specific target groups for the use of automated minibuses and consist of five parts. In the first part, the results of the large-scale, representative survey 2021 are used to analyse market segments of citizens. Hereafter, section 6.2, focusses on the target group of people with reduced mobility. Section 6.3 analyses differences between people living in urban and rural areas. Section 6.4 draws conclusions on the different target groups assessed in this chapter.

6.1 Market segments

In this section, we will present the target groups of potential users that are distinguished based on the analysis of the representative survey, conducted in the four AVENUE cities in 2021. In defining target groups, a two-step approach was applied as detailed in the methodology section (see section 2.2.2). The items measuring attitudes towards the automated minibus (see also chapter 5) were compressed by a factor analysis Two factors were identified (see Table 6.1). The first factor correlates to statements that address positive effects of the automated minibuses. The second factor correlates to the statements that address perceived risks of the automated minibuses.

6.1.1 Factor analysis

A factor analysis, with the variables for the expected advantages and disadvantages of the autonomous electric minibuses, was carried out to compress the data and identify correlations in the data. An item battery of 26variables was used to ask for these advantages and disadvantages (questions 24 & 25 of the appendix). The Scale leads from (1) meaning “Fully disagree” to (5) meaning “Fully agree”. The additional scale point (6) “I cannot judge” was set on missing for the factor analysis. At first a missing ration was calculated for every case concerning the 26 relevant variables. All cases which showed a missing ration above 0.29 were excluded from the factor analysis. This preparation was fundamental to guarantee high quality for the cases.

In total 1400 cases were included in the analysis. Missing values of these cases were replaced by mean imputation. In total 22 items were included in the analysis. Four variables were excluded from the analysis due to inadequate interpretability.

The principal component method (PCA) was used to extract the factors. The Kaiser-Meyer-Olkin measure of sampling adequacy was, 0.950 representing a relatively good factor analysis (meritorious following Kaiser 1990). The Bartlett´s test of Sphericity was significant (Chi-Quadrat (231) = 12285.458 $p < .001$) indicating that correlations between items were sufficiently large for performing a PCA (Tabachnick and Fidell 2014; Cleff 2015).

Two factors are extracted to explain the expected advantages and disadvantages of the automated minibuses, see Table 6.1 **Items and factor loading**

The VARIMAX method is used to rotate the factors and yield orthogonal, interpretable factors. The decision for two factors is based on contextual interpretability and the Eigenvalues. The factors can explain 54.28 percent of the total variance. All factor loadings are higher than 0.6, indicating high construct validity (Field 2013).

Table 6.1 Items and factor loading

Rotated component matrix		
	Component	
	Benefits	Risks
… provide enhanced freedom for people with mobility issues	0.717	-0.038
… reduce the negative impact on the environment	0.691	-0.127
… reduce congestion	0.745	-0.095
… be used for routes that are less popular	0.636	-0.009
… be booked on demand in the future	0.670	-0.064
… cause fewer accidents, as they avoid human errors	0.677	-0.222
… be more efficient, as you would be able to use your time better than in a car, walking or cycling	0.736	-0.097
… be pleasant and comfortable	0.740	-0.061
… Guarantee security due to installed video cameras inside the bus	0.672	-0.065
… be successfully integrated into the public transport system	0.790	-0.133
… increase flexibility by an increase of locations to get on the public transport	0.773	-0.093
… increase flexibility by an increase of frequency of public transport offers	0.792	-0.097
… it is not clear who is liable in the event of an accident	-0.052	0.710
… it is not clear how automated minibuses interact with motorized road users	-0.068	0.823
… it is not clear how automated minibuses interact with non-motorized road users	-0.038	0.807
… the systems are not reliable	-0.211	0.739
… the software may be hacked or otherwise misused	-0.036	0.661
… it is not clear how automated minibuses react in unforeseen situations	-0.057	0.804
… I would not feel secure in an automated minibus in case of harassment and assault	-0.014	0.638
… The technology is not yet ready to drive on public roads	-0.128	0.746
… The systems are not secure	-0.116	0.778
… it will be difficult to integrate automated minibus services into the public transport system	-0.205	0.631

As a next step, a check was made whether factor values or the mean values can be calculated for the factors. For this purpose, a reliability analysis is performed for each group of variables of the corresponding factor, whereby the Cronbach α is calculated in each case. This indicates how well the variables measure the same, i.e. whether the factor value variables can be formed or not. For both factors Cronbach's Alpha was higher than 0.9, which is very good.

6.1.2 Cluster analysis

As a next step, the factor values were calculated, saved as new variables and used to carry out a hierarchical cluster analysis in order to identify different target groups. The squared Euclidean distance was set as distance measure and the ward method as a fusion algorithm. Furthermore, a z-standardization

was made. To find the right number of clusters, the agglomeration schedule and the dendrogram were examined indicating for a 5 cluster-solution. Nevertheless, cluster-solutions 3 to 6 were saved in order to conduct several one-way analyses of variance. The analysis of variance is a useful tool to find differences between groups and thus helps to interpret the clusters. The independent variable is the respective Cluster-solution (from 3 to 7), the dependent variables are the calculated factor values. A comparison of the factor mean values between the clusters and their attitude on the perceived advantages and disadvantages of automated minibuses is now possible. The best interpretable result was found in the 5-cluster solution. The factor mean values of benefits differed statistically significant for the different clusters. All clusters differed from each other. The factor mean values of concerns also differed statistically significant for the different clusters. All clusters differed from each other, except of Sceptical goodwill to Unconvinced refusers. According to the degree of accordance/approval and rejection to the perceived advantages and disadvantages of automated minibuses the clusters were named.

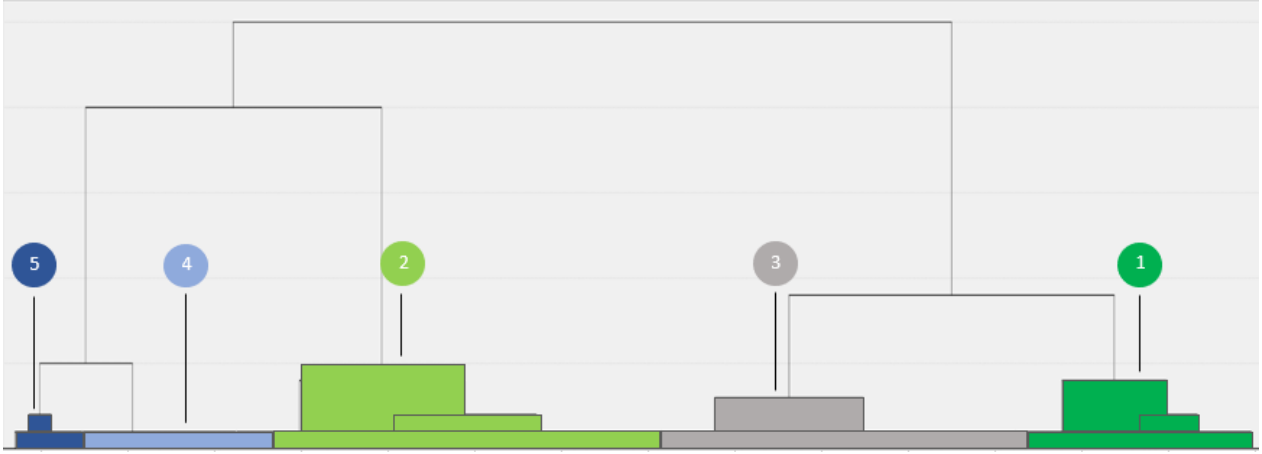


Figure 6.1 Dendogram

(1= Unserved Goodwill; 2= Sceptical goodwill; 3= Undecided; 4= Critical reserved; 5= Unconvinced refusers)

6.1.3 The market segments

As a result of the factor and cluster analysis, five market segments of potential users can be discerned (Figure 6.2). The identified clusters significantly differ on the two factors measuring expected benefits and concerns (Figure 6.2 and Table 6.2)

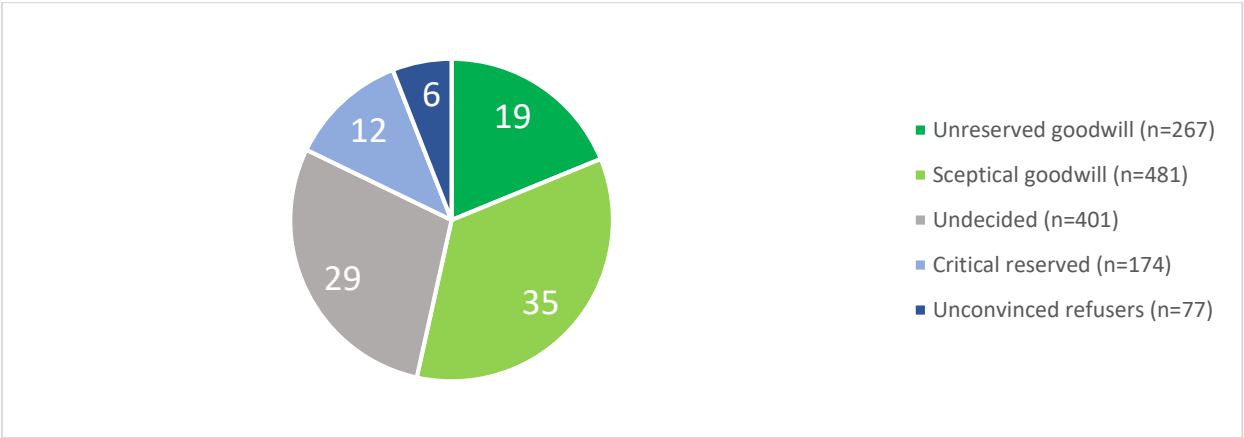


Figure 6.2 Market segments, % (n=1400).

- The unreserved goodwill (19%) values the advantages highly (mean value of 4.2) and concerns are rated below average (mean: 2.19)
- The sceptical goodwill (35%) value the advantages highly (mean: 4.27), but also see the concerns (mean: 3.92), most notably a high agreement on concerns related to the unclarity of the AM's reaction to unforeseen situations (4.4), accidents (4.1), motorized (4.3) and non-motorized road users (4.2).
- The undecided (29%) only slightly agree or tend to give medium answers with both the benefits (3.46) and the concerns (3.14), but are overall undecided.
- The critical reserved (12%) also only slightly agree with the l benefits of the AM (mean: 3.13), but agree more strongly with the concerns (mean: 4.2). This means that their reservations are dominating. Comparable to the sceptical goodwill they show a high agreement with concerns related to the unclarity of the AM's reaction to unforeseen situations (4.7), accidents (4.4), motorized and non-motorized road users (4.5).
- The unconvinced refusers (6%) do not at all see the benefits of the automated minibuses (mean value 1.87), but show a high agreement with the concerns (means value of 4.2). Comparable to the sceptical goodwill and the critical reserved they show a high agreement with concerns related to the unclarity of the AM's reaction to unforeseen situations (4.6), accidents (4.3), motorized (4.5) and non-motorized road users (4.3).

Table 6.2 Cluster description

		Unreserved goodwill	**Sceptical goodwill**	**Undecided**	**Critical reserved**	**Unconvinced refusers**	**Overall**
		n=267	n=481	n=401	n=174	n=77	n=1400[2]
		19%	35%	29%	12%	6%	100%
Benefits[*1]	Mean value[1]	4.22	4.27	3.46	3.13	1.87	3.78
	Factor value	0.43	0.75	-0.44	-0.68	-2.39	
Concerns[*2]	Mean value[1]	2.19	3.92	3.14	4.29	4.20	3.47
	Factor Value	-1.42	0.67	-0.39	0.96	0.61	

[1]Mean values on factor variables (higher values mean higher consent, where 1= lowest, 5=highest)

[2] Missing respondents: 1400 respondent at of the total of 1816 respondents were included in the cluster analysis. The remaining 418 respondents (22,9% of the sample) was not included in the cluster analysis. These respondents were excluded as they answered >30% of the items with 'I cannot judge'

[*1] Factor values of benefits differed statistically significant for the different clusters, $F(4, 379) = 642.497$, $p < .001$,

[*2] Factor values of Concerns differed statistically significant for the different clusters, $F(4, 372) = 775.340$, $p < .001$

All groups were different from each other except of Sceptical goodwill to Unconvinced refusers

In general attitudes towards the automated minibuses are not correlated to gender or age. But there is a smaller tendency that female seem to be more frequently represented among the groups that weigh more differentiated both benefits and concerns, hence, the sceptical goodwill and the critical reserved. The male respondents are over-represented in the groups that take a clearer position; unreserved goodwill and

unconvinced refusers (Table 6.3). Younger citizens up to 26 years seem to be more undecided in their opinions, with an overrepresentation in the group of undecided. The older respondents (66 years and older) tend to show higher goodwill, with an overrepresentation in the groups of unreserved goodwill and sceptical goodwill. There are differences between the cities. The respondents from Luxembourg are overrepresented in the groups of critical reserved and unconvinced refusers. The respondents from Copenhagen are overrepresented in the group of unreserved goodwill and underrepresented in the group of unconvinced refusers.

Table 6.3 Description of clusters: demographics

		Unreserved goodwill	**Sceptical goodwill**	**Undecided**	**Critical reserved**	**Unconvinced refusers**	**Overall**
		n=267	n=481	n=401	n=174	n=77	N=1816
Gender	Female	46%	**53%**	48%	**56%**	39%	53%
	Male	**54%**	46%	52%	44%	**61%**	47%
	Other	0%	0%	0%	0%	0%	0%
Age[*1]	16-25 years old	5%	5%	**14%**	7%	7%	8%
	26-35 years old	17%	15%	21%	26%	12%	17%
	36-45 years old	22%	19%	22%	20%	16%	19%
	46-55 years old	21%	21%	18%	19%	33%	20%
	56-65 years old	18%	22%	15%	18%	23%	19%
	66-75 years old	**15%**	**16%**	8%	9%	9%	13%
	76 years and older	4%	3%	3%	1%	1%	4%
City[*2]	Copenhagen	**27%**	22%	28%	22%	17%	24%
	Geneva	18%	18%	19%	15%	8%	17%
	Luxembourg	28%	23%	28%	**40%**	**60%**	30%
	Lyon	28%	38%	25%	23%	16%	29%

No Statistical dependence between clusters and gender, weak tendency, p< .92

[*1] Statistical dependence between clusters and age, (Chi-Square(24) = 76.163, $p < .001$)

[*2] Statistical dependence between clusters and age, (Chi-Square(12) = 70.050, $p < .001$)

Knowledge of the AM prior to answering the survey, varies between the clusters. There seems to be a positive correlation between knowledge and clear opinion: Clusters with strong positive attitudes as unreserved goodwill have heard more probably about AM (69%) than in the overall sample (57%). The same is observed for clusters with strong negative attitudes as the unconvinced refusers (68% had heard about). Actual experiences seem to be positively correlated with positive attitudes: The group of unreserved goodwill is slightly more probably already experienced (18%) than the overall sample (15%). On the other hand, if experiences are underrepresented, attitudes also tend to be more negative: Among critical reserved only 8% and among unconvinced refusers only 12% are already experienced.

The analysis shows that there is also a positive correlation between source of information and positive attitudes. The unreserved goodwill and sceptical goodwill more probably collected relevant information about AM via internet or social media. However, at this stage, it cannot be assessed whether content in social media differs (more positive or negative) compared to other media or whether open-minded citizens use internet more. This is consistent with Zmud and Sener (2017) who found that individuals with a higher intent to use automated vehicles were the ones using Smartphones, text-messaging, Facebook, and transportation apps, and with Lavieri et al. (2017) who found that tech-savvy individuals are likely to be early adopters of automated vehicles.

Table 6.4 Source of information*: 2021

		Unreserved goodwill	Sceptical goodwill	Undecided	Critical reserved	Unconvinced refusers	Overall
		n=183	n=250	n=220	n=98	n=52	N=1003[1]
Newspaper		40%	37%	36%	37%	42%	37%
Radio / TV*1		49%	56%	44%	42%	56%	50%
Internet		38%	37%	31%	34%	29%	33%
Social media		20%	21%	14%	10%	15%	15%
Seen on test-site*2		29%	20%	21%	13%	23%	22%
Friends		15%	13%	14%	7%	12%	13%

Q11.1.1: What was the source of information?

* answer-options lower than 20% are not shown

* More than one answering option was allowed in this question

[1] This question was only asked to those respondents that indicated to have heard about AM prior to participating in the survey

No Statistical dependence between clusters and Newspaper as source of information

*1 Statistical dependence between clusters and radio/TV as source of information, (Chi-Square(4) = 10.369, *p*=.035)

No Statistical dependence between clusters and internet as source of information

No Statistical dependence between clusters and social media as source of information, , weak tendency, *p*=.072

*2 Statistical dependence between clusters and seen on test-site as source of information, (Chi-Square(4) = 10.009, *p*=.040)

No Statistical dependence between clusters and friends as source of information

Cross cluster, the car (45%) is the most preferred transport option, followed by public transportation services as bus, train, metro or tram (22%), see also chapter 3. The five market segments do not differ strongly in their current use of transport systems but there are minor differences. Daily car use is lower among the groups of unreserved goodwill (43%), sceptical goodwill (46%) and undecided (44%), while it is higher among the critical reserved (51%) and unconvinced refusers (60%). Frequent car users are thus more sceptical towards the use of the automated minibuses and are less ready to give up their own car. This outcome confirms earlier research of Dittmar (Dittmar 2011) and Salonen and Haavisto (Salonen and Haavisto 2019) that claim that cars are used to express one's social position in addition to being an entity providing functional benefits. However, an alternative explanation could be that these groups cannot see any convincing benefits in AM; they do not believe that AM could increase flexibility nor be an improvement of public transport systems. In contrast, the groups of unreserved goodwill and sceptical goodwill use public transport more frequently (27%; 25%). It seems to be characteristic for the undecided that they feel torn between car (daily use 44%) and public transport (daily use also high with 23%).

Important criteria for selecting preferred means of transport are 'Speed and travel time' (59% rank this item first, second or third), 'punctuality' (46%) 'accessibility' (39%) and 'price performance (38%). These mobility needs are mostly consistent across the clusters with some differences:

- Comfort, punctuality and private atmosphere are more important for the unconvinced refusers and the critical reserved compared to the other groups. Obviously, they do not believe that the AM could meet these needs as good as the car does. In addition, environmental friendliness is of lesser importance to these groups.
- Speed and travel time are more important for the sceptical goodwill, compared to the other groups, whereas private atmosphere is of lesser importance to this group. Obviously, the group of sceptical goodwill see a potential that AM may be more time efficient but are not yet convinced.

There is no clear support for a need for the presence of a safety operator in the bus; this is very important for 34% of the respondents, whereas 8% report that this is not important at all (and 12% not important) to them. However, for the group of critical reserved, a majority of 54% state that the presence of safety operators is very important, for the unconvinced refusers as well as for the sceptical goodwill, 42% think that a safety operator on board is very important. whereas this only accounts for 18% of the unreserved goodwill and the undecided.

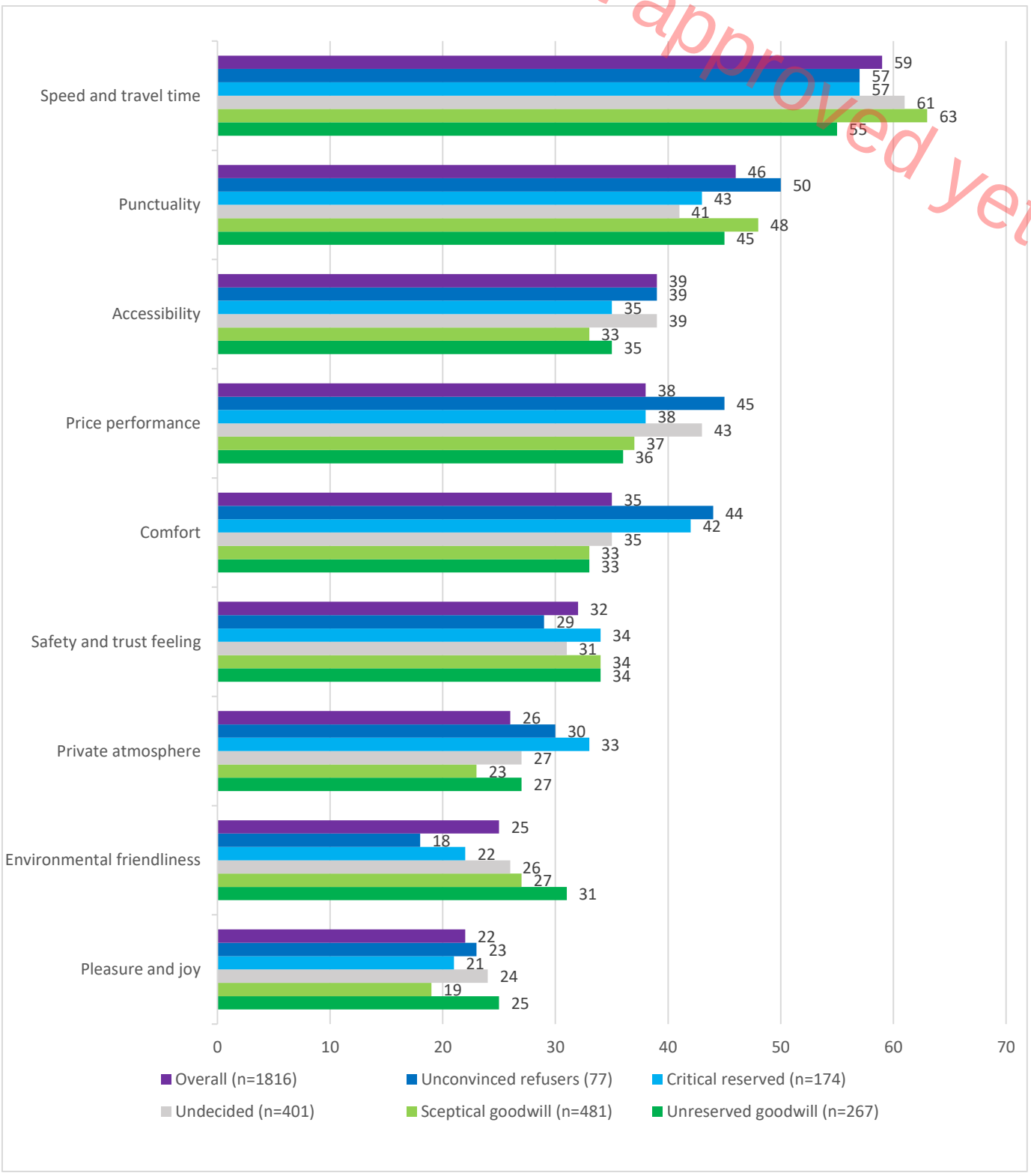


Figure 6.3 Importance of factors for selecting preferred mode of transport, divided by the market segments (in %)

The more potential users see a need for improvement in public transport services the less they are willing to believe that AM may be a convincing solution for the future (Figure 6.4 and Figure 6.5). This shows that a negative image transfer from traditional public transport systems may lead to a stronger reservation against AM.:

- Accessibility; overall 40%, but 44% for sceptical goodwill & only 32% for unreserved goodwill.
- Price performance: overall 50%, but only 38% of the unconvinced refusers, and 43% of the critical reserved
- Safety and trust feeling: overall 37%, but; major differences between the groups. Undecided 30%, sceptical goodwill 45%, unreserved goodwill 34%, unconvinced refusers 47% and critical reserved 45%.
- Speed and travel time: overall 46%, but more often named by unreserved goodwill (51%) unconvinced refusers (52%) and critical reserved (54%).
- Environmental friendliness: overall 37%, but more often named by sceptical goodwill (42%) and unreserved goodwill (43%), whereas of the unconvinced refusers only 23% think that this should be improved

Figure 6.4 Aspects of public transport that should be improved, shown are % of respondents that indicate that an item should be improved (in %)_part 1

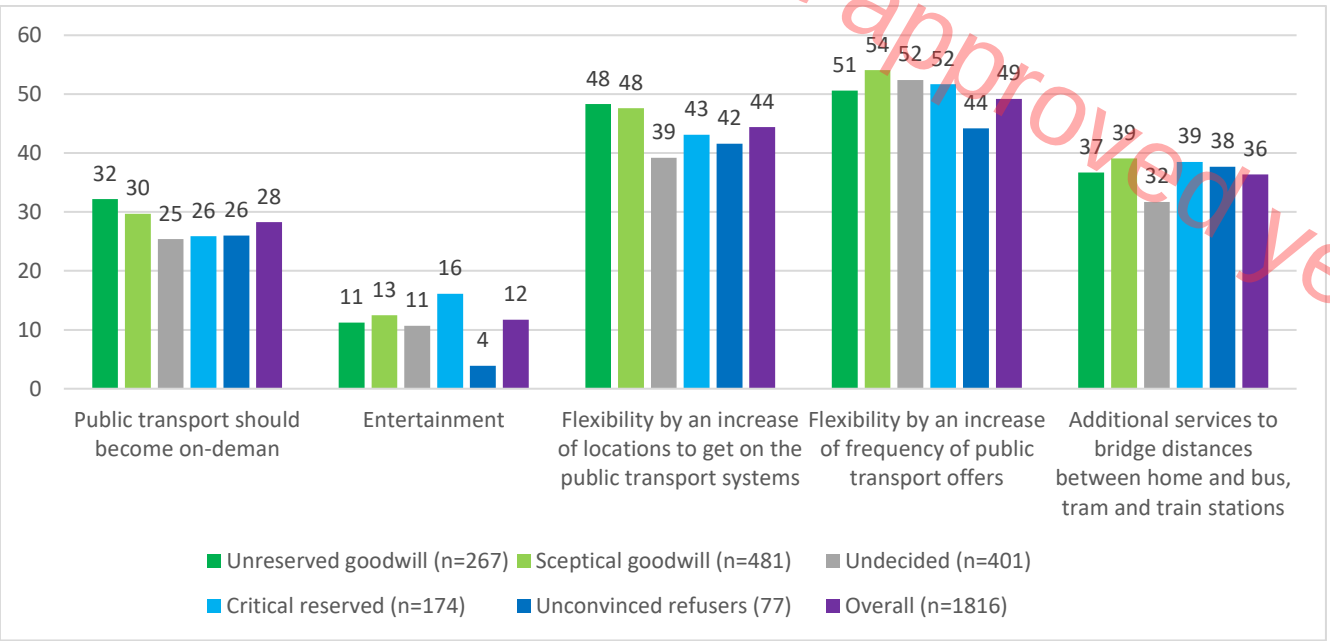


Figure 6.5Aspects of public transport that should be improved, shown are % of respondents that indicate that an item should be improved (in %)_part 2

These differences are also visible in the general satisfaction of the groups on the public transportation offer in their area (see Figure 6.6). The group of unconvinced refusers are least satisfied about the public transportation offer (only 39% is satisfied or very satisfied) and traffic situation in around their city (only 16% is satisfied or very satisfied).

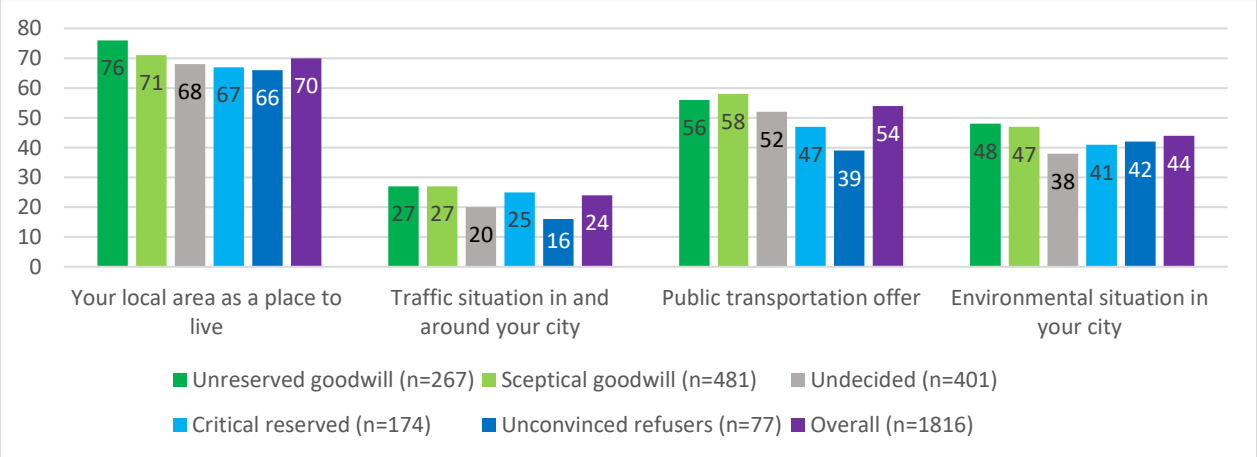
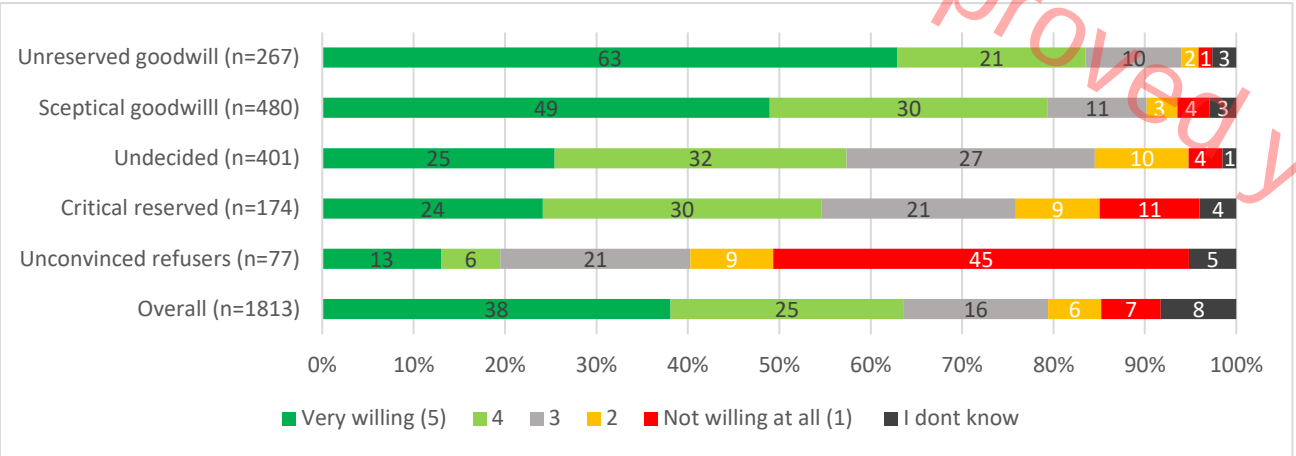


Figure 6.6 Satisfaction with life qualities. Shown are the percentages of groups that are satisfied or very satisfied (topbox 4&5). N=1812

A look on the willingness to use the AM if the service will be on-demand, door-to-door, shows that the clusters clearly explain different levels of willingness. The level of willingness is highest among unreserved goodwill, followed by sceptical goodwill, significantly lower among the undecided and critical reserved and lowest among unconvinced refusers.

6.1.4 Willingness to use the automated minibuses.



Q18.1: How willing would you be to use the automated minibus, if the automated minibus… Please tell us on a scale from 1 to 5, where 1 means not willing at all and 5 means very willing. With the other points on the scale you can grade your answer.

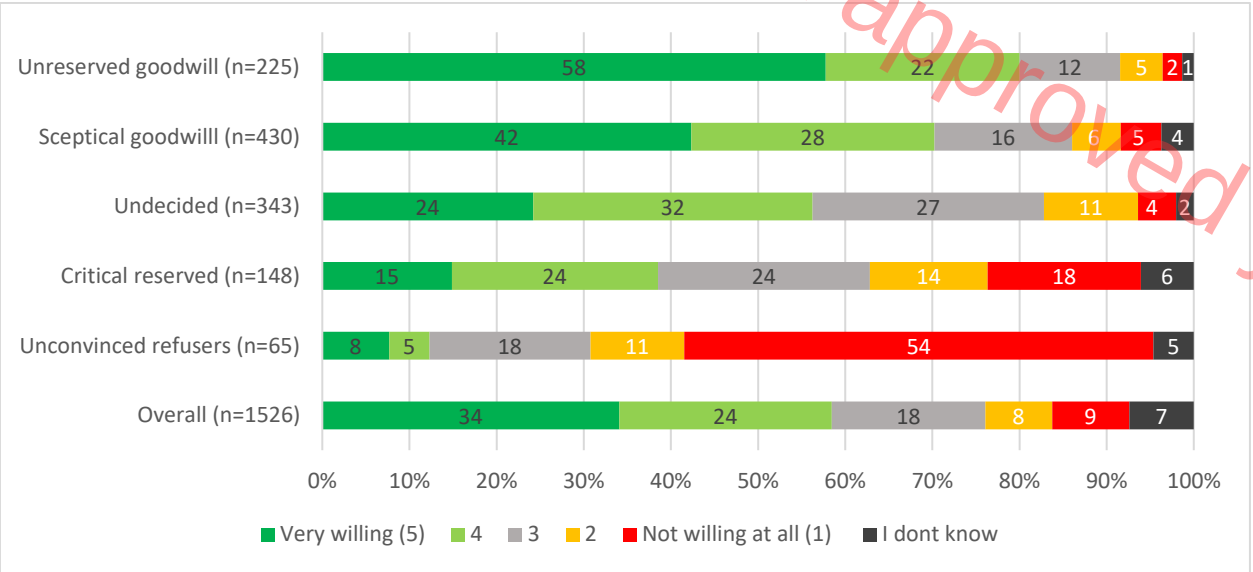
Figure 6.7 Willingness to use the automated minibus if the automated minibus offers an on-demand, door-to-door service 2021

Table 6.5 willingnesss to use the automated minibus if the automated minibus offers an n-demand, door-to-door service (means)

	Unreserved goodwill (n=260)	Sceptical goodwill (n=466)	Undecided (n=395)	Critical reserved (n=167)	Unconvinced refusers (n=73)	Overall (n=xxx)
Mean value*[1]	4.5	4.2	3.7	3.5	2.3	xxx

*[1] Willingness to use the automated minibus if the automated minibus offers an on-demand, door-to-door service differed statistically significant for the different clusters, $F(4, 355) = 63.094$, $p < .001$,
All groups were different from each other except of Undecided to Critical reserved, , only weak tendency, $p < .058$

For a successful implementation of AM, it is important potential users are willing to reduce or give up the use of their car. Under the condition of an on-demand service, 34% are very willing and 52% are at least willing (very willing plus willing to reduce the use of their car. Here, the clusters even show stronger differences as indicated in Figure 6.8 and Figure 6.9. As expected, a majority of 59% of the unreserved goodwill are very willing to reduce the use of their car. Among the sceptical goodwill still 42% are very willing to do so. Among the undecided and critical reserved only a minority is very willing (23% and 16%) but still 55% (undecided) and 37% (critical reserved) are at least willing to do so. Among the unconvinced refusers, a majority refuses the use (Figure 6.8and Table 6.6).



Q19.1: How willing would you be to reduce the use of your own car, if the automated minibus… Please tell us on a scale from 1 to 5, where 1 means not willing at all and 5 means very willing. With the other points on the scale you can grade your answer.

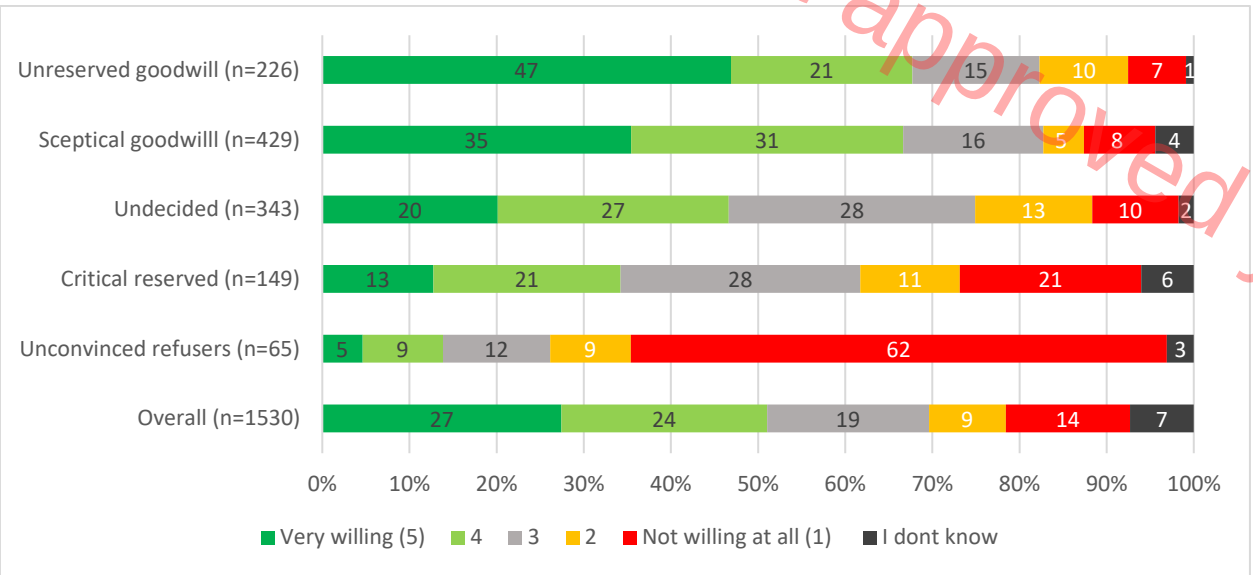
Figure 6.8Willingness to reduce the use of own car if the automated minibus offers an on-demand, door-to-door service 2021

Table 6.6 Willingness to reduce the use of own car, if the automated minibus offers an on-demand, door-to-door service (means)

	Unreserved goodwill (n=222)	Sceptical goodwill (n=414)	Undecided (n=336)	Critical reserved (n=139)	Unconvinced refusers (n=62)	Overall (n=xxx)
Mean value*[1]	4.3	4.0	3.6	3.1	2.0	xxx

*[1] Willingness to reduce the use of own car if the automated minibus offers an on-demand, door-to-door service differed statistically significant for the different clusters, $F(4, 303) = 60.717$, $p < .001$,
All groups were different from each other

Follow-up questions on whether respondents are willing to give up the use of their car, under the condition of an on-demand service, and willingness to increase the use of public transport rendered similar results (Figure 6.9, Table 6.7, Table 6.8 and Figure 6.10).



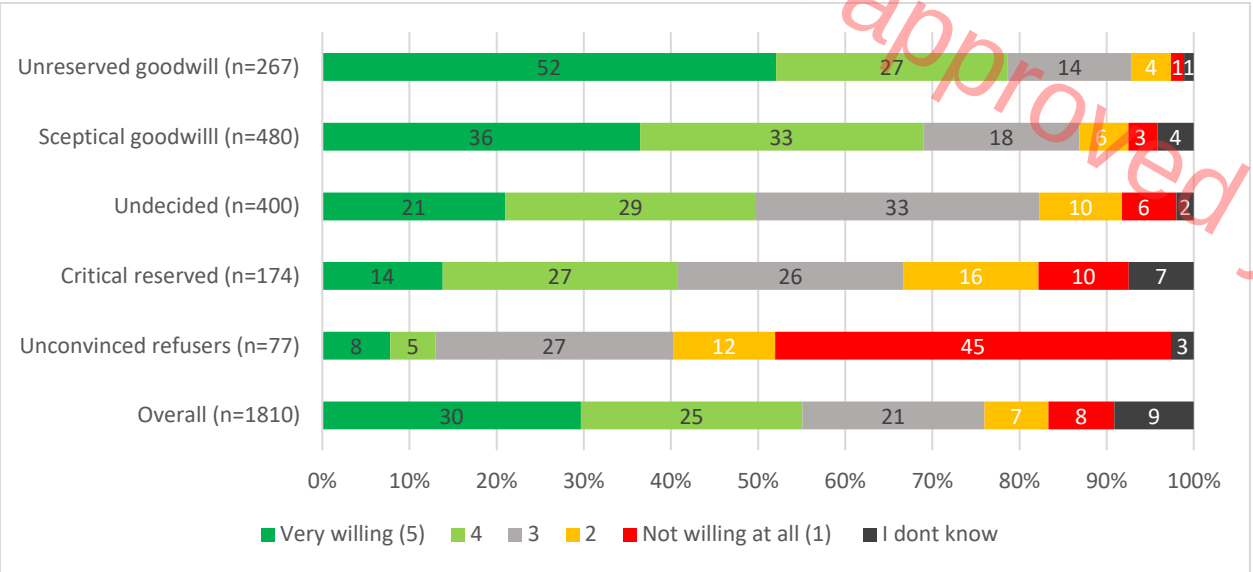
Q20.1: How willing would you be to give up the use of your own car, if the automated minibus… Please tell us on a scale from 1 to 5, where 1 means not willing at all and 5 means very willing. With the other points on the scale you can grade your answer.

Figure 6.9 Willing to give up use of own car if the automated minibus offers an on-demand, door-to-door service 2021

Table 6.7 Willing to give up use of own car if the automated minibus offers an on-demand, door-to-door service

	Unreserved goodwill (n=224)	Sceptical goodwill (n=410)	Undecided (n=337)	Critical reserved (n=140)	Unconvinced refusers (n=63)	Overall (n=xxx)
Mean value*[1]	3.9	3.9	3.3	2.9	1.8	xxx

*[1] Willing to give up use of own car if the automated minibus offers an on-demand, door-to-door service differed statistically significant for the different clusters, $F(4, 1169) = 51.054$, $p < .001$,
All groups were different from each other except of Unreserved goodwill to Sceptical goodwill



Q21.1: How willing would you be to increase the use of public transport systems in general (including current offers), if the automated minibus… Please tell us on a scale from 1 to 5, where 1 means not willing at all and 5 means very willing. With the other points on the scale you can grade your answer.

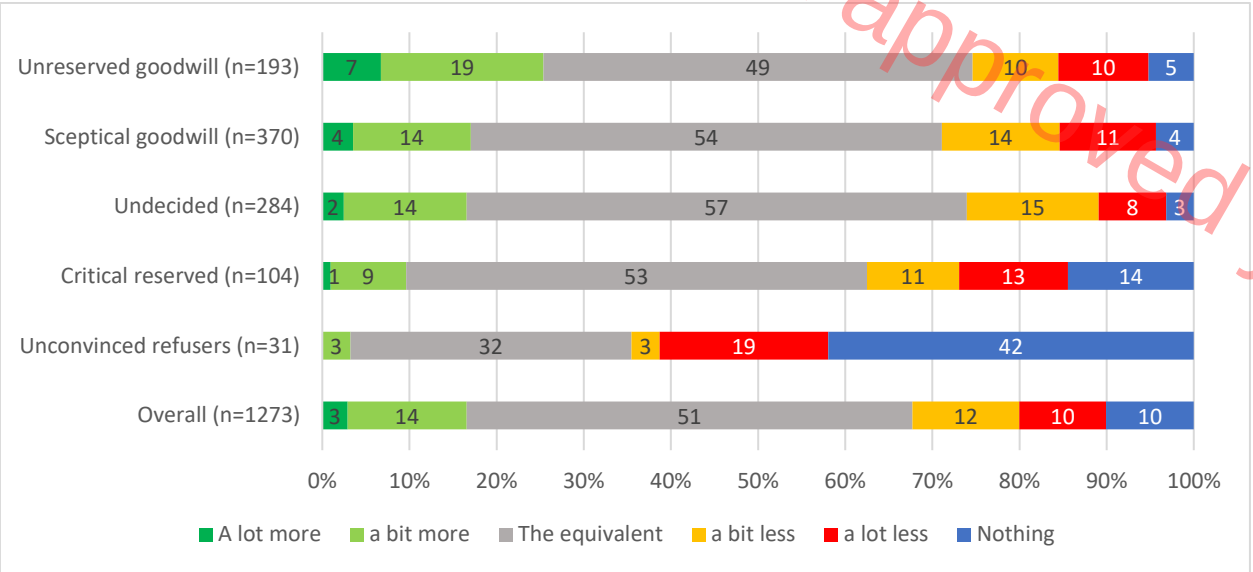
Figure 6.10 Willing to increase the use of public transport systems if the automated minibus offers an on-demand, door-to-door service 2021

Table 6.8 Willingness to increase the use public transport systems

	Unreserved goodwill (n=264)	Sceptical goodwill (n=460)	Undecided (n=392)	Critical reserved (n=161)	Unconvinced refusers (n=75)	Overall (n=xxx)
Mean value*[1]	4.3	4.0	3.5	3.2	2.2	xxx

*[1] Willingness to increase the use public transport systems differed statistically significant for the different clusters, $F(4, 363) = 63.596$, $p < .001$,
All groups were different from each other except of Undecided to Critical reserved

Lastly, we see that the willingness to pay a lot more is generally low. But among the unreserved goodwill every fourth (26%) can imagine to pay at least a bit more. Among the sceptical goodwill these are still 18%, followed by the undecided with 17%. These numbers are against lowest among the critical reserved and the unconvinced refusers. (see Figure 6.11 and Table 6.9). The unconvinced refusers again show that they see no advantages over the car that would justify paying anything.



Q22.1: What would you be willing to pay to use automated minibuses, compared to current, classic public transport?

Figure 6.11 Willingness to pay to use the automated minibus in general 2021

Table 6.9 Willingness to pay (means)

	Unreserved goodwill (n=193)	Sceptical goodwill (n=370)	Undecided (n=284)	Critical reserved (n=104)	Unconvinced refusers (n=31)	Overall (n=xxx)
Mean value*[1]	3.1	3.3	3.2	3.7	4.7	xxx

*[1] Willingness to pay statistically significant for the different clusters, $F(4, 172) = 10.876$, $p < .001$,
All groups were different from each other except of Undecided to Sceptical Goodwill and Unreserved goodwill, Sceptical goodwill to Unreserved goodwill

6.1.5 Overview of clusters

In order to provide a brief, compact insight into the various target groups, they are summarized again below.

SIZE: 19 %

Attitude towards the shuttles:

- **Very willing** to use the shuttles if on-demand service is offered
- **Very willing** to reduce / give up the use of the own car if on demand is offered
- **Very willing** to increase the use of public transport if on demand is offered
- 75% of the people are willing to pay the **equal or even more** for AM compared to classic public transport

See many Opportunities: (average factor benefits: 4.2)

- … provide enhanced freedom for people with mobility issues *(average 4.4)*
- ... be successfully integrated into the public transport system (average 4.4)
- ... increase flexibility by an increase of locations to get on the public transport (average 4.4)

Do not really see any risks: (average factor risks 2.2)

- … the software may be hacked or otherwise misused (average 2.5)

Current mobility behavior:

Use car and affinity to public transport

Punctuality, Speed & travel time are important aspects. Comfort is not as important as for the other cluster.

Demographics and information behaviour:

- More men(54%) than women (46%)
- 79% are 36 years and older
- Many people from Copenhagen (27%)
- Source of information: Radio/TV (49%) and more important than in other cluster: social media (20%)

Figure 6.12 Overview of the unreserved goodwill

Size: 35%

Attitude towards the shuttles:

- **Very willing** to use the shuttles if on-demand service is offered
- **Very willing** to reduce and **willing** to give up the use of the own car if on demand is offered
- **willing** to increase the use of public transport if on demand is offered
- 72% are willing to pay the **equal or even more** for AM

See many opportunities: (average factor benefits 4.3)

- … provide enhanced freedom for people with mobility issues (average 4.5)
- … reduce the negative impact on the environment (average 4.4)

See a lot of risks: (average factor risks 3.9)

- … it is not clear how automated minibuses react in unforeseen situations (average 4.4)
- … it is not clear how automated minibuses interact

Current mobility behaviour

Use car and affinity to public transport

Speed & travel time are the most important aspects. Private atmosphere is not important.

Demographics and information behaviour

- More women (53%) than men (46%)
- 80% are 36 years and older
- Many people from Lyon(38%)
- Source of information: Radio/TV (56%) and more important than in other clusters: social media (21%)

Figure 6.13 Overview of the sceptical goodwill

Size: 29%

Attitude towards the shuttles:

- in abeyance concerning decision finding
- **willing** to use the shuttles if on-demand service is offered
  willing to reduce/ give up the use of the own car if on demand is offered
- **willing** to increase the use of public transport if on demand is offered
- 73% are willing to pay **the equal or even more** for AM

See some opportunities: (average factor benefits 3.5)

- … provide enhanced freedom for people with mobility issues *(average 3.7)*
- … be used for routes that are less popular (average 3.6)

See some risks: (average factor risks 3.1)

- … it is not clear how automated minibuses react in unforeseen situations (average 3.4)
- … it is not clear how automated minibuses interact with motorized road users (average 3.3)

Current mobility behavior

Affinity to the car and to public transport

Punctuality, speed & travel time are important aspects, followed by price.

Demographics and information behaviour

- More men (52%) than women (48%)
- 35% are 35 years and younger
- Many people from Copenhagen (28%)
- Source of information: Radio/TV (44%) and less on Social media (14%)

Figure 6.14 Overview of the undecided

Size: 12%

Attitude towards the shuttles:

- **willing** to use the shuttles if on-demand service is offered
- **Partly willing** to reduce / give up the use of the own car if on demand is offered
- **Partly willing** to increase the use of public transport if on demand is offered
- 38% are only willing to **pay less** than for AM

See some opportunities: (average factor benefits 3.1)

- … be used for routes that are less popular (average 3.6)
- provide enhanced freedom for people with mobility issues *(average 3.5)*

See a lot of risks: (average factor risks 4.2)

- … it is not clear how automated minibuses react in unforeseen situations (average 4.7)
- … it is not clear how automated minibuses interact with motorized road users (average 4.6)

Current mobility behaviour

Use of car is clearly more important than public transport

Comfort, punctuality and private atmosphere are important, but not Environmental aspects

Demographics and information behaviour

- More women (56%) than men (44%)
- 32% are 35 years and younger
- Many people from Luxembourg (40%)
- Source of information: Radio/TV (42%) and less on Social media (10%)

Figure 6.15 Overview of the critical reserved

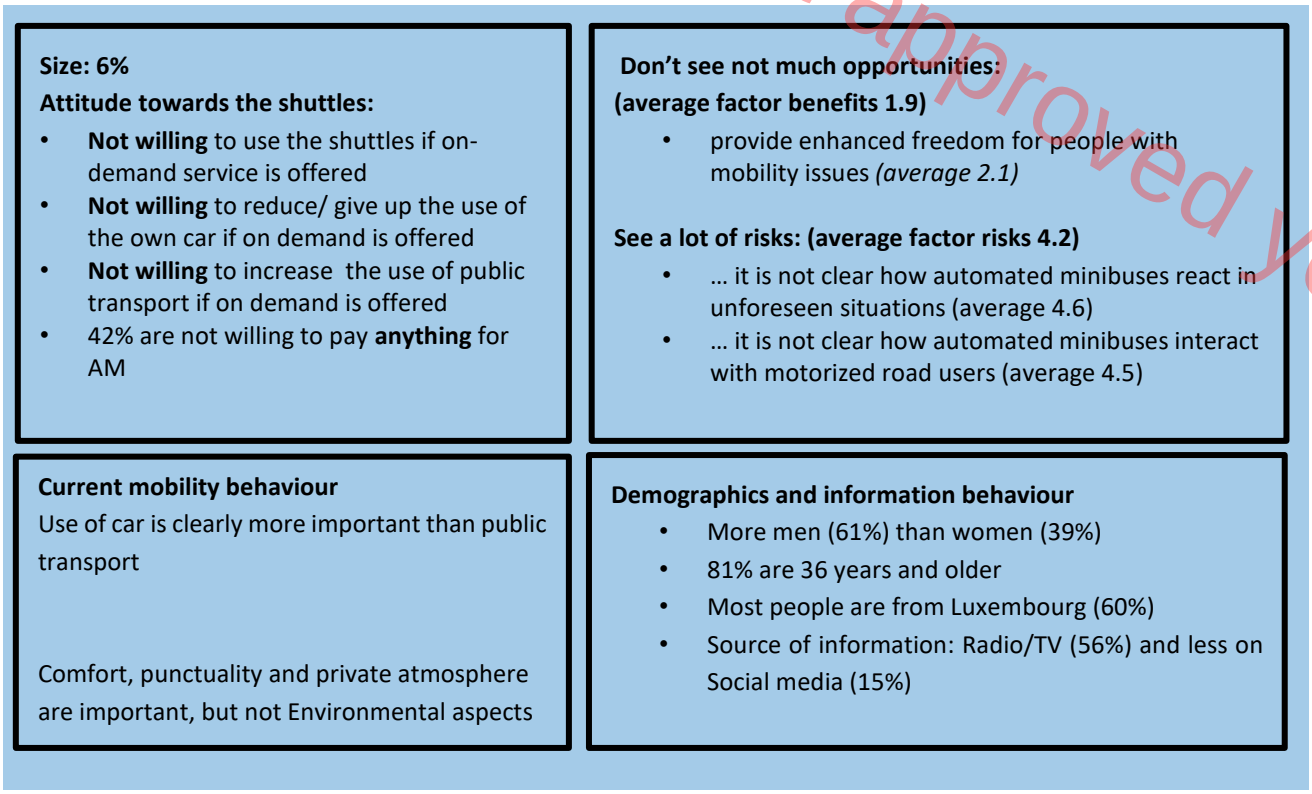


Figure 6.16 Overview of the unconvinced refusers

6.1.6 Conclusions market segments

The analysis shows that goodwill is dominating. About half of the citizens – unreserved or sceptical goodwill – show willingness to use the automated minibuses. About a third of the citizens is still undecided, but may be convinced by further communication and experience. Only a smaller part of about every fifth citizen feels reserved or is even explicitly refusing.

In the clusters unreserved goodwill and sceptical goodwill a majority is willing to use the AM if the service is on-demand door-to-door. On demand services may increase the attractiveness of car sharing services with automated (Piao et al. 2016; Merat et al. 2016). Important drivers to create acceptance are detailed knowledge about the AMs, even better, if this knowledge is taken from the social media. And direct experiences with the AMs in addition support the creation of acceptance.

Acceptance is not strongly correlated to demographic aspects as sex or age but with the area people are living. The clusters unreserved goodwill and sceptical goodwill clusters are overrepresented in Copenhagen and are underrepresented in Luxembourg. This could again be explained by the experiences people already have made with the current traffic situation or the traditional public transport offers. Satisfaction is already higher in Copenhagen and is lower in Luxembourg. Especially in Luxembourg, citizens are less satisfied with public transport in general. On the one hand, they may transfer this dissatisfaction to the automated minibuses. On the other hand, the automated minibuses achieved highest awareness in Luxembourg, but not only in a positive manner. There have been specific problems in

Luxembourg which may in addition have led to a lower acceptance of the automated minibuses (see chapter 5).

As there is a risk that negative experiences with traditional public transport systems may also reduce acceptance of the AM, a clear differentiation between the new system and current bus offers has to be communicated. The AMs should not be introduced just as a new bus offer but as a completely new service which combines the benefits of a car (high level of flexibility) with the advantages public transport offers in comparison to the own car: flexibility comparable to own car or bike, but increased cognitive and environmental relief as well as lower costs (see chapter 4 and 5).

Second, speed, travel time and punctuality are the most important drivers for preference of transport systems. It is therefore important that the automated minibus can compete with other means of transport regarding speed, travel time and punctuality. At the current state of technology, the automated minibus operates at low speed (between 8 – 15 km/h). This low speed results in low ratings by users (Nordhoff et al. 2018b). These results are confirmed by Kreuger and colleagues (Krueger et al. 2016) that define travel time and waiting time as critical determinant of the use and acceptance of automated minibus. These insights are also confirmed by safety operators, stating that people will only use the shuttle in case of bad weather, otherwise walking is faster. However, low speed can increase feelings of safety, positively impacting acceptance (Bekhor et al. 2003).

6.2 Persons with reduced mobility

Persons with reduced mobility (PRM) are highly dependent on public transport (PT) in all areas of life. The lack of accessibility, even in one component of the entire system, results in hindering the participation to education, social and working life. Depending on the type of disability, driving a car, taking an e-scooter or riding a bike is not possible, therefore public transport is the only means to travel without assistance from others e.g. from Home to Work. Accessible and frequent PT service is therefore an essential criterion for people with reduced mobility when choosing a place of residence: the availability of a higher frequency of PT connections in larger cities offers more flexibility compared to rural areas. When introducing automated vehicles to persons with disabilities, one of their first statements often is that this development can have positive effects on their way of life, with automated vehicles they no longer have to live in a city in order to have a good infrastructure. "*This opens up space for life in the countryside as well."* With regard to those statements the work situation of the majority of PRMs must also be considered, which is statistically worse than that of non-PRM and thus results in a lower, if at all, income (Eurostat 2020). Hence, the amount of financial resources available for rent are limited which, in many urban areas, results in nearly none to sparse affordable living quarters. Therefore, opening up rural areas through accessible AVS as potential place of residence to PRM would give them the equal choice where to live. A survey conducted for Deliverable *D2.4 First Passenger needs analysis and specification* with 58 persons concerning the acceptance of AVs confirms this assumption: Automated public transport will be accepted more easily with

increasing distance and decreasing frequency of public transport, while age seems not to play and important role.

6.2.1 Accessible services and accessibility of AM

It is expected that AM will provide the necessary frequency and that the vehicle will be able to stop even at location with low passenger frequency, thus better meeting the individual needs of users as public transport becomes more individual. This can lead to a significant improvement in the participation of people with disabilities, as it is another building block that enables them to be mobile and able to manage their daily lives without assistance from others. Especially for blind passengers AVs provide particular added benefit because they could ensure a higher degree of individual independence.

This is also emphasized in the report "Self-Driving Cars: Mapping Access to a Technology Revolution" of the National Council on Disability (NCD): "*Lack of personal independent mobility has resulted in the exclusion of people with disabilities from education, employment, and social life.*" […] "*AVs present a tremendous opportunity to end exclusion and promote independence for anyone who presently cannot obtain a driver's license, but significant work remains to ensure that technological systems currently in development will enable independent use by people with disabilities. It is important that manufacturers and government agencies collaborate with stakeholders, such as the disability community, to ensure that these technologies are fully accessible and available to all.*" (NCD 2015). As mentioned in this report, vehicles, the related services (ordering, communication, payment, etc.) and the stops must be accessible in order to benefit from this technology.

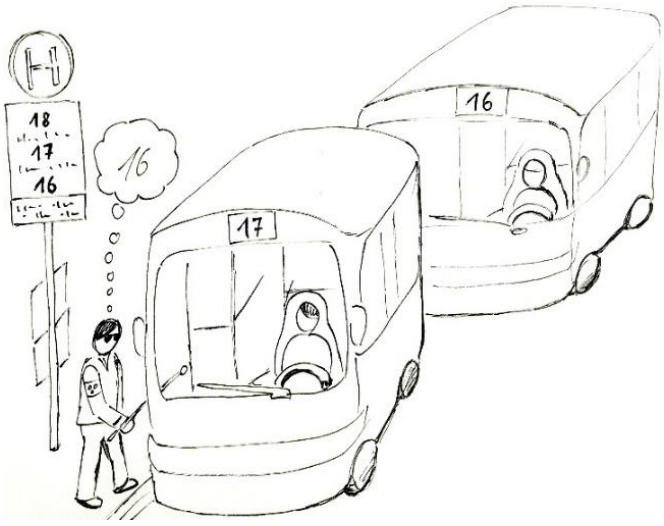


Figure 6.17 Blind passenger trying to find the right bus

The lack of accessibility of today's vehicles (identification of the right vehicle, ramps, etc.) is compensated (in many cases) by assistance given by the driver. Having no driver on an AM means, that the accessibility of the vehicle and the bus stop needs to be increased to avoid an exclusion of PRM. The impact of missing accessibility in combination with a missing driver could be demonstrated during the current pandemic situation: During the COVID-19 pandemic, the bus driver was isolated from the passengers, so that the passengers could not receive assistance from the driver.

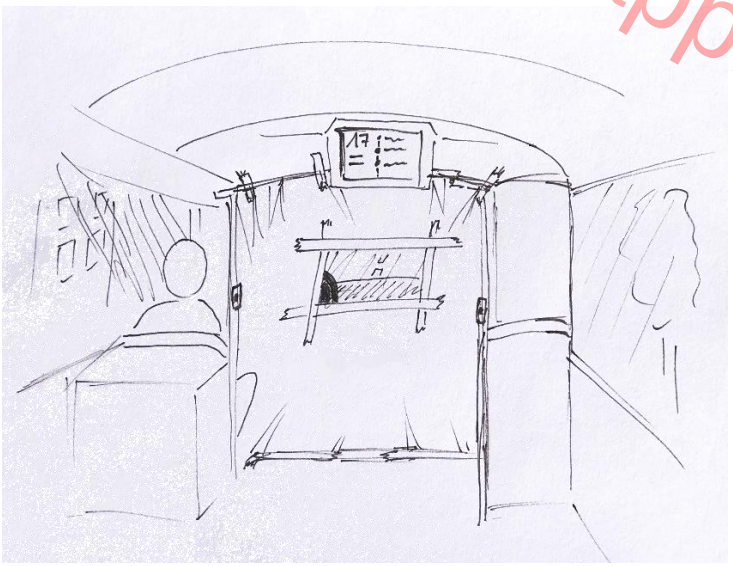


Figure 6.18 Driver isolated in the front

Newsletter and relevant mailing lists of people with disabilities, personal observations, and discussions with PRMs showed that even previously frequent users of public transport stopped using public transport because they feared that they would be helpless without the driver´s help. Therefore, accessible services and accessible vehicles play a crucial role for AVs, as they will not have a driver that could compensate missing accessibility: To increase the user acceptance of PRM, the specific assistance systems required for these user groups must be provided by the AVs. It should be ensured that the various assistance systems can be operated by the affected passengers on their own without any problems and completely without the help of third parties. For example, persons with limited vision or hearing should be able to perceive all necessary passenger information while on the go. Currently there is no accessible passenger information available, neither onboard nor via an accessible app. Wheelchair users or persons with walkers should be able to comfortably request and use the ramp for a safe entry and exit at normal or alternative bus stops on their route, without any risks. Currently not all AM are equipped with a ramp, some only have a manual ramp which can only by operated by a PTO. A further problem arises inside the vehicle because the wheelchair/walker cannot be fixed without help.

Figure 6.19 Fixating a wheelchair in AV

The following list contain the most important features that have to be realized:

- Two channel principle for all related information (APP, website and onboard information)
- Possibility to identify the correct bus by blind or visual impaired persons
- Vehicle must have a ramp to allow wheelchair users to enter the bus
- There must be the possibility to fix wheelchairs, walkers, etc.

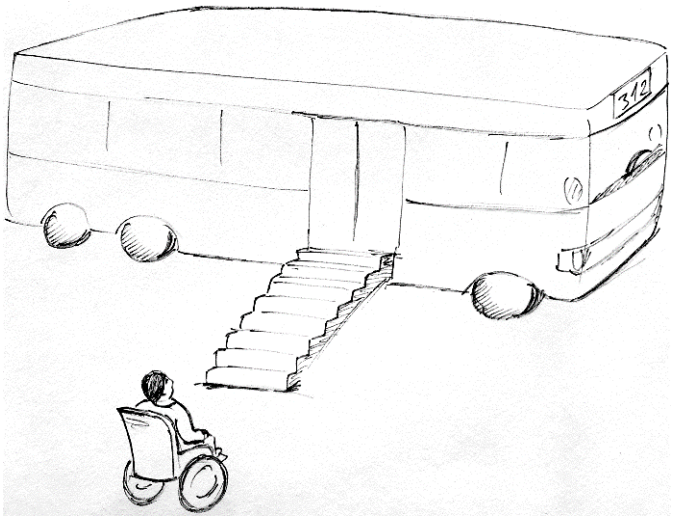


Figure 6.20 A bus without a ramp as seen from a wheelchair

Only if the reliability of these assistance systems is 100% guaranteed AM will be a real alternative to other public or private transport systems and, moreover, a real step forward for mobility and thus for the inclusion of people with disabilities.

6.2.2 AVENUE services as an opportunity for persons with disabilities

The Avenue project focuses on easy-to-use services that provide real added value for the various user groups in everyday use. For example, the project will provide an automated tracking service, primarily designed for school children, but also offering persons with mild-cognitive difficulties an additional protection in public transport. Thus, a continuous location tracking can be activated and guaranteed for these persons, which enables a kind of transport escort. Relatives or friends can use this service to track affected persons during planned bus trips and to provide immediate support, if necessary, e.g., in complex situations such as bus transfers. With its unobtrusive assistance potential, the tracking service promotes the maintenance of the self-determined action of this user group and also relieves relatives who now have less to worry about.

Another example is the door-to-door services realized in the AVENUE project. Such service would be a revolution, it would enable the provision of public transport in areas with fewer passengers, it would connect people without private cars and it would open up a new mobility for people with reduced abilities: Persons with reduced mobility often require a high level of assistance, which could be drastically reduced

by special door-to-door services; this would be the first time that persons with reduced mobility would have almost the same (mobile) flexibility as persons without reduced mobility. Such door-to-door services result in short walking distances that have to be covered by this user group, which also reduces the risk of accidents in their everyday life.

Another service is the detection of aggression and theft. This service is especially interesting for people with limited abilities, as they often become victims of theft because they do not notice it, or they notice it too late and because they are usually not that mobile. Such a service could help to make the journey more enjoyable because passengers do not have to be on their guard all the time.

In general AVs will improve rural areas and areas with a low number of public transport connections. Thus, AVS in general would substantially benefit rural areas and regions with poor public transport serves. For people living in these regions the quality of life would increase and for younger people and people with disabilities rural areas would be opened as main focus point of life.

However, all these services have one common issue: to reach all passengers, including those with a disability, the complete service must be accessible: Booking of the service, finding and identification of the vehicle, the necessary onboard information (e.g., arrival or departure delays) to word only a few.

6.2.3 Insights of attitudes towards AM by PRM

In AVENUE social impact assessment, we aimed to focus on PRM in detail. However, due to the COVID-19 pandemic, it was impossible to conduct specific supervised, on-board studies with PRMs. In all surveys, we asked respondents to indicate whether they have any mobility issues. As a result, we have a total of 130 respondents of our 2021 survey among citizens in the AVENUE cities that indicated to have reduced mobility, which is a total of 7% (see Figure 6.21). This section presents results of this group of respondents, focusing on general attitudes on the local situation, travel preferences, willingness to use AM services, and requirements of AM services.

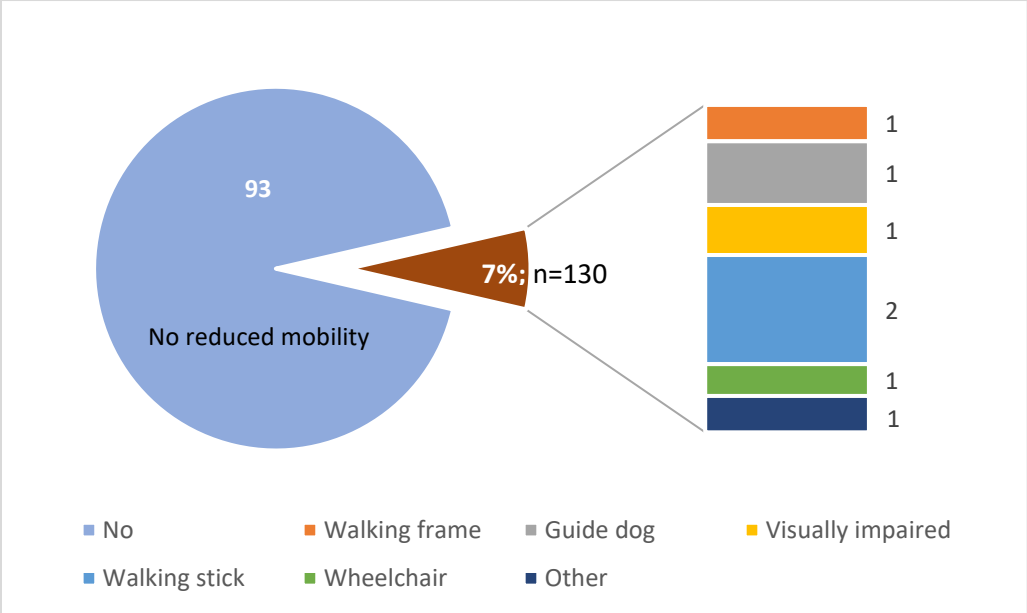


Figure 6.21 Reduced mobility among the respondents of the 2021 survey (in %; n=1816)

6.2.3.1 General attitudes about the local situation

For general attitudes about the local situation, we see the groups of PRM are slightly less satisfied with each of the categories, see Figure 6.22 and Table 6.10. However, the general satisfaction is relatively high, with means for the PRM of 3.6 for 'your local area as a place to live', 2.7 for 'traffic situation in and around your city', 3.3 on 'public transportation offer' and 3.1 for the environmental situation in your city' (the means for the non-PRM groups are 3.9; 2,7; 3.5; 3.3 respectively). PRMs are slightly less satisfied with public transport offers (3.3 vs. 3.5) but the satisfaction with public transport offers is generally not high and does not significantly differ between PRMs and Non-PRMs.

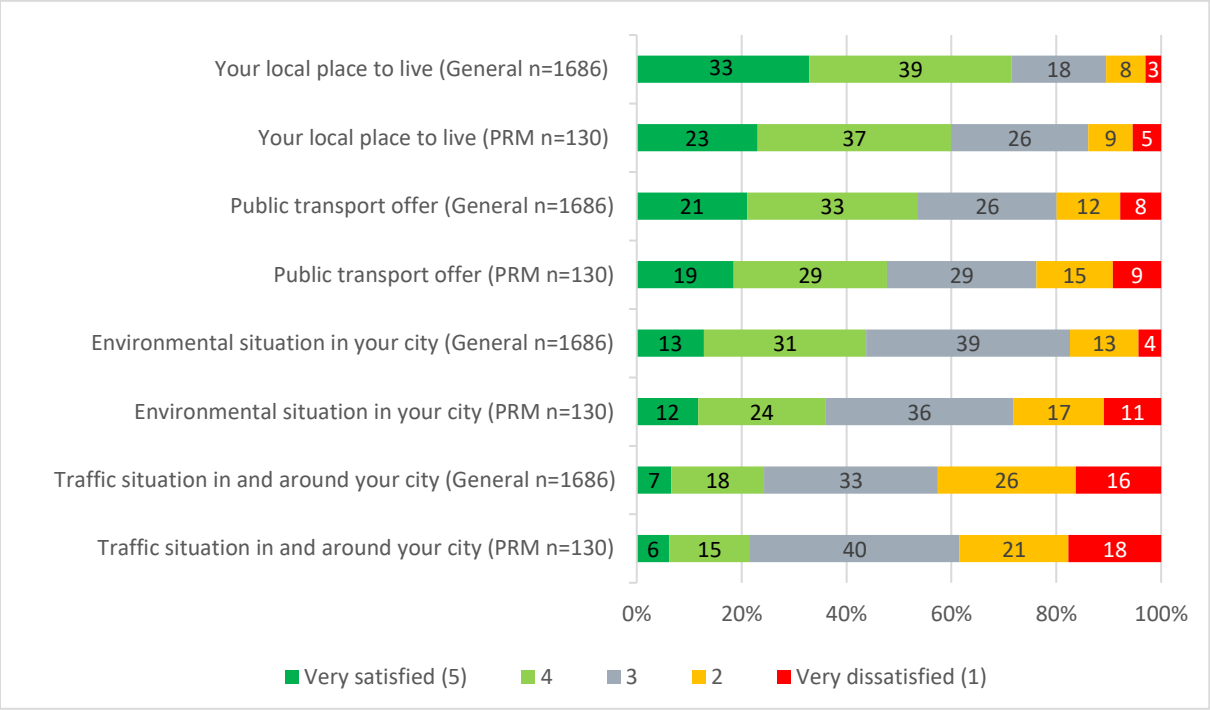


Figure 6.22 General attitudes on local situation, PRM versus non-PRM respondents

Table 6.10 Satisfaction with life qualities (means)

	PRM (n=130)	Non-PRM (n=1686)
Your local place to live*[1]	3.6	3.9
Public transport offer	3.3	3.5
Environmental situation in your city*[2]	3.1	3.4
Traffic situation in and around your city	2.7	2.7

*[1] significant difference of the mean values for … Your local place to live, t(1813) = -2.839, p =.005,
No significant difference of the mean values for … Public transport offer
*[2] significant difference of the mean values for … Environmental situation in your city, t(1810) = -2.838, p =.005,
No significant difference of the mean values for … Traffic situation in and around your city

More than half (54%) of the PRM respondents – significantly more than non-PRMs (39%) - indicate that accessibility of public transport should be improved, see Table 6.11. Also, additional services and offering

on-demand services are selected significantly more often by the PRM respondents (45%), compared to the non-PRM respondents (35%). Whereas half of the non-PRM respondents, indicate that price performance should be improved (51%), this accounts significantly less for 40% of the PRM respondents.

Table 6.11 What needs to be improved in public transport? (in %)

Item	PRM (n=130)	Non-PRM (n=1686)
Information, such as on the timetable, online in the bus or at the bus stop	39	33
Accessibility, i.e. can be used by all people[*1]	54	39
Price performance[*2]	40	51
Safety and trust feeling	37	37
Speed and travel time	45	46
Environmental friendliness	36	37
Public transport should become on demand[*3]	35	27
Entertainment	16	11
Flexibility by an increase of locations to get on the public transport systems	45	44
Flexibility by an increase of frequency of public transport offers	45	49
Additional services, to bridge the distance between home and bus, tram and train stations[*4]	45	35

No Statistical dependence between PRM/Non-PRM and Information, such as on the timetable, online in the bus or at the bus stop
[*1] Statistical dependence between PRM/Non-PRM and Accessibility, i.e. can be used by all people, (Chi-Square(1) = 11.604, p = .001)
[*2] Statistical dependence between PRM/Non-PRM and Price performance, (Chi-Square(1) = 5.297, p = .021)
No Statistical dependence between PRM/Non-PRM and Safety and trust feeling,
No Statistical dependence between PRM/Non-PRM and Speed and travel time,
No Statistical dependence between PRM/Non-PRM and Environmental friendliness,
[*3] Statistical dependence between PRM/Non-PRM and Public transport should become on demand, (Chi-Square(1) = 4.012, p = .045)
No Statistical dependence between PRM/Non-PRM and Entertainment,
No Statistical dependence between PRM/Non-PRM and
Flexibility by an increase of locations to get on the public transport systems,
No Statistical dependence between PRM/Non-PRM and Flexibility by an increase of frequency of public transport offers,
[*4] Statistical dependence between PRM/Non-PRM and Additional services, to bridge the distance between home and bus, tram and train stations, (Chi-Square(1) = 5.743, p = .017)

6.2.3.2 Current mobility preferences

In selecting the preferred preferences there are significant differences between the groups of PRM and non-PRM. The bus is the preferred means of transport of 13% of the group of PRM, whereas it is only preferred by 6% in the non-PRM group. The bike is only preferred by 2% of the PRM group, compared to 13% of the non-PRM group, see Table 6.12.

Table 6.12 Preferences in transportation systems of PRM and Non-PRM (in %)[*1]

	PRM (n=130)	Non-PRM (n=1686)	Overall (n=1816)
Car	52%	54%	53%
Train	4%	5%	4%
Bus	13%	6%	7%
Bike	2%	13%	13%
Walking	14%	13%	13%

[*1] Statistical dependence between PRM/Non-PRM and preferred transport system, (Chi-Square(11) = 76.268, p < .001)

To assess differences in the importance of factors in selecting preferred means of transport, respondents were asked to rank nine criteria. In comparing the results between PRM and non-PRM respondents (Table 6.13), the results show significant differences in aspects like accessibility being more important for PRMs, but aspects like speed and travel time or private atmosphere being significantly less important to them.

Table 6.13 Criteria for selecting preferred means of transport of PRM and Non-PRM

Mean*	Top box 1-3 (important) in % Low box 7-9 (not important) in %	PRM (n=130)		Non-PRM (n=1686)	
Comfort		4.2	40 18	4.6	34 24
Accessibility*[1]		4.1	47 24	4.8	38 32
Safety and trust feeling		4.5	42 25	4.9	32 28
Speed and travel time*[2]		4.0	50 16	3.4	60 12
Pleasure and joy		5.5	25 41	5.7	22 43
Punctuality		4.0	44 17	4.1	46 17
Price performance		5.1	35 41	4.7	39 30
Environmental friendliness		5.8	23 45	5.7	25 45
Private atmosphere*[3]		6.2	18 50	5.6	27 44

* Means: 1: is most important criteria, 9 is least important criteria. Hence, the higher the mean, the least important the criteria scores.

No significant difference of the mean values for Comfort,

*[1] significant difference of the mean values for Accessibility, t(1688) = -2.498, p =.013,

No significant difference of the mean values for Safety and trust feeling,

*[2] significant difference of the mean values for Speed and travel time, t(1713) = 2.772, p =.006,

No significant difference of the mean values for Pleasure and joy,

No significant difference of the mean values for Punctuality,

No significant difference of the mean values for Price performance,

No significant difference of the mean values for Environmental friendliness,

*[3] significant difference of the mean values for Private atmosphere, t(133) = 2.362, p =.020,

6.2.3.3 Current mobility use

There is no major difference between the group of PRM and the non-PRM in daily use of car or buses (Table 6.14). The only difference is that for the PRM, but not surprisingly, walking or biking is significantly less usual.

Table 6.14 Current use of transport PRM vs non-PRM

	PRM (n=130)	Non-PRM (n=1868)	Overall (n=1816)
Car	45%	45%	45%
Train[*1]	2%	5%	5%
Bus	10%	9%	9%
Bike[*2]	6%	11%	11%
Walking[*3]	46%	62%	61%

No Statistical dependence between PRM/Non-PRM and current use of car

[*1] Statistical dependence between PRM/Non-PRM and current use of train, (Chi-Square(4) = 10.138, p = .038)

No Statistical dependence between PRM/Non-PRM and current use of bus

[*2] Statistical dependence between PRM/Non-PRM and current use of bike, (Chi-Square(4) = 16.787, p = .002)

[*3] Statistical dependence between PRM/Non-PRM and current use of walking, (Chi-Square(4) = 25.124, p < .001)

Zooming into the respondents that selected the bus as their preferred means of transport, shows that a slightly lower percentage of the PRM are using the bus on a daily basis (Table 6.15), and higher percentage uses the car on a daily basis (19% vs 8%), but difference is not significant (only n=17 persons remain in the PRM-group).

Table 6.15 Use of bus and car by preferred bus users

	Selected bus as preferred means of transport:		
	PRM (n=17)	Non PRM (n=103)	Total (n=120)
Uses bus on a daily basis	47%	55%	54%
Uses bus on a weekly basis	35%	37%	37%
Uses own car on a daily basis	19%	8%	8%
Uses own on a weekly basis	13%	37%	37%

No Statistical dependence between PRM/Non-PRM and current use of bus

No Statistical dependence between PRM/Non-PRM and current use of car

6.2.3.4 Acceptance and willingness to use AM services

Awareness on the existence of AM services and prior use of the AM is similar between the groups of PRM and non-PRM (59% vs 55%, and 15% vs 12% respectively). PRM are slightly less positive (but not significant) about the enhanced freedom that AM could provide for people with mobility issues (37% fully agree vs 34% fully agree). An app to organize the journey is significantly less important for PRMs. maybe because of the fact that is what not mentioned if the app will be barrier free.

Table 6.16 Importance of different aspects of AM services in PRM and non-PRM

Mean*	Top box 4-5 (important) in % Low box 1-3 (not important) in %	PRM (n=130)		Non-PRM (n=1686)	
A safety operator on board		3.7	64 21	3.6	59 19
In vehicle entertainment, e.g. screens displaying the news		2.6	27 47	2.4	22 55
An app that helps me to organize my journey[*1]		3.2	46 27	3.6	60 18
Access to wifi in the AM		3.0	40 38	2.8	37 43
Giving feedback about the minibus service via QR codes in the vehicle		2.8	37 41	2.6	26 45
In-vehicle information about the performance of the vehicle, e.g. speed		2.8	35 42	2.6	29 45
In-vehicle information, e.g. information about the area where the AM operates		3.5	63 21	3.5	65 21

* Means: 1: is not important at all, 5 is very important. Hence, the lower the mean, the more important are the AM services.
No significant difference of the mean values for A safety operator on board,
No significant difference of the mean values for In vehicle entertainment, e.g. screens displaying the news,
[*1] significant difference of the mean values for An app that helps me to organize my journey, t(128) = -2.858, p =.005,
No significant difference of the mean values for Access to wifi in the AM,
No significant difference of the mean values for Giving feedback about the minibus service via QR codes in the vehicle,
No significant difference of the mean values for In-vehicle information about the performance of the vehicle, e.g. speed,
No significant difference of the mean values for In-vehicle information, e.g. information about the area where the AM operates,

There are no differences between PRM and overall respondents in the assessment of AM as an alternative to walking, cycling, PT and car use

Table 6.17 . There are no clear differences between the PRM and non-PRM groups, in assessing their willingness to use an AM, see Figure 6.23.

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Table 6.17 Possible alternatives for AM services in PRM and non-PRM

	PRM (n=130)	Non-PRM (n=1686)	Overall (n=1816)
For distances I normally have to walk, because there is no Public transport	49%	46%	46%
For distances, I normally have to use the bike, because there is no Public transport	25%	25%	25%
For distances I normally use my own car, because there is no Public transport	38%	45%	45%
For distances, I normally have to use current, classic Public transport.	38%	42%	42%

No Statistical dependence between PRM/Non-PRM and For distances I normally have to walk, because there is no Public transport
No Statistical dependence between PRM/Non-PRM and For distances, I normally have to use the bike, because there is no Public transport
No Statistical dependence between PRM/Non-PRM and For distances I normally use my own car, because there is no Public transport
No Statistical dependence between PRM/Non-PRM and For distances, I normally have to use current, classic Public transport.

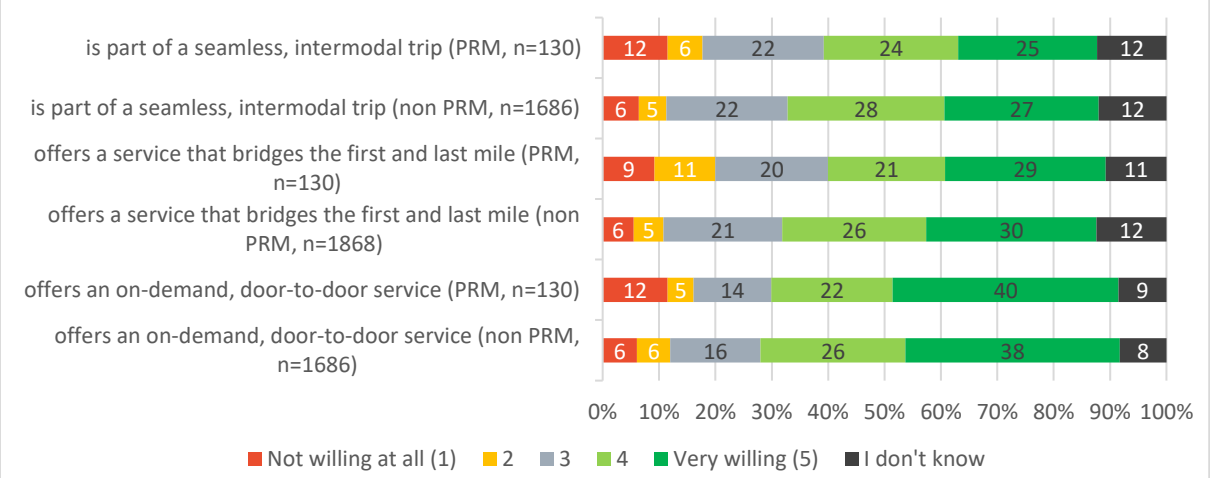


Figure 6.23 Willingness to use the AM service, if the AM…. (in %)

Table 6.18 Willingness to use the AM service, if the AM…. (Means)

	PRM (n=130)	Non-PRM (n=1686)
is part of a seamless, intermodal trip*[1]	3.5	3.8
offers a service that bridges the first and last mile*[2]	3.5	3.8
offers an on-demand, door-to-door service	3.8	3.9

*[1] significant difference of the mean values for is part of a seamless, intermodal trip, t(127) = -2.005, p =.047,
*[2] significant difference of the mean values for offers a service that bridges the first and last mile
, t(129) = -1.978, p =.050,
No significant difference of the mean values for offers an on-demand, door-to-door service

However, PRM are less inclined to pay more to use an AM, rather, they prefer to not pay anything at all, see Figure 6.24. Willingness to pay is significantly less than among non-PRMs.

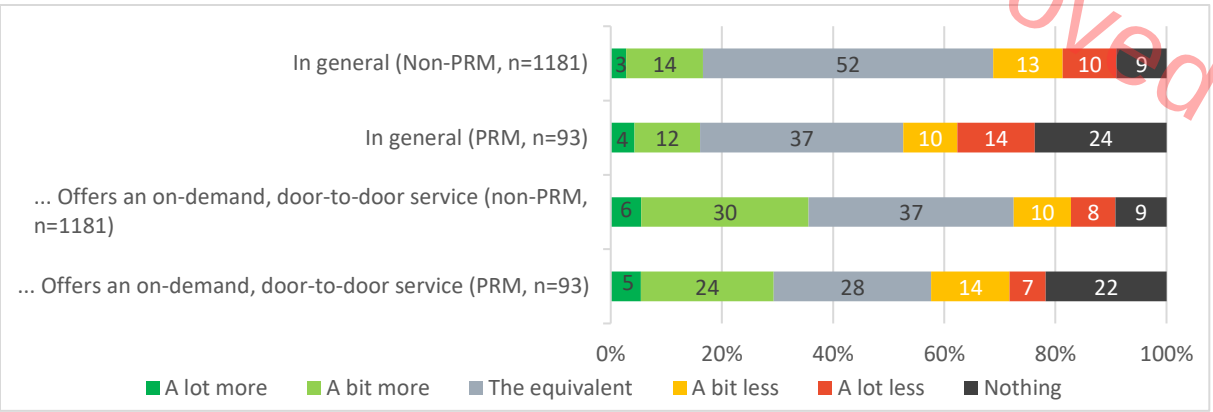


Figure 6.24 Willingness to pay to use the AM, in general, and if the AM offers an on-demand, door-to-door service (in %)

This question has not been asked in Luxembourg, hence the reduced base.

Table 6.19 Willingness to pay to use the AM, in general and if the AM offers an on-demand, door-to-door service (means)

	PRM (n=93)	Non-PRM (n=1181)
In general*[1]	3.9	3.4
offers an on-demand, door-to-door service *[2]	3.6	3.1

*[1] significant difference of the mean values Willingness to pay to use the AM, in general, t(101) = 3.019, p =.003,

*[2] significant difference of the mean values for offers an on-demand, door-to-door service

, t(101) = 2.641, p =.010,

6.2.4 Final reflections on PRM and AM

Higher preference for using the bus, but lower actual use of the bus. But only 38% of the PRM indicates that they would use the AM as a substitution for distances they travel by bus now.

6.3 Urban vs Rural respondents

Automated minibuses are thought to be a solution for both urban, mobility-dense areas, as well as for rural areas with low mobility density. In the urban areas, AM services are thought to substitute other forms of transport, reducing congestion. In the rural areas, AM services could bridge mobility gaps, such as the distances between homes and train stations. Smaller, flexible AM could provide a solution for routes that are less popular, and where regular bus-line are perceived to be not economically viable. AM services could be a gap-filler, and stimulate the use of public transport in these areas. Therefore, in this section a distinction is made on the area in which the respondents live. The respondents are grouped into four categories; the open countryside (n-169), a small village or small town (n=498), a medium to large town (n=457), a city or city suburb (n=669). A small percentage of the respondents (n=19) did not wish to disclose the area in which they live.

Overall, the results show an extremely higher percentage of car preference in the open countryside (75%) compared to urban areas (41%). Preference for using the bike and walking show the opposite, bike (22%) and walking (15%) are more preferred in urban areas, as in the open countryside (bike 2%, walking 9%), see Table 6.20.

Table 6.20 Current mobility preferences, divided by urban-rural areas*

	the open countryside (n=169)	a village or small town (n=498)	a medium to large town (n=457)	a city or city suburb (n=669)	don't wish to disclose (n=19)	Overall (n=1814)
Car	75%	67%	49%	41%	79%	53%
Train	4%	5%	7%	2%	-	4%
Bus	7%	5%	8%	7%	5%	7%
Bike	2%	5%	11%	22%	-	13%
Walking	9%	11%	15%	15%	-	13%

*Statistical dependence between living area and preferred transport system, (Chi-Square(44) = 233.742, p<.001)

There are also differences in the aspects that are important for respondents in selecting their preferred mode of transport. Whereas respondents living in rural areas select ‘accessibility’ as a not so important criteria (with a mean of 5.6, and only 26% selecting accessibility in their top 3), it is more important for respondents living in an urban area (with a mean of 4.3, and 46% selecting it in their top 3) (.Table 6.21)

Table 6.21 Important aspects in selecting preferred means of transport, divided by place of living

Mean*	Top box 1-3 (important) in % / Low box 7-9 (not important) in %	the open countryside (n=169)		a village or small town) (n=498)		a medium to large town (n=458)		a city or city suburb (n=670)		Overall (n=1814)	
Comfort*[1]		4.3	41	4.4	36	4.8	32	4.8	32	4.6	35
			19		20		27		27		23
Accessibility*[2]		5.6	26	4.8	36	4.3	46	4.3	46	4.7	39
			45		33		26		26		32
Safety and trust feeling		4.6	37	4.9	32	4.8	31	4.8	31	4.8	32
			25		31		25		25		27
Speed and travel time*[3]		3.2	62	3.6	53	3.4	59	3.4	59	3.4	59
			8		14		13		13		12
Pleasure and joy*[4]		5.3	30	5.9	18	5.6	21	5.6	21	5.7	22
			37		45		42		42		42
Punctuality		4.1	48	3.8	52	4.2	42	4.2	42	4.1	46
			19		16		17		17		17
Price performance*[5]		5.4	27	5.0	36	4.4	43	4.4	43	5.7	38
			41		36		25		25		31
Environmental friendliness		5.7	21	5.7	26	5.7	25	5.7	25	5.7	25
			47		47		45		45		45
Private atmosphere*[6]		5.5	26	5.1	35	6.1	21	6.1	21	5.7	26
			41		33		47		52		44

* Means: 1: is most important criteria, 9 is least important criteria. Hence, the higher the mean, the least important the criteria scores.

*[1] Importance of comfort differed statistically significant for the different living areas, $F(4, 1700) = 2.934$, $p = .020$,
No significances between the groups, A village or small to town - a city or city suburb: weak tendency, $p = .071$

*[2] Importance of accessibility differed statistically significant for the different living areas, $F(4, 1683) = 9.553$, $p < .001$,
A city or city suburb < the open countryside, a village or small town (0.012), a medium to large town; don't wish to disclose < the open countryside; The open countryside> a village or small town (0.27)
Importance of safety and trust feeling differed not statistically significant for the different living areas,

*[3] Importance of speed and travel time differed statistically significant for the different living areas, $F(4, 1708) = 2.785$, $p=.025$, a medium to large town< a village or a small town (0.024)

*[4] Importance of pleasure and joy differed statistically significant for the different living areas, $F(4, 1602) = 3.769$, $p=.005$,
No significances between the groups. The open countryside - A village or small to town: Tendency, $p = 0.068$
Importance of punctuality differed not statistically significant for the different living areas,

*[5] Importance of price performance differed statistically significant for the different living areas, $F(4, 1665) = 6.037$, $p<.001$,
A city or city suburb < the open countryside, a village or small town, The open country side - a medium to large town, tendency, $p = 0.060$
Importance of environmental friendliness differed not statistically significant for the different living areas

*[6] Importance of private atmosphere differed statistically significant for the different living areas, $F(4, 1588) = 11.359$, $p<.001$,
A village or a small town< a medium to large town, a city or city suburb

Respondents in the open countryside are overall more satisfied with their local area as a place to live (75.6% compared to 70.6% overall), but are less satisfied with the public transportation offer in their area (31.9%) compared to respondents that live in a city or city suburb (64.0%) (Figure 6.25).

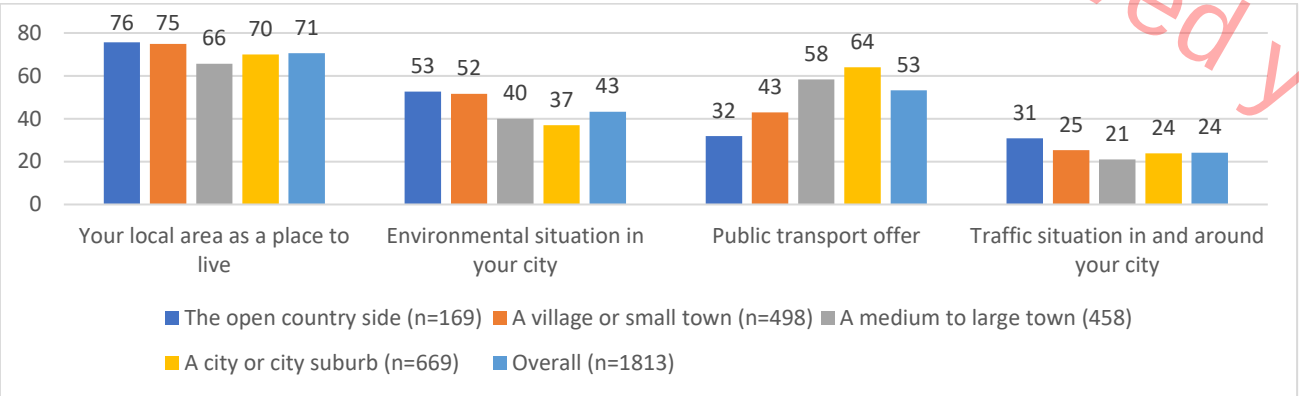


Figure 6.25 satisfaction about local place to live, divided by area of living (The figure shows the % of satisfied respondents; topbox 4-5: satisfied & very satisfied)

As a result, respondents that live in urban areas make less use of a car on a daily basis (31%) compared to respondents that live in the open country side (66%). The daily use of the bus is higher in the urban areas (10%) compared to the rural areas (5%).

Table 6.22 Current use of transport rural vs urban (in %)

		the open countryside	a village or small town	a medium to large town	a city or city suburb	don't wish to disclose	Overall
Car[*1]	daily users	66%	61%	40%	31%	79%	45%
Train[*2]	daily users	4%	5%	7%	4%	5%	5%
Bus[*3]	daily users	5%	6%	11%	10%	5%	9%
Bike[*4]	daily users	3%	4%	8%	20%	-	11%
Walking[*5]	daily users	44%	57%	61%	67%	53%	61%

[*1] Statistical dependence between living area and current use of car, (Chi-Square(16) = 224.272, p<.001)
[*2] Statistical dependence between living area and current use of train, (Chi-Square(16) = 86.601, p<.001)
[*3] Statistical dependence between living area and current use of bus, (Chi-Square(16) = 129.633, p<.001)
[*4] Statistical dependence between living area and current use of bike, (Chi-Square(16) = 123.796, p<.001)
[*5] Statistical dependence between living area and current use of walking, (Chi-Square(16) = 66.559, p<.001)

In rural areas, the open country side the AM is significantly more attracting for distances one normally has to use the own car. In cities or city suburbs it is significantly more attracting for distances one normally uses classic transport (Table 6.23)

Table 6.23 Occasions to use the AM service, shown are % of respondents that could imagine to use an AM service

	the open countryside	a village or small town	a medium to large town	a city or city suburb	don't wish to disclose	Overall
For distances I normally have to walk, because there is no PT	43%	44%	49%	47%	32%	46%
For distances, I normally have to use the bike, because there is no PT	27%	24%	23%	27%	11%	25%
For distances I normally use my own car, because there is no PT*[1]	60%	51%	43%	37%	73%	45%
For distances, I normally have to use current, classic PT*[2] .	37%	34%	42%	49%	21%	42%

No Statistical dependence between living area and For distances I normally have to walk, because there is no Public transport
No Statistical dependence between living area and For distances, I normally have to use the bike, because there is no Public transport

*[1] Statistical dependence between living area and For distances I normally use my own car, because there is no Public transport, (Chi-Square(4) = 49.378, p<.001)

*[2] Statistical dependence between living area and For distances, I normally have to use current, classic Public transport. (Chi-Square(4) = 32.235, p<.001)

Table 6.24 Willingness to use the AM, willingness (shown are means*[1])

Scenario	the open countryside (n=154)	a village or small town (n=466)	a medium to large town (n=424)	a city or city suburb (n=605)	don't wish to disclose (n=13)	Overall (n=1662)
Willingness to use the AM service, if the AM offers an on-demand, door-to-door service*[2]	4.1	3.9	3.9	3.9	3.0	3.9
Willingness to use the AM service, if the AM offers if the AM offers a service service that bridges the first and last mile *[3]	4.0	3.7	3.8	3.8	3.2	3.8
Willingness to use the AM service, if the AM is part of a seamless, intermodal trip*[4]	3.8	3.6	3.8	3.8	2.9	3.7

*1 Means: 1 is not willing at all, and 5 is very willing. This means, that the higher the mean, the more willing the respondents are
*2 Willingness to use the AM service, if the AM offers an on-demand, door-to-door service differed statistically significant for the different living areas, F(4, 1657) = 2.512 , p<.040,
Don't wish to disclose< The open countryside (0.028)
*3 Willingness to use the AM service, if the AM offers if the AM offers a service service that bridges the first and last mile different living areas, F(4, 1583) = 2.533 , p<.039,
No significances between the groups
*4 Willingness to use the AM service, if the AM offers if the AM is part of a seamless, intermodal trip different living areas, F(4, 1588) = 3.212 , p<.012,

7 Changes in attitudes and mobility behaviour

The AVENUE project does not only aim to demonstrate that automated minibuses can be successfully deployed within urban public transport systems, but also aim to show changes in mobility behaviour. After all, a public transport system including automated minibus services should contribute to a more sustainable urban transport system. Therefore, in the AVENUE social impact assessment, measuring (possible) changes in attitudes and mobility behaviour was key. Three studies were conducted to measure this change. First, a longitudinal study among residents of the Nordhavn pilot site in Copenhagen (for a description of the methodology, see section 2.2.2). Secondly the representative survey was conducted as a zero measurement in 2019 and 2021, which allows for an analysis of changes in this period. Thirdly, the social media analysis was conducted in 2019 and repeated in 2021. In this chapter, these studies are presented.

7.1 Changes in attitudes and mobility behavior in the Nordhavn pilot site, Copenhagen

The Copenhagen pilot site is situated in an area of the city called Nordhavn. Nordhavn is an active industrial port that is undergoing a transformation – turning into Copenhagen's new international waterfront district offering residential and commercial buildings. Currently, the Nordhavn area is serviced by a nearby S-train station (app. 1,1 km away) and bus stops located near the train station. There are however no buses or trains running directly in the area – creating a great opportunity for automated vehicles to function as a new public transport solution, connecting the area much better than it is today. In 2020 two new metro stations will have been built – opening in the periphery of the neighbourhoods.

The automated minibus service is placed in the area called Århusgadekvarteret. The route is a circle line around the area (blue line on the map below), making it easier to get around and to enter the area from outside Nordhavn. Our garage is located on the next peninsula close to Århusgadekvarteret (the red line in Figure 4.1). The automated minibus service was in operation from July 2020 up to December 2020. During the time of operation, residents of the area participated in a study on their mobility behavior and attitudes towards automated minibuses. A full description of the methodology can be found in section 2.2.2.

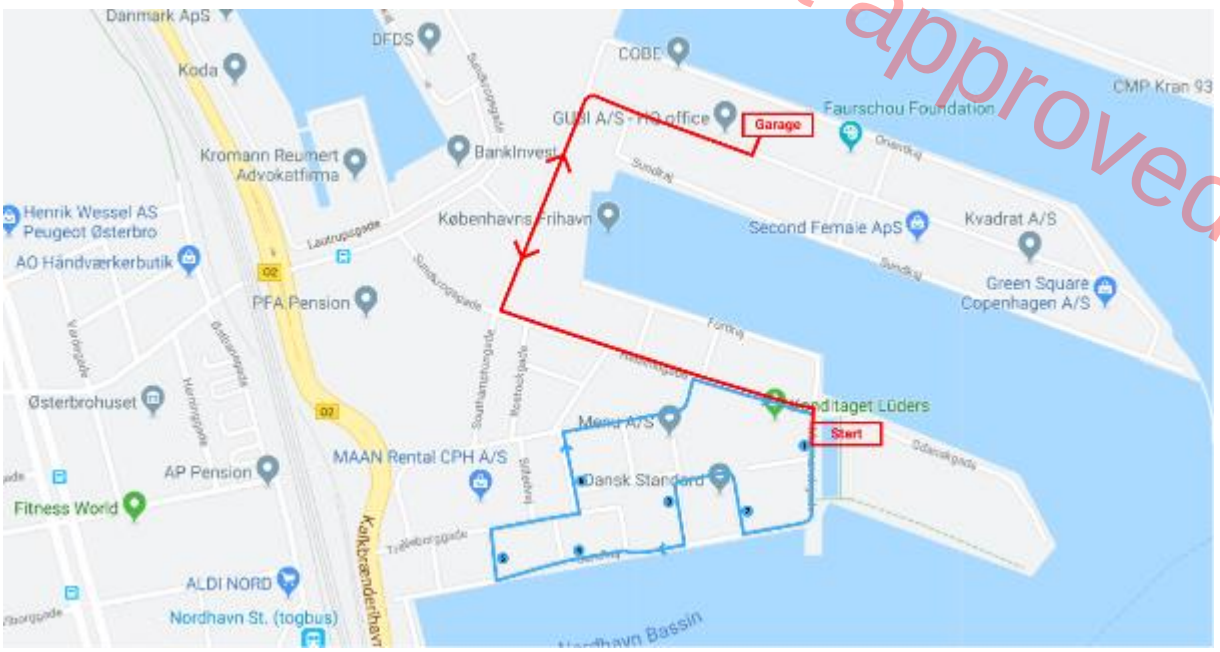


Figure 7.1 Pilot route in Nordhavn

7.1.1 Attitudes of the participants and changes during the study

In terms of the existing attitude towards the current public transportation system participants had a predominantly positive attitude which was gained through operant conditioning using the transportation system. Regarding the attitude towards the AMs, the participants of the study had little personal experience with and knowledge about the AMs before the study. They arrived at their judgement and attitude about the AMs through existing knowledge and spontaneous associations about the technology of autonomous driving. This knowledge and the associations were then transferred to the autonomous e-minibuses.

The formation of the attitudes of the participants can be explained through the model of classical conditioning, whereby the neutral stimulus of 'automated minibuses' is paired with the stimuli 'autonomous driving' or 'electric mobility'. Existing associations and knowledge about these two topics lead to a reaction in the participants which become conditioned with the neutral stimulus of the AMs. The participants did not gain much personal experience with the AMs during the study; however, they were confronted with the topic over a longer period of time. Any changes in the attitude of the participants are therefore explained by the cognitive processes of the participants.

The mobility behavior of the participants also slightly changed during the course of the study due to the Covid-19 pandemic. Hygiene and social distancing gained relevance for the survey participants who started using public transportation less. This was reinforced by the call of the Danish government to use less public transportation. Therefore, individual transportation like the use of bicycles, cabs and walking increased as they fulfilled this hygiene need better.

7.1.2 Freedom and flexibility

Prior to the study, the participants evaluated AMs as a way to satisfy their need for freedom as well as temporal and local flexibility. Because participants associate autonomous driving as being integrated, they assumed that AMs are able to drive to any place at any time, therefore enabling temporal and local flexibility. Another association of participants was that autonomous vehicles are able drive without a driver or any human component. Therefore, the AMs would be able to drive at a high frequency at any time, even at night. Additionally, through the cost savings, the AMs could service more remote areas that are currently seen as unlucrative. This again is associated with higher temporal and local flexibility. However, based on their knowledge about electric mobility participants assumed that AMs are limited in terms of their range. This is seen as a caveat to their flexibility and therefore the AMs are regarded as an option mainly for short and medium distances within the city of Copenhagen.

In Conclusion, participants generally had a positive attitude towards the Integration of AMs concerning the temporal and local flexibility, especially for short and medium distances. Based on the cognitive processes during the study, the participants reinforced their initial, positive attitude concerning temporal and local flexibility of the AMs.

7.1.3 Convenience and comfort

Participants expect the AMs to offer door-to-door mobility, therefore eliminating the need to change means of transportation and offering more spontaneous mobility. For women and men with handicap AMs are seen as offering physical relief as an alternative to the bus, e.g., when carrying heavy bags.[16] Women additionally expect that AMs can satisfy their need for protection against bad weather and more temporal flexibility at night. It is expected that women and men with handicap gained a positive attitude through the cognitive processes concerning the expected temporal and local flexibility of AMs that will satisfy their need for convenience and comfort. There was no change of attitude for women during the study but for men. At the beginning of the study men did not express the need for protection against bad weather. However, during the course of the study, the changing weather condition due to the winter months caused men to have negative experiences in this regard. They developed a more positive attitude towards AMs as a way to satisfy their need for comfort in bad weather conditions.

7.1.4 Safety

The participants are especially critical concerning the safety of AMs. One advantage is seen in accident prevention which is based on the information of participants that autonomous vehicles provide higher safety than human drivers. Through the cognitive information processing this feeling of safety becomes conditioned to the neutral stimulus of AMs inducing a positive reaction. Participants therefore have a positive attitude towards the safety of AMs (in the long run when the technology has been tested sufficiently). This positive attitude remained stable throughout the study.

Another reason for the positive attitude in this case is based on operant conditioning. The participants already had experiences with the fully autonomous metro in Copenhagen. The autonomous metro was

[16] Dony, p. 65

evaluated as safe by the public transportation operators and the government, and the usage experience installed trust in the participants towards the safe integration of new technology in the transportation system. This positive attitude, however, is only applicable in the long term, when the technology has been sufficiently tested. In current conditions, there are still concerns from the participants. The concerns regards whether the technology is mature enough lead to a negative attitude towards the AMs concerning safety at this point in time.

Regarding the presence of a 'supervisor' on board of the AMs the participants expressed an aversion as they expect autonomous vehicles to not need any human component. The positive attitude towards AMs presupposes that no supervisor is present. Instead of a human they would want to satisfy the need for safety through SOS buttons or an emergency call system. The group of 'users' which was able to make personal experiences with the AMs experienced technical problems and unforeseen stops in the AMs leading to a reinforcement of their safety concerns. This, however, also lead to a more positive evaluation of the supervisor who was able to solve the problem. Through operant conditioning the negative attitude changed towards a more positive one. The group of 'non-users' did not change their negative attitude.

7.1.5 Sustainability

Participants were shown to have a high involvement with the topic of sustainability/ sustainable mobility and are therefore highly motivated to take this topic into consideration regarding the AMs. Participants associate electric mobility with reduction of greenhouse gas emissions. Through cognitive processes these positive reactions induce a positive attitude towards the AMs as they are also associated with electric mobility. The identified group of 'engaged environmental advocates' see the AMs as a way to substitute Diesel-powered buses. Participants – expect for the group 'Car friends' – are motivated to substitute the use of their car with the AMs. This additionally leads to a positive attitude towards AMs regarding sustainability. Engaged environmental advocates also see the benefits of reducing traffic noise through the AMs. Here existing information was connected to newly learned information about the AMs and the initial positive attitude was reinforced. The group of 'environmental friends' also expressed a positive attitude, however for them the aspects of temporal flexibility were more relevant than the sustainability aspects. They did not change their attitudes during the study.

7.1.6 Technology of Autonomous driving

The participants had a high openness and interest regarding innovation and a high degree of involvement concerning autonomous driving. Therefore, the participants had already engaged with the topic and had existing knowledge about it. Two groups could be identified:

- 'Higher involvement'
    - high involvement, high level of knowledge regarding current technology, opportunities, and barriers; professionals from the software or IT industry; personal experience with automatization or artificial intelligence.
    - Higher involvement participants already had a quite concrete understanding of the opportunities and barriers concerning the AMs.
- 'Lower involvement'

- less interest in the topic, less knowledge and less concrete understand about the concepts of automated driving and integration of AMs.
- Their involvement increased through the study, and they gained a more concrete understanding of the possibilities of integration of AMs.
- This also enabled them to see the added value of AMs and develop a more positive attitude towards them.

7.1.7 Integration concepts

The participants developed different concepts for integrating the AMs:

- on-demand concept
  - connection of the AMs with a smartphone app through which the AMs can be ordered and paid; app also provides additional information.
  - This concept was liked most by participants who see their relevant needs of freedom, convenience and comfort as satisfied through such a concept.
  - The higher involvement group expressed concerns regarding the feasibility of such a concept and expressed less affection for it. They see greater viability in the fixed-routes concept. This positive affection was reinforced during the study.
- fixed-routes concept
  - AMs service on a pre-defined route with high frequency at all times.
- fixed-routes with time schedule
  - similar to existing public transportation; added routes to the current transportation system or substitution of normal buses.
  - This concept was least liked by participants as is it seen as not satisfying the current needs.

7.1.8 Conclusions

Participant had a generally positive attitude towards the integration of AMs with the caveat of their safety-need being sufficiently satisfied. There was no major rejection or skepticism towards autonomous driving amongst the participants. Opportunities are especially seen in the flexibility and relief the AMs can provide. During the study the positive attitude of the participants was reinforced. Participants engaged with the topics of autonomous driving and integration of the AMs and therefore gained a better understanding of the potentials causing their attitudes to change. An attitude change due to personal experience or operant conditioning was only seen for the evaluation of the safety driver.

7.2 Comparison results representative survey Lyon 2019 and 2021

One goal of WP8 is to identify changes in terms of social impact. Therefore, we will compare the results of the AVENUE 2019 survey with the results of the 2021 survey. As explained in chapter 2 (methodology) the data collected in 2019 are only representative for Lyon. Therefore, a comparison with a specific look on possible changes in awareness, attitudes and willingness to use towards automated minibuses only makes sense for Lyon but not for Copenhagen, Geneva and Luxembourg.

Data collection for Lyon in 2021 is presented in chapter 5. Both samples, 2019 and 2021, are representative. But there is one difference. In 2019, the data were collected via CATI-interviews, in 2021, data were collected via online-interviews. In 2019, the data collection for Lyon was integrated in the "Barometre Usages et Profils 2019 – Questionaire de l´enquete". Lyon is the only city that thus had no problems in reaching the aimed quota of 600 respondents in 2019. However, only a limited number of questions from our survey were included in the Barometer.

7.2.1 The Lyon demonstration site:

Nayva and Keolis Lyon operated an automated minibus service in Lyon in 2016. This automated minibus served the Confluence eco-district along the river Saone. For the AVENUE project, SYTRAL and Keolis Lyon offer an innovative public transport service to the Groupama Stadium,in Lyon. This service is deployed in times when there are no stadium events, such as football matches and concerts. Tramline T3 provides transport during events. The shuttle bus route will link the T3 Décines Grand Large tramway station to Groupama Stadium, reinforcing the existing 85 bus line. The introduction of the automated minibus service will provide a solution for the last kilometre.

The automated minibuses are in operation since 17 September 2019 in a test mode. As of 18 November 2019, the automated minibuses can be used by the general public. The operations were halted on 14 March 2020, due to the COVID-19 pandemic. In the period between 18 November 2019 and 14 March 2020, the automated minibus service was used by 4,000 passengers. The automated minibuses drove a total of 6,400 km. This results in an occupancy rate of 1.13 passengers per journey. The minibuses resumed operation on 14 September 2020. However, the operations were impacted by the COVID-19 restrictions and were not as functional as in the previous period. In the period between 14 September 2020 – 31 January 2021, the automated minibuses transported 1,639 passengers, and drove a total of 4,750 km. This results in an occupancy rate of 0.3 passengers per journey.

7.2.2 Awareness of automated minibuses

In 2019 already more than every second respondent had at least about automated minibuses. But knowledge did not really increase between 2019 and 2021 (see Figure 7.2). This relatively high knowledge on automated minibuses can be explained due to the automated minibus pilot that run in Lyon in 2016. This was the first ex, and has gained tremendous media attentions. The small increase between the two

time-periods may be explained by the relatively small operation site of the AVENUE automated minibuses. The site is located near Groupama stadium, outside the city center, and is not in operation during events in the Stadium. The number of experienced citizens slightly increased from 7 to 9 percent. This low increase in users can be explained by the fact that the automated minibus service in Groupama reached a small, but stable user base. Furthermore, the COVID-19 pandemic reduced the overall use of public transport.

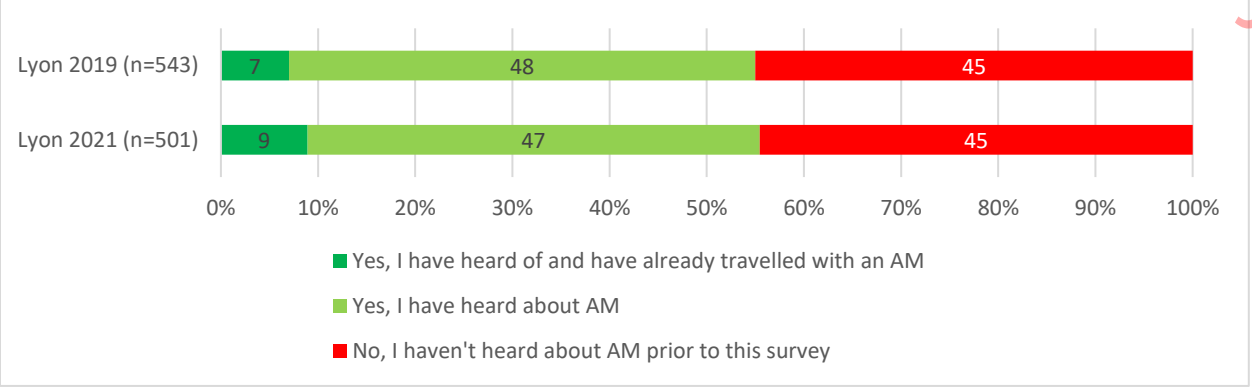


Figure 7.2 Knowledge of automated minibuses 2019 and 2021 (in %)

Q1: Have you ever heard of automated minibuses before participating in this survey?
Q2: Have you ever travelled with an automated minibus?

If respondents knew about the automated minibuses it is still driven by classic media as newspaper and radio/TV but as well by internet and social media. The overall presence of the automated minibuses fortunately increased between 2019 and 2021, especially on the internet, in social media and also on the test-site itself.

Table 7.1 Source of information*: Lyon 2019 vs. 2021

	Lyon 2019	**Lyon 2021**
	n=359	n=278
Newspaper	24%	26%
Radio / TV*1	31%	42%
Internet*2	18%	27%
Social media*3	5%	12%
Seen on test-site*4	14%	32%
Friends	13%	14%

Q: What was the source of information?
* Filter question, only asked to those respondents that indicated to have heard about AM
* More than one answering option was allowed in this question
No Statistical dependence between year of survey and Newspaper as source of information
*1 Statistical dependence between year of survey and radio/TV as source of information, (Chi-Square(1) = 8.949, p=.003)
*2 Statistical dependence between year of survey and internet as source of information, (Chi-Square(1) = 8.265, p=.004)
*3 Statistical dependence between year of survey and social media as source of information, (Chi-Square(1) = 8.225, p=.004)
*4 Statistical dependence between year of survey and seen on test-site as source of information, (Chi-Square(1) = 31.139, p<.001)
No Statistical dependence between year of survey and friends as source of information

Important indicators for social acceptance are the perception of advantages and concerns of the automated minibuses. Awareness has not increased but the information density seems to have increased.

This could explain that the respondents seem to have a higher profile opinion about the automated minibuses, partly more positive attitudes, but fears partly also have increased.

7.2.3 Perceived benefits and risks

A general impression is that the respondents have a positive perception on the benefits of automated minibuses. And this overall positive perception even became more positive from 2019 to 2021 (Table 7.2). In 2021 a majority expects the automated minibuses to ("agree" or "fully agree") provide enhanced freedom for people with reduced mobility (68% in 2019 vs. 81% in 2021), about two thirds expect them to be used as a transport offer for routes that are less popular (51% vs. 68%) and to be more efficient, as you would be able to use your time better than in a car, walking or cycling (45% vs. 59%). Expectations towards an opportunity to book the automated minibuses on demand keep stable at 65%. Questions asking for increased flexibility and successful integration in the public transport were not yet asked in 2019 as these indicators were only identified as important in retrospect (see chapter 4). Additionally, positive expectations that the negative impact on environment (67% vs. 73%) and congestion may be reduced also increased (48% vs. 70%).

Table 7.2 Perceived benefits of AM services 2019 and 2021, part 1

Mean	Top box 4 & 5 (agree) Low box 1 & 2	Lyon 2019		Lyon 2021	
Basis		n= 629		n= 443	
…reduce the negative impact on the environment. *1		3.87	67 18	4.06	73 8
Basis		n=630		n=435	
… reduce congestion *2		3.37	48 27	3.91	70 12
Basis		n=632		n=418	
… be more efficient, as you would be able to use your time better than in a car, walking or cycling *3		3.21	45 32	3.68	59 13
Basis		n=342		n=259	
… provide enhanced freedom for people with mobility issues. *4		3.86	68 18	4.21	81 5

Q: To what extend do you agree with the following statements? Automated minibuses will…

*All Mean values which differed statistically significant from each other based on t-tests

*1 significant difference of the mean values for …reduce the negative impact on the environment, $t(1054) = 2.612$, $p = .012$,

*2 significant difference of the mean values for … reduce congestion, $t(1044) = 7.087$, $p < .001$,

*3 significant difference of the mean values for … be more efficient, as you would be able to use your time better than in a car, walking or cycling, $t(1011) = 6.250$, $p < .001$,

*4 significant difference of the mean values for … provide enhanced freedom for people with mobility issues., $t(593) = 3.807$, $p < .001$,

Also, a pleasant and comfortable journey (58% vs. 75%) is more often expected in 2021 Table 7.3. More cautious are still the positive expectations regarding the question if the automated minibus will really cause fewer accidents by avoiding human errors (57% in 2021) but as well are higher than in 2019 (48%).

Table 7.3 Perceived benefits of AM services 2019 and 2021, part 2

Mean	Top box 4 & 5 (agree) / Low box 1 & 2	Lyon 2019		Lyon 2021	
Basis		n= 341		n= 243	
… be used for routes that are less popular *1		3.39	51	3.90	68
			26		10
Basis		n=344		n=235	
… be booked on demand in the future		3.83	65	3.80	65
			14		13
Basis		n=342		n=238	
… cause fewer accidents, as they avoid human errors *2		3.34	48	3.57	57
			28		20
Basis		n=332		n=250	
… be pleasant and comfortable *3		3.74	58	4.07	75
			8		5

Q: To what extend do you agree with the following statements? Automated minibuses will…

*1 significant difference of the mean values for … be used for routes that are less popular, t(579) = 5.125, p < .001,

No significant difference of the mean values for … be booked on demand in the future,

*2 significant difference of the mean values for … cause fewer accidents, as they avoid human errors, t(578) = 2.039, p = .042,

*3 significant difference of the mean values for … be pleasant and comfortable., t(561) = 3.934, p < .001,

On the perceived concerns we see a slightly more differentiated picture. Respondents show a high agreement with concerns regarding the functioning of the automated minibus and especially in these indicators an increase in fears is observed: this includes the interaction with motorized (47% in 2019 to 57% in 2021 who agree to this concern) and non-motorized (46% to 60%) traffic being not clear, its reaction to unforeseen situations and issues of liability in the case of an accident (57% in 2019 and 2021). Respondents are also still concerned that the software may be hacked (48% vs. 54%) Table 7.5. The fear that jobs may get lost is lower in Lyon than in general and reduced from 46% to 22% in 2021.

Table 7.4 Perceived risks of AM services 2019 and 2021, part 1

Mean	Low box 1 & 2 (do not agree) Top box 4 & 5	Lyon 2019		Lyon 2021	
Basis		n= 344		n= 238	
… privacy is not protected		2.41	56 22	2.47	53 19
Basis		n=341		n=234	
… it is not clear who is liable in the event of an accident		3.54	26 57	3.63	16 57
Basis		n=344		n=246	
… it is not clear how automated minibuses interact with motorized road users *1		3.35	29 47	3.59	20 57
Basis		n=339		n=246	
… it is not clear how automated minibuses interact with non-motorized road users *2		3.38	26 46	3.66	18 60

Q: To what extend do you agree with the following statements? Automated minibuses will…

No significant difference of the mean values for … privacy is not protected

No significant difference of the mean values for … it is not clear who is liable in the event of an accident

*1 significant difference of the mean values for … it is not clear how automated minibuses interact with motorized road users, t(570) = 2.155, p = .032,

*2 significant difference of the mean values for … it is not clear how automated minibuses interact with non-motorized road users., t(559) = 2.568, p = .010,

Table 7.5 Perceived risks of AM services 2019 and 2021, part 2

Mean	Low box 1 & 2 (do not agree) Top box 4 & 5	Lyon 2019		Lyon 2021	
Basis		n= 342		n= 235	
… the software may be hacked or otherwise misused *1		3.28	30 48	3.57	19 54
Basis		n=342		n=232	
… I have to learn how to use an automated minibus		3.02	41 41	3.11	29 38
Basis		n=346		n=254	
… the pleasure of driving gets lost		3.04	42 43	2.86	41 33
Basis		n=637		n=417	
… jobs get lost *2		3.21	35 46	3.58	55 22
Basis		n=610		n=361	
… the systems are not reliable *3		2.75	42 27	2.99	31 32

Q: To what extend do you agree with the following statements? Automated minibuses will…

*1 significant difference of the mean values for … the software may be hacked or otherwise misused, t(550) = 2.613, p = .009,

No significant difference of the mean values for … I have to learn how to use an automated minibus

No significant difference of the mean values for … the pleasure of driving gets lost

*2 significant difference of the mean values for … jobs get lost, t(980) = 4.236, p < .001,

*3 significant difference of the mean values for … the systems are not reliable, t(836) = 3.029, p = .003

As already mentioned for the cities overall (see chapter 5), despite several fears, there seems to be a general trust in "the system". Only a small part of the respondents fears that the system may not be reliable (27% vs. 32%). In 2019 the willingness to use the automated minibuses was only asked for one of the three different scenarios asked in 2021: service on demand.

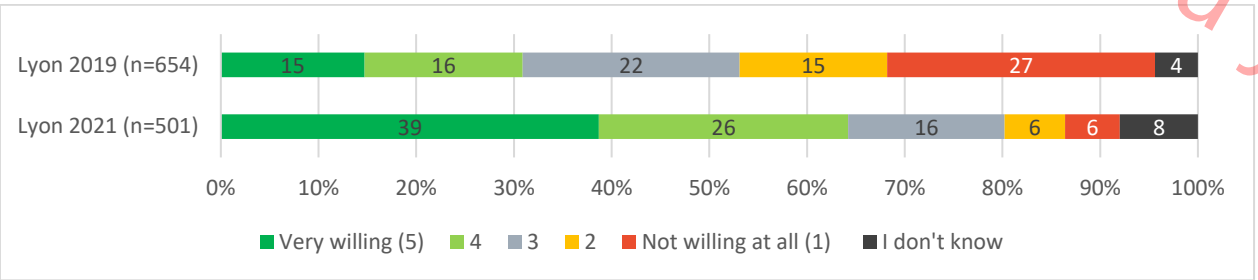


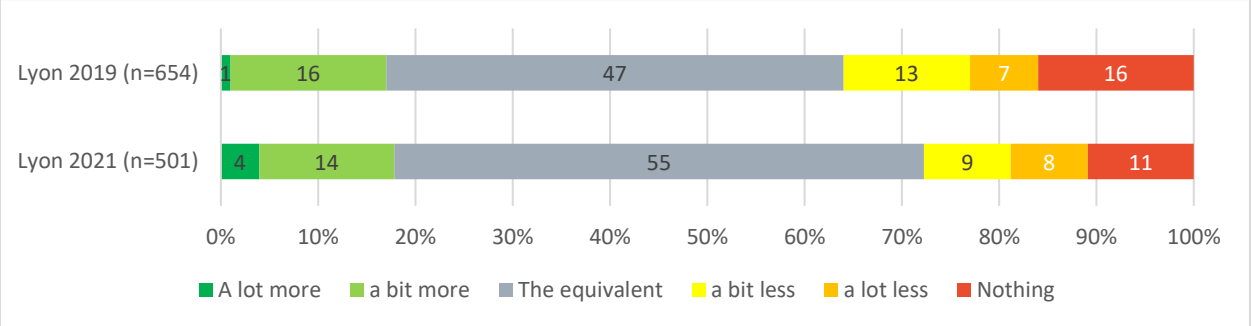
Figure 7.3 Willingness to use the automated minibus if the automated minibus offers an on-demand, door-to-door service. Lyon 2019 vs Lyon 2021 (in %)

Table 7.6 Willingness to reduce the use of own car, if the automated minibus offers and on-demand, door-to-door service (means)

	Lyon 2019 (n=631)	**Lyon 2021 (n=417)**
Mean value*[1]	3.47	3.86

*[1] significant difference of the mean values for Willingness to reduce the use of own car if the automated minibus offers an on-demand, door-to-door service, t(1016) = -4.507, p < .001,

Very important is the insight that in the past potential users were not really be willing to pay more for the automated minibuses. In general, this is still low with 4% are very willing and 14 % are willing to pay at least a bit more if the service would be on-demand door to door. But on the other hand, those refusing to pay more (bit less to nothing) reduced from 36% to 28%.



Q17.1: What would you be willing to pay to use automated minibuses, compared to current, classic public transport?

Figure 7.4 Willingness to pay to use the automated minibus in general Lyon 2019 vs. 2021 (in %)

Table 7.7 Willingness to pay (means)

	Lyon 2019 (n=654)	**Lyon 2021 (n=501)**
Mean value*[1]	3.56	3.36

*[1] significant difference of the mean values for Willingness to pay to use the automated minibus in general, t(1104) = 2.681, p =.007,

7.3 Social media analysis

A new media/social media monitoring has been conducted according to the same principles and format that the one previously done, focusing this time on a period extending from the last third of 2020 to the end of 2021. It includes more than 1'200 comments associated to different online textual contents, images or videoclips from all over the world related to the topic of autonomous public transit coming from various channels ranging from the online press to internet communities and blogposts through the multiple social networks (see the first monitoring report to learn more about these sources but also more generally about the methodology adopted).

7.3.1 Results of the monitoring

Although the most quoted comment is that autonomous public transport is needed and its advent very welcome (17,6% of the comments), the results of this new study indicate that the criticisms and fears towards the autonomous public transit system are significantly more widespread than the positive or enthusiastic remarks about it. Indeed, out of the thirteen comments that independently registered more than 2% of occurrences, only two were positive-minded or highlighting its benefits. In addition, the number of comments affirming that accidents or traffic congestion will be increased by the shuttles' presence is greater than those stating the opposite (1.5 and 2.2 times more respectively). However, the pictured situation of the perceptions is not totally negative and pessimistic neither, the remarks gathered within the "pure positiveness" group (the really enthusiastic ones) represent a large part of the answers (19.1%) and those reflecting "pure negativity" about the autonomous public transport system (putting down the concept without giving it any chance to improve) are, on the other hand, accounting for only 5.1% of the remarks. The number of comments stating that it will be a benefit for the environment is also two times higher than those stating the opposite. In a more general note, it can also be highlighted that "social concerns" is by far the most represented of the previously established categories (concerning 43% of the comments) and that within the theme-based groupings, economic is the most prevalent one (within 26.8% of the remarks). See the figures below and the database results sheet for illustration and details about the results of this monitoring.

7.3.2 Evolution between the monitorings

Despite these mixed conclusions, we can clearly observe that the public opinion is much more favorable to autonomous public transport than it was before when comparing these results to those obtained during the previous monitoring (which covered the 2014 to the second third of 2020 period). This, for example, by noticing that positive remarks are much more present than it was previously the case, and that, out of the nine types of comments occurring more frequently than prior, seven express a positive vision of this new transport model. Also showing this increased positiveness we can furthermore observe:

- A 244.2% increase in the share of comments stating that autonomous public transport is a good option and is very welcome.
- The share of remarks stating that this system will revolutionize daily lives increased by 66.7%.

- The proportion of comments stating that it is an investment for the future was 1100% greater within the second survey.
- Confidence toward autonomous public transport also seems to have improved: the part of comments stating that accidents will be reduced have increased by 142.9%.
- Shuttles are now considered more capable of adapting to their environment, as shown by the increase of the share of comments stating that the system will contribute to reduce traffic congestion (+300%) or that it represents an environmental boon (+155.6%).

Let's also note that the types of comments that increased in proportion during the second monitoring are overwhelmingly positive (see Figure below)

	Count (all channels) **First** monitoring	Share (%)	Count (all channels) **Second** monitoring	Share (%)	Share fluctuation
ASCT will suffer from incivilities	69	1,7	40	3,3	+94,1% *
ASCT are welcome we need them!	209	5,2	217	**17,9**	+244,2% *
ASCT = waste of public funds	210	5,2	101	**8,3**	+59,6% *
ASCT will reduce/stop road accidents	113	2,8	82	6,8	+142,9% *
ASCT will reduce/stop traffic congestion	12	0,3	14	1,2	+300% *
ASCT are Eco-friendly	36	0,9	28	2,3	+155,6% *
ASCT are an investment for the future	4	0,1	14	1,2	+1100% *
ASCT will change our lives	50	1,2	24	2	+66,7% *

Figure 7.5 Type of comments that increased in proportion in the second monitoring with respective rates of increase

(ACST = **autonomous** shuttles for collective transport). Almost all results obtained there have an extremely high significance (significant at p <0.01 or less are accompanied by a green asterisk). In bold are represented the top 3 most common comments at the scale of the whole monitoring.

Adopting an inverted standpoint is still suggesting an improvement of the opinions towards autonomous public transport: the part of negative remarks is mostly decreasing when compared to the first monitoring. Importantly, this decrease is particularly noticeable for some of the crucial recriminations that could easily hamper the diffusion of this new transportation model:

- The share of remarks claiming that autonomous public transports are dangerous is decreasing (-27.8%), same for those stating that they are unreliable (-71.4%) or susceptible to be hacked, to bug or to be used for terrorist attacks (-39.4%).
- The proportion of complaints related to the erratic or abrupt behavior of the vehicle have decreased sharply as for those related to rude braking (no more occurrence) or stopping without a valid reason (-69.6%). The criticism that shuttles can't handle real life situation also decreased (-40.9%).
- No more comments related to the question of personal data protection.
- Significantly fewer negative comments concerning the service itself, they are for example proportionally much less to state that there are too many delays and a correct service is not assured (-66.7%), that the journeys are not numerous enough or badly placed (-87.5%), not long enough (-75%) or that the service is too expensive (-75%).
- Autonomous public transport also seems to be perceived as a more serious alternative, and its future generalization is less questioned than it was before. Thus, the statement that they are sporadic and have no future was not even encountered, whereas it represented 47 occurrences in the previous monitoring. In this same optic, we can also note that the share of comments claiming there will be no

customers for this service or that the legal framework is not ready yet are also decreasing (from respectively -77.8% and -58.3%).

Furthermore, all types of comments that occurred less frequently than before (with a statistically significant decrease) expressed a negative vision of autonomous public transports. The situation where the three most frequent remarks in the initial monitoring were negative has now changed for the better as well. On a larger perspective, it can also be observed that in most cases the criticisms that were frequently made in the first monitoring are now much more occasional.

	Count (all channels) **First** monitoring	Share (%)	Count (all channels) **Second** monitoring	Share (%)	Share Fluctuation
ASCT are dangerous / we can't trust them	393	**9,7**	85	7	-27,8% *
ASCT are stupid / can be hacked / "Bug"	135	3,3	24	2	-39,4%
Jobs are going to be cut	645	**15,9**	180	**14,9**	-6,3% *
Operators don't care about the population but only about their profits	12	0,3	1	0,1	-66,7% *
Will make unfair competition with other services that offer door-to-door	47	1,2	0	0	-100% *
ASCT are sporadics / don't have any future	46	1,1	0	0	-100% *
ASCT are not ready for real life experiments at the time/ can't handle	180	4,4	31	2,6	-40,9% *
Conspiracy theory	15	0,4	2	0,2	-50% *
There is obstacle management issues / Need to stop everytime	92	2,3	8	0,7	-69,6% *
A correct service is not assured /often late	11	0,3	1	0,1	-66,7% *
There is not enough passengers per Shuttle	69	1,7	8	0,7	-58,8% *
ASCT slow down the traffic / create congestions- traffic jams	112	2,8	31	2,6	-10% *
No tender call, cronyism	42	1	3	0,2	-80% *
ASCT are slow	394	**9,7**	88	7,3	-24,7% *
ASCT services are too expensive	17	0,4	1	0,1	-75% *
ASCT are braking too hard/abrubtly	12	0,3	0	0	-100% *
Journeys are not long enough	31	0,8	2	0,2	-75% *
There is no costumers for autonomous PT	35	0,9	3	0,2	-77,8% *
Misplaced/not enough courses	31	0,8	1	0,1	-87,5% *
The legal framework is not ready	49	1,2	6	0,5	-58,3% *
Robotization of the society	84	2,1	9	0,7	-66,7% *
Will decompartmentalize rural areas / poorly served areas	91	2,2	16	1,3	-40,9% *
Problematic use of personal data	10	0,2	0	0	-100% *
ASCT are unreliable and always break-up	29	0,7	2	0,2	-71,4% *

Figure 7.6 **Comments with a share decrease in the second monitoring (with respective decrease rates).**
(*green = significant at p<0.01, *yellow = significant at p<0.1, *red = not significant at p<0.1)

The trend is obviously the same if we look at the composite indicators evaluating the level of positiveness/negativity that were established within the first monitoring. Indeed, the share of the "pure negativity" indicator decreased from 5.8% to 4.1% and the part of the "pure positiveness" one increased from 5.3% to 19.1%. The share of comments denoting the need of significant improvements dropped from 25.9% to 14.7%. These categorical aggregations also show us that technical failures fears are less common within the latest monitoring, as well as safety concerns and comments stating the service is poorly adapted to customers. See figure below for details on the evolution of categorical and thematic groupings:

However, it is necessary to put these upbeat conclusions into perspective, as certain recriminations remain

Categories	**First** monitoring		**Second** monitoring		
	Count	Share (of the total)	Count	Share (of the total)	Share fluctuation
Social concern	1607	39,7%	521	43%	(+8,3%)
Technical insufficiency	980	24,2%	191	15,8%	(-34,7%)
Security concern	921	22,7%	218	18%	(-20,7%)
Sercvices ill-adapted/ maladjusted to the costumer	805	19,9%	135	11,1%	(-44,2%)
Services inadapted to their environment	734	18,1%	194	16%	(-11,6%)

Thematic	**First** monitoring		**Second** monitoring		
	Count	Share (of the total)	Count	Share (of the total)	Share fluctuation
Economy	1235	30,5%	324	26,8%	(-12%)
Technology	812	20,1%	124	10,2%	(-50%)
Ecology/ landscape	128	3,2%	56	4,6%	(+44%)

very frequent, such as those denouncing the negative consequences for the job market (14.9% of the occurrences) and a waste of public money; but it is nevertheless noticeable that these complaints are, in relative terms, decreasing. We can also notice that the vast majority of the contents related to autonomous public transit don't even have led to a single comment, showing that enthusiasm is not really prevalent either.

A new temporal analysis was also carried out as a follow-up to the first one. Here, the results obtained are not able to confirm the trends that just have been observed (because those particular studies are based on comments related to *Youtube* and online newspaper articles solely but also because we are talking there only on absolute terms). Nevertheless, this analysis permitted to draw the assertion that the peak

of comments (in total but also for the specific recriminations we focused on) that had been reached in the second third of 2019 has not been exceeded since then and that their actual number for the period of the second monitoring were stagnating at the level that prevailed since early 2016. Because of these sparse results, the different curves of evolution of the comments over time are only available in the annex section. Note that other conclusions (but also methodological information, the limit of this procedure etc.) are proposed in the first monitoring temporal analysis.
Note that the combined results, were also calculated without making any real extra conclusion possible. These results are available on the database result sheet…

7.3.3 Why have perceptions changed so favorably?

As has been shown, when comparing the two different monitoring phases, the perceptions of autonomous public transport have improved. This evolution, driven by societal changes and shaped by the intricacies of the human psyche, can be explained by multiple factors.

The enhancement of autonomous technologies

Firstly, and very pragmatically, this improved perception can be directly linked to technological improvements and recent advances in the field of autonomous public transport technologies, particularly in terms of vehicle behavior. Progress has also been very palpable in terms of reliability but also of service quality, with an improved punctuality, less interruptions as well as more frequent journeys, with more varied and longer routes within most of the more recent projects.
The sharing of the experience and the positive feedback from those who have had the opportunity to test the technology and see for themselves how well it works (mainly via word of mouth or social networks) means that gradually these successful results are beginning to be known, thus changing the popular perception for the better. In the context of autonomous public transport precisely, Attias and Antonialli state that "exposing commuters to the technology at very early stages on a small-scale and under controlled conditions gradually and slowly expose and familiarize the population with ASCTs (*autonomous shuttles for collective transport*)"[17] and that "after getting acquainted with the technology, users showed positive attitudes towards the implementation of ASCTs, perceiving the shuttles as convenient, accessible and safe"[18].
The increasing frequency and scale of projects implementing autonomous public transport also reflects the progress of the model, and these test phases foster the public's confidence. In this regard, Rasouli and Tsotos state that the people who heard about those experiments "had higher acceptance compared to general population for autonomous driving technologies"[19]. Hanappe & al. also confirm that projects and experiments conducted around the world "support not only technological advancements, but also societal familiarity and comfort with the technology"[20].

[17] ANTONIALLI, Fabio, ATTIAS, Danielle, *Social and economic impacts of Autonomous Shuttles for Collective Transport: an in- depth benchmark study*, Laboratoire Génie Industriel, 17 pages, 2019
[18] Ibid.,
[19] RASOULIS, Amir, TSOTSOS, John, *Autonomous Vehicles That Interact with Pedestrians: A Survey of Theory and Practice*, IEEE Transactions on intelligent transport systems, Vol. 21, p.900-917, 2020
[20] ALBA, Dominique, HANAPPE, Florence, HUDSON, Annie, *Impacts and POTENT IAL benefits of autonomous vehicles*, Atelier parisien d'urbanisme, 49 pages, 2018

From a more global point of view, it is worth noting that the latest generations of advanced driving assistance systems (ADAS) for individual vehicles already give a strong foretaste of the autonomous future, which contributes to the enthusiasm for the prospect of an autonomous public transport system, which then seems less and less a scientist's and politician's utopia, but above all reinforces the feeling of confidence in such technologies.

The above mentioned opinion changes are for sure influenced by the progressive and incremental technological evolution of ASCT that began a decade ago, but it is interesting to note that concerning Navya vehicles which represent a substantial part of all the ACST with almost two hundred vehicles spread over 21 countries (according to Antonialli, they are present in 31 of 92 conducted experiments that he accounted for[21]), the most decisive changes in the driving behavior took place during an update whose date coincides with the beginning of the second monitoring (last third of 2020). To a certain extent, it may then eventually be the influence of this very specific advance that is more particularly reflected in the positive evolution of the public perceptions observed from one monitoring to the other. To be more precise, we are evoking there the implementation of the 6.0 software version (first rolled out on the AVENUE Belle-idée/TPG site) and of the 6.1 one, which quickly followed to correct some bugs, that has permitted to no longer restrict the field of vision of the LiDARs, since the update allows the management of three times more vertical lines for the horizontal scanning process than previously possible (formerly software restricted), thus also significantly increasing the precision of the images collected by the shuttles and thus improving the perception capabilities of the vehicle in a more general sense. The sensitivity of the shuttles to challenging situations such as overtakings has also been adjusted; they now understand that an overtake is about to happen and therefore do not make dangerous braking when these situations occur. The behavior of the shuttles has also been fine-tuned through this update, they no longer let the rest of the circulation dictate their pace, don't give everyone the priority when they shouldn't anymore, they now demonstrate their determination by moving forward slowly, whereas previously they were giving room for abuse by stopping completely. The shuttles now have more poise, insistence and, when needed, firmness, thus gaining confidence and facing the realities of the traffic better that they now take well into consideration.

Strong media visibility

The highlighting of various autonomous public transport projects through the print and digital media, television and social networks, initiated back in 2014, has resulted in the familiarization of the population with this new mobility concept, but also with the visual appearance of the different autonomous shuttles. Thus, this is the "media attention on autonomous vehicles, which made the vehicle feel familiar"[22]. Furthermore, this media exposure also strongly contributes to the improvement of the opinions and the reinforcement of acceptance, as confirmed by researchers such as Jing and Xu, who state that "preferences

[21] ANTONIALLI, *International benchmark on experimentations with Autonomous Shuttles for Collective Transport*, International journal of automotive technology and management, vol.21, pages 5-28, 2021

[22] SOLONEN, Arto, HAAVISTO, Noora, *Towards Autonomous Transportation. Passengers' Experiences, Perceptions and Feelings in a Driverless Shuttle Bus in Finland*, MDPI open access journal, 19 pages, 2019

of AVs would change due to media promotion"[23], or by Nordhoff who concludes that "communication mechanism may be required to positively relate to AVs acceptance and use"[24].
Another benefit of this strong visibility is that it allows everyone to see all of the innovative features of autonomous public transport and to realize the benefits of adopting such a system; indeed, "by explaining the clear purpose of driverless shuttle buses [...] interest and desire (can be) created"[25]. Another aspect underlined by this significant media coverage that may have favored an improvement in acceptance is the evocation of the functioning principles of autonomous vehicles and their associated technologies. These references, although brief and caricatural, reinforce the feeling of awareness of the audience, which is comforting and leads to a greater confidence and thus to a higher propensity to accept and use these technologies. Thus, as Merat and Mardigan point out, "increasing public engagement and awareness of the vehicle's capabilities is likely to increase the acceptance"[26] and Cheng also presses the need "to educate individuals about how the (autonomous) technology works"[27].
During their reports, the media also echo the concrete improvements evoked above, allowing the public to become aware of it.

7.3.4 Impact of the pandemic on the attitude towards technology

Another critical factor driving the growing acceptance and optimism of autonomous public transport is the changing perception of technology induced by the pandemic situation. Indeed, "the extremely disrupting impact of the COVID-19 pandemic causes theories and models that used to be helpful in studying and explaining technology acceptance and technology use to suddenly become obsolete (at least partially)"[28].
Indeed, the appearance of the virus has encouraged the adoption of digital technologies at a rate and scale never seen before. These technologies are used both to maintain a professional and social life (remote/cloud working, teleconferencing, social networks), but also as a means of active and passive fight against the virus (touch-free payment and QR codes generalization, covid certificate, forms of delegation of tasks to machines, etc.). Velikic notes in this regard that "COVID-19 restrictions have called for inevitable and immediate adoption of technology in almost every field […] people had no choice but to accept using technology not just for performing daily tasks but also for ensuring survival"[29] along with Vargo & al. who say that "in an effort [..] to maintain the status quo, various types of human behavior (e.g., shopping, learning, working, meeting, and entertaining) shifted from offline to online, resulting in an accelerated

[23] JING, Peng, XU, Gang, JIN SHI, Juji, *The Determinants behind the Acceptance of Autonomous Vehicles: A Systematic Review* Jiangsu University, 2020
[24] NORDHOFF, Sina, MERAT, Natasha, *Human Factors, User Requirements, and User Acceptance of Ride-Sharing In Automated Vehicles*, Delft University of Technology, 26 pages, 2017
[25] SOLONEN, Arto, HAAVISTO, Noorda, *Towards Autonomous Transportation. Passengers' Experiences, Perceptions and Feelings in a Driverless Shuttle Bus in Finland*, MDPI open access journal, 19 pages, 2019
[26] NORDHOFF, Sina, MERAT, Natasha, *Human Factors, User Requirements, and User Acceptance of Ride-Sharing In Automated Vehicles*, Delft University of Technology, 26 pages, 2017
[27] CHENG, Michael, *PwC Survey Reveals What People Really Think About Autonomous Cars*, Future car.com [*consulted on 26 déc. 2021*]
1 [28] VAN DEN HEUVEL, Sjoerd, *COVID-19 beats current technology acceptance theories*, 2020
[29] VELIKIC, G., TODOROVIC, B., KUKOLJ, *Post COVID-19 thoughts: controversies and merits of the technology progress,* IEEE Consumer Electronic *Magasin* 9, p.92–94, 2020

diffusion of emerging digital technologies among ordinary people"[30]. Digital technology floods daily lives and adopts all forms and functions; some call the era the digital new deal.

Technology being now omnipresent and mastered even by those who were the most reluctant to adopt it, it is consequently increasingly accepted. This proximity also means that technology is increasingly being trusted in more and more situations and areas of public life, right down to the most intimate day-to-day matters. Ouma & al. thus note that, "trends that are likely to be exacerbated by the pandemic (are) specifically the growing public reliance on tech firms for basic services"[31]. Moreover, there is no reticence here to deal with entirely new technologies, as individuals have already crossed the digital threshold in many other areas and no longer have the slightest apprehension about facing major changes. The vast majority does not hesitate to place strong responsibilities on the machine shoulders (as autonomous public transit solutions require it). We can also underline that the lockdowns and the changes induced by the arrival of the virus (movements and travels limitations, wearing of the mask, social distancing, fear of the virus itself) have created upheavals, a real rupture which has created a fertile ground for the acceptance of large-scale changes, such as those represented by the transition to the autonomous public transit system. The generalization of technologies and their acceptance are moreover increased drastically by the fact that the machine is now considered healthy and safe, as opposed to its human counterparts who are potential vectors of the virus feared by the crowds; the threat here is therefore no longer the machine, but quite the contrary, which puts the traditional recurring complaint of the absence of a driver into perspective.

The better technological mastery forged by the daily use of digital tools means that people also tolerate it more and more, that they become increasingly familiar with it; "chances of experiencing mastery using technology is enhanced, which ultimately may have reflected in a favorable attitude toward accepting technology in general"[32]. To go further, this new acceptance is facilitated by the "belief of technology usefulness"[33].

These influences of the pandemic on technology acceptation have already been highlighted by the research and Anderson & al. state in this regard that "people's relationship with technology will deepen"[34], as do Sajid and Erum who point out that "in the post-COVID-19 world […] a much more favorable attitude among people in general toward accepting technology than before COVID-19 (is to expect)"[35].

The use of teleworking will be maximized and changes in commuting motives and habits ("we may yearn to travel but not for work"[36]) will make the flow of transportation more evenly distributed throughout the day. This fits perfectly with the autonomous public transportation system's capabilities, which, as already noted by the AVENUE teams, is an extremely efficient means of transportation in cases of diffuse and regular demand. This is particularly relevant because, as confirmed by the research, teleworking and its associated lifestyle habits will persist regardless of the existence of the virus. Indeed, in this regard, Riom

[30] VARGO, Deedra, ZHU, Lin, BENWELL, Briana, YAN, Zheng, *Digital technology use during COVID-19 pandemic: A rapid review*, *Human Behavior and Emerging Technologies,* 2020

[31] IAZZOLINO, Gianluca, OUMA, Marion, MANN, Laura, A Digital New Deal Against Corporate Hijack of the Post-Covid 19, 2020

[32] ERUM, Ishaq, SAJID, Bashir, RAMSHA, Zakariya, SARWA, Aisha, *Technology Acceptance Behavior and Feedback Loop: Exploring Reverse Causality of TAM in Post-COVID-19 Scenario,* Frontier Psychology, 7 pages, *2021*

[33] Ibid.,

[34] ANDERSON, Janna, VOGEL, Emily, *Experts Say the 'New Normal' in 2025 Will Be Far More Tech-Driven, Presenting More Big Challenges*, Pew Research Center, 2021

[35] Ibid.,

[36] VARGO, Deedra, ZHU, Lin, BENWELL, Briana, YAN, Zheng, *Digital technology use during COVID-19 pandemic: A rapid review*, 2020

and Valero found that over 90% of innovating firms intend to keep such changes in place once the immediate crisis is over.
This context, which is very favorable to new technologies, is obviously an opportunity for the implementation of the autonomous public transport model, but paradoxically, the current sanitary measures may seem incompatible with this concept because of the small size of the vehicle particularly; indeed, the situation has already prevented the implementation of many projects and the smooth operation of test or operating phases in the existing ones. This therefore implies, in a more distant perspective, a delaying of the generalization of the model. In addition, due to teleworking and the fear of the virus, commuting was greatly reduced and the use of public transport underwent the same trend. People who have avoided public transport by fear of the virus during the crisis, may have also become comfortable with their new mode of transport (bicycle, electric scooter, car or any alternative) and do not want to go back to public transportation. The long-term implications of the crisis are therefore not easy to establish and it is difficult to know what the real impact will be on the use of public transport in general.

Since the first monitoring ends in the second third of 2020, i.e. shortly after the emergence of the pandemic, it is in the second monitoring that we can assume that these specific influences on acceptance can be perceived, and this may then also be one of the reasons for the sudden perceptible opinion improvements.

7.3.5 Personal experimentation and daily-use.

Nowadays, autonomous public transports are still extremely infrequently made available to the public. Therefore, the intrinsic experimentation has itself had only a small influence on the current degree of acceptance although it will ultimately determine much of the final acceptance. Wood & al. states in this regard that "as the public increasingly interacts with AVs, their attitudes toward the technology are more likely to be positive"[37]. In other words, "consumer acceptance [...] can be encouraged through widespread experimentation and engagement with a new technology"[38]. This seems paradoxical, as the experimentation is essentially determined by the acceptance, but these two forces will only grow exponentially and widely through the action of their mutual reinforcement; thus, in a rather intriguing way, the usage allow the reduction of fears and the maximalization of acceptance, which in turn encourages the usage. From this we can also conclude that the first experimentation is very impactful but only daily use will finish cement the confidence.

7.3.6 Results reliability and limits

With 4’000 remarks in the initial monitoring and 1’200 in the second one, the sample size is substantial and the results obtained are thus statistically very significant. Furthermore, the sources and channels monitored are diversified, numerous and originate from all over Europe which gives a good idea of the

[37] PENMETSA, Praveena, KOFI, Emmanuel, WOOD, Dustin, *Perceptions and expectations of autonomous vehicles – A snapshot of vulnerable road user opinion*, Technological Forecasting & Social Change, Volume 143, Pages 9-13, 2019
[38] ALBA, Dominique, HANAPPE, Florence, HUDSON, Annie, *Impacts and POTENTIAL benefits of autonomous vehicles*, Atelier parisien d’urbanisme, 49 pages, 2018

prevailing perceptions at this particular scale (but may also lead to conclusions that may not be valid for more specific contexts, as concerns vary greatly according to geographical or social context).
However, a potential bias raised by the AVENUE teams is that those with grievances against the concept of public transport or a particular project might be more likely to post a comment and thus their opinions might be overrepresented. But this may be just as well offset by those who are curious about the topic or involved in the various projects, who display more optimism and open-mindedness.

8 User experiences

To gain insights into the experiences of people that use the automated minibuses and to examine the usability of the new service, a well-recognized instrument is a user survey (see also deliverable 8.8; (Korbee et al. 2019)). In this user survey, citizens experienced the automated minibus in a real situation, means, they were not specifically asked to do so for the survey. It was their own decision to use the service. Inside the automated minibuses they were invited (see chapter 2) to reflect on their experience and to evaluate the usability as well as overall satisfaction but also satisfaction with specific aspects.

In this chapter we will report on the results of the user survey in Nordhaven, Copenhagen and in Sion, Switzerland. Out of the four original pilot cities, we have only been able to conduct the survey in Copenhagen. In Luxembourg operations were stopped due to damage (vandalism), and have not been able to return to deployment due to COVID-19. The pilot site in Belle-Idée, Geneva, is still in test-mode, operating without users. The Groupama site in Lyon was partly in operation in 2020, but due to COVID-19 there were too few passengers, which resulted in a very low response to the survey. Due to a change in software used and the lasting consequences of the COVID 19 pandemic, the site has not been in operation from August 2021 onwards.

The user surveys were planned to start in all cities in March 2020. They were developed, checked and programmed in the period September 2019 – February 2020 in cooperation with the WP8 partners (Sales Lentz, Keolis, TPG, Amobility, ECP and Siemens). The process of developing the user surveys has been detailed in Deliverable 8.8: First iteration Social Impact Assessment (Korbee et al. 2019). However, due to the COVID-19 pandemic all operations were halted, and therefore, the user surveys had to be postponed. In addition to waiting for a restart of the operations, and keeping in close contact with our partners, we developed a guideline for continuation after the COVID-19 pandemic.

In June 2020, we were able to start a user survey in the pilot site in Oslo. This user survey was originally not planned, but included to allow for as much input on user experiences as possible. Unfortunately, we have not been able to get enough respondents to include Oslo in our data analysis. According to Amobility, the reason for non-respondence was that there were too few passengers. Due to travel restrictions, HS PF has not been able to visit the site to conduct alternative user surveys. To increase responses, a shortened paper-pencil survey has been developed, but unfortunately, this also did not result in more replies.

In October 2020, we were able to start the user survey in the Groupama Stadium pilot site, in Lyon. Unfortunately, we experienced low respondents in this site as well. According to Keolis this low response is due to a limited number of frequent users of the automated minibus line. Around 30 users travel with the automated minibus on a regular basis. The three respondents do therefore account for a response rate of 10%. However, this is a too small basis for an analysis. To increase responses, a shortened paper-pencil survey has been developed, that was planned to be conducted in 2021. However, due to ongoing COVID-19 restriction, and a change in software, the site has not been in deployment.

In 2021, we were able to start a user survey in the replicator site in Sion. The results of this survey are included in this deliverable as section 8.2.

In the final stages of the AVENUE project, we continue to push for user surveys to be conducted. Preliminary results are integrated in section 8.3. Those surveys that cannot be included in this deliverable, will be included in WP7, task 7.6.

8.1 User survey Nordhavn, Copenhagen

8.1.1 General Insights

In the user survey, we included a question about overall satisfaction with the local traffic situation, public transportation offers and the local environmental situation. The reason that these questions were included (near the end of the survey) is that they can provide information on the general level of satisfaction of respondents. Including these questions, can provide insights in whether respondents have a general positive or pessimistic attitude – this may also influence their responses regarding the point of interest in the topic of interest here: the user experiences with the automated minibus.

In general, we see that the respondents of our survey have a rather positive view (see also Figure 8.1**Error! Reference source not found.**). About a third of the users mention to be (very) satisfied with the environmental (average 3.2) and traffic (3.0) situation in Copenhagen, where 1 is not satisfied at all and 5 is very satisfied. Nearly two thirds of the asked users state to be (very) satisfied with the public transport offer in Copenhagen (with an average value of 3.6). This may explain that potential users of public transport systems in Copenhagen are on the one hand very open-minded (see representative survey) but do not experience an acute need for alternative transport systems. Compared to the results of the representative survey with potential users in Copenhagen (see Chapter 4), we see that the satisfaction with the local traffic situation (3.1), the public transportation offer (3.4) and the local environmental situation (3.4) is rated similarly.

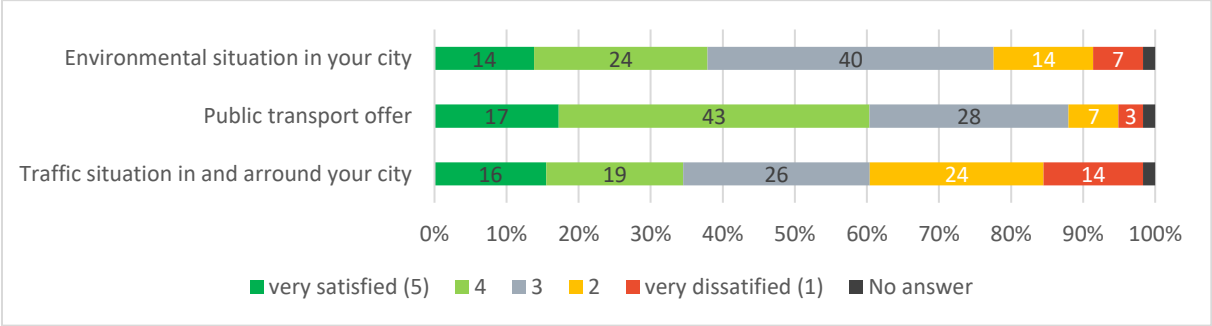


Figure 8.1 General satisfaction with the environment, public transport and traffic (n=7)

8.1.2 Awareness and Acceptance of the automated minibus

There is a wide range of sources of information through which users became aware of the automated minibus (Figure 8.2): the main sources are the internet (28%, especially social media 16%), direct contact on test site (28%) or informal sources such as word of mouth (17%) and friends (10%). Only every fifth user read about it in newspapers (18%) or heard a news item on the radio (16%).

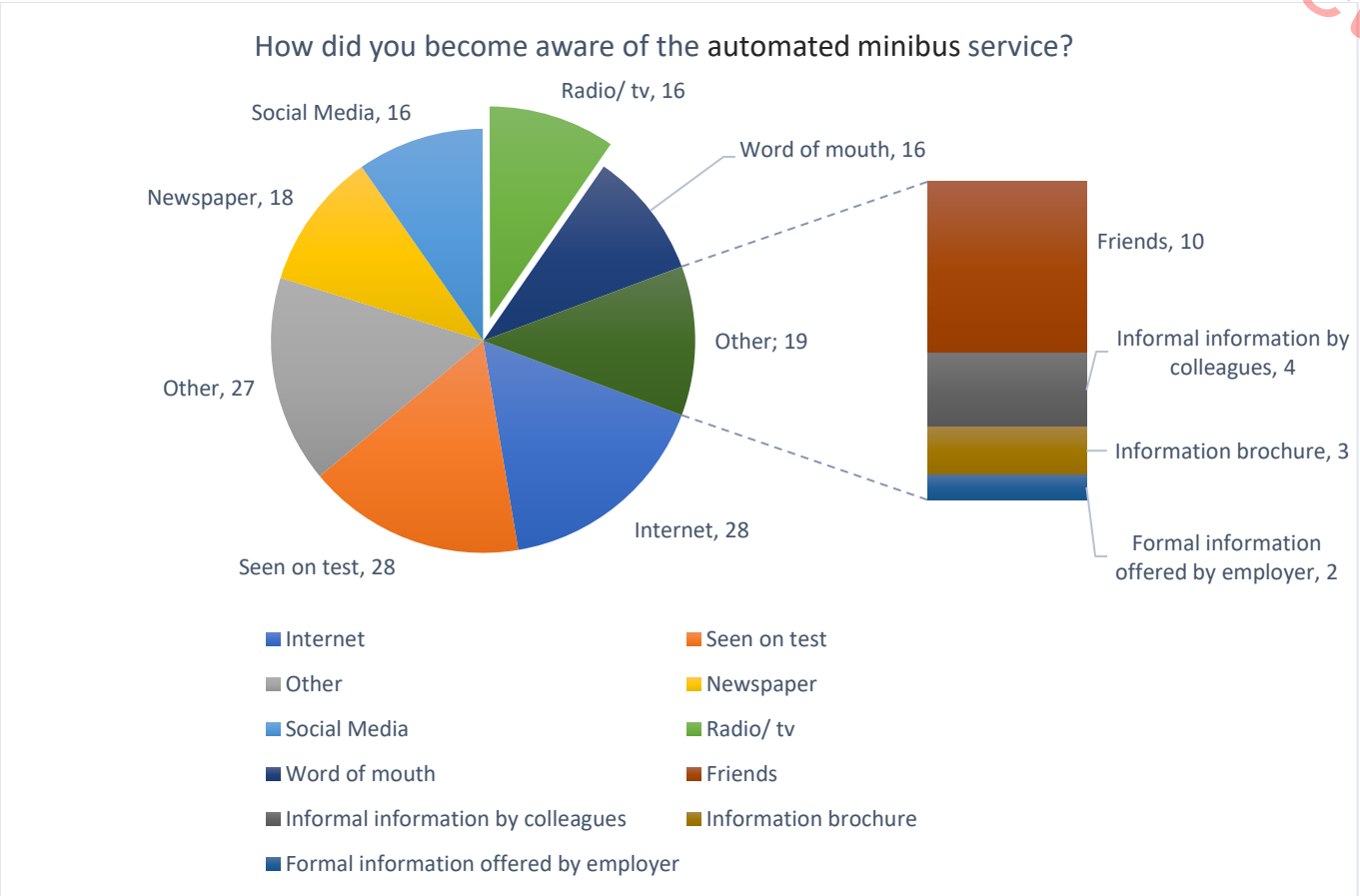


Figure 8.2 Sources of information (in %, n=60)

8.1.3 Motivation to use an automated minibus

The analysis of the motivation to use the automated minibus shows that the users did not plan on using the automated minibuses, but rather made a spontaneous decision, following emotions such as curiosity (88%) or cannot give a concrete reason at all (43%) (see Figure 8.3). This shows that the barriers to use are quite low, but on the other hand it shows that there is still a lack of real conviction in favour of the new mobility system. Positive attitudes that could lead to planned use (see Theory of Planned Behavior (Ajzen 1991)) have not yet been established. Only 4% state that they use the automated minibus because they are already convinced by positive experiences.

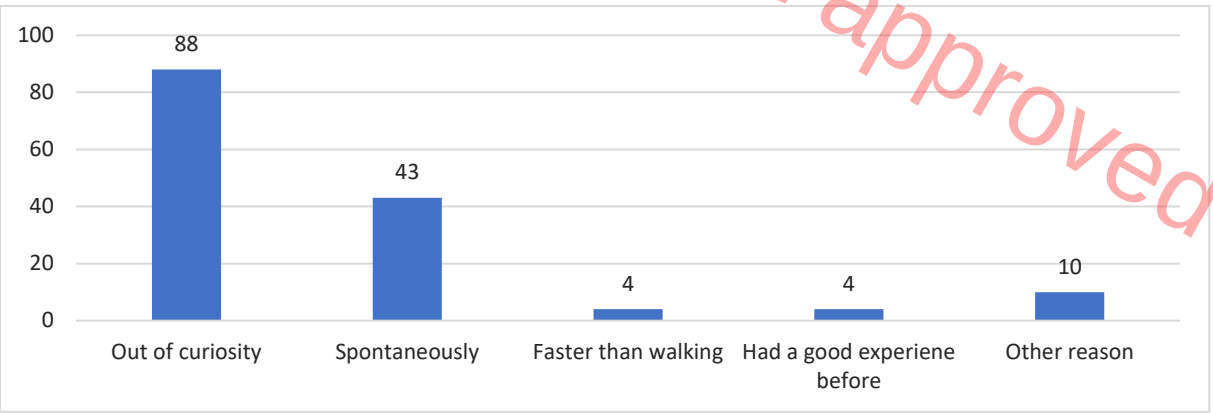


Figure 8.3 Reason to use the automated minibus (in %; n=68)

The automated minibus seems to replace primarily bikes (46%), and not so much other motorized transport systems (see Figure 8.4). In this particular case, this might have to do with the length and location of the line.

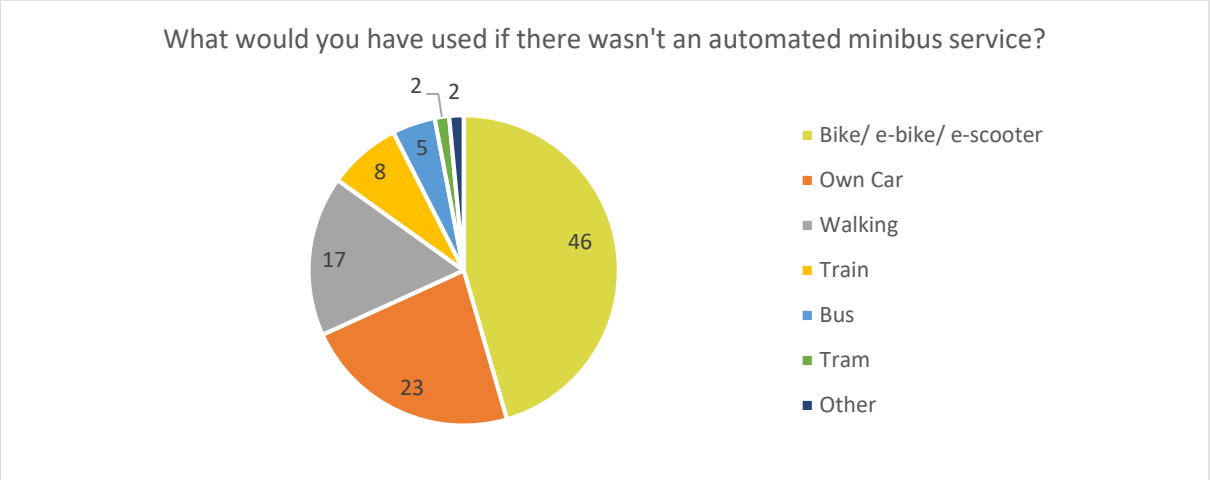


Figure 8.4 Means of transport replaced by the automated minibus (in %, n=66)

When asked whether people brought anything with them on the trip, the majority indicated (89%) that they did not take anything with them. Those that brought something with them on the automated minibus brought luggage (5%), a shopping trolley (2%) or something else (8%). Nobody brought a baby stroller with them. This information is relevant for the discussion on the usability of automated minibuses for people with reduced mobility (that does also include people travelling with luggage and/or baby strollers).

The analysis of the current motivation for use shows that use is currently not motivated by market presence in the sense of concrete knowledge and conviction, but is mainly controlled by spontaneous interest.

8.1.4 User Experience and Satisfaction

Users were asked to their satisfaction of their last ride. Overall, users were highly satisfied with their last ride (mean 4.5 on a 5 point-scale, 5 being very satisfied). Nearly two-thirds (59%) of the users stated to be

very satisfied. An analysis of what was most satisfying shows that especially the overall atmosphere in the automated minibus was experienced comfortable (see Figure 8.5**Error! Reference source not found.**)

- temperature (4.6)
- cleanliness (4.6)
- noise level in the bus (4.5)
- atmosphere in the bus (4.4)
- and comfort (4.0).

Also convincing and satisfying are:

- accessibility (4.1)
- as well as security form outside the bus (4.4)
- and safety in the bus (4.1).

Items that are more difficult to evaluate, due to a lack of experience of the users (most of the respondents had experienced the automated minibus for the first time), are aspects related to quality of service, such as punctuality. As a result, over 50 % of the respondents did not answer these items. If they were able to evaluate the quality of service, the following features were satisfying:

- location of stops (4.3)
- punctuality (4.2)
- location of pilot site (4.1)
- reliability (4.1)
- and waiting time (4.1).

In comparison to these highly satisfying aspects the following aspects were rated slightly worse on average:

- speed/travel time (3.9)
- frequency of service (3.9)
- connection to other transport means (3.0).

The offer of information in the bus is again satisfying (4.5), other offers of information are rarely evaluated. This again stresses that current users did not schedule their ride straight away and therefore did not have any need for more detailed information in advance.

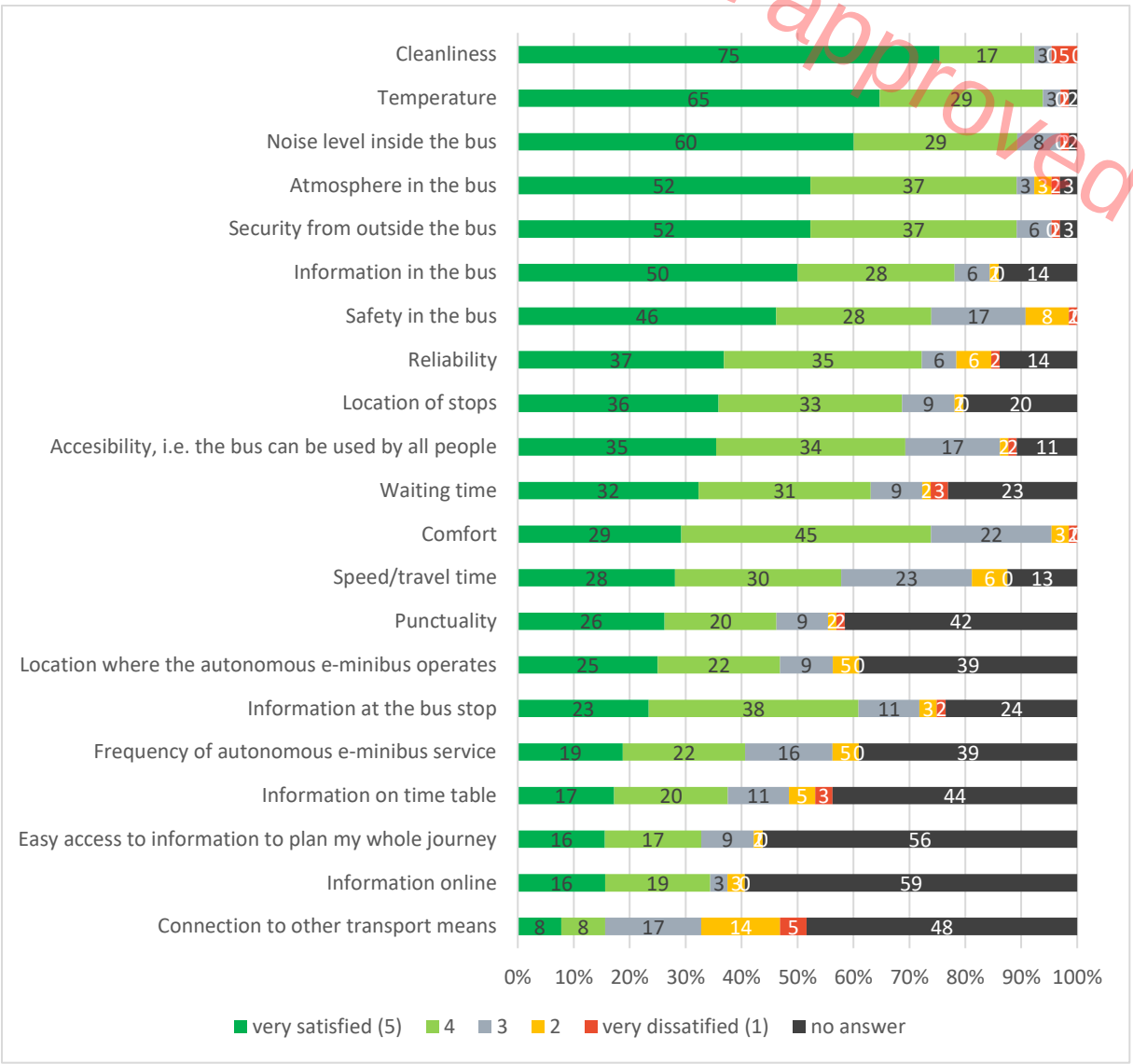


Figure 8.5 Detailed satisfaction with last ride (n=68)

Users seem to experience the ride in a relaxed atmosphere. This is supported by the results of the question 'what describes your feeling/emotions toward automated minibuses best?'. These subjective feelings are described as being characterized by optimism (74%) and curiosity (68%). Suspicious or anxious feelings extremely seldom occurred (less than 5%).

These positive feelings are reinforced by low occurrence of problems. When explicitly asked for 26% of the respondents (16 users out of 62 users that answered this question) mention problems during their trip: unplanned stops, conflicts with other road members, long interruptions, sudden breaking manoeuvre (see Figure 8.6)

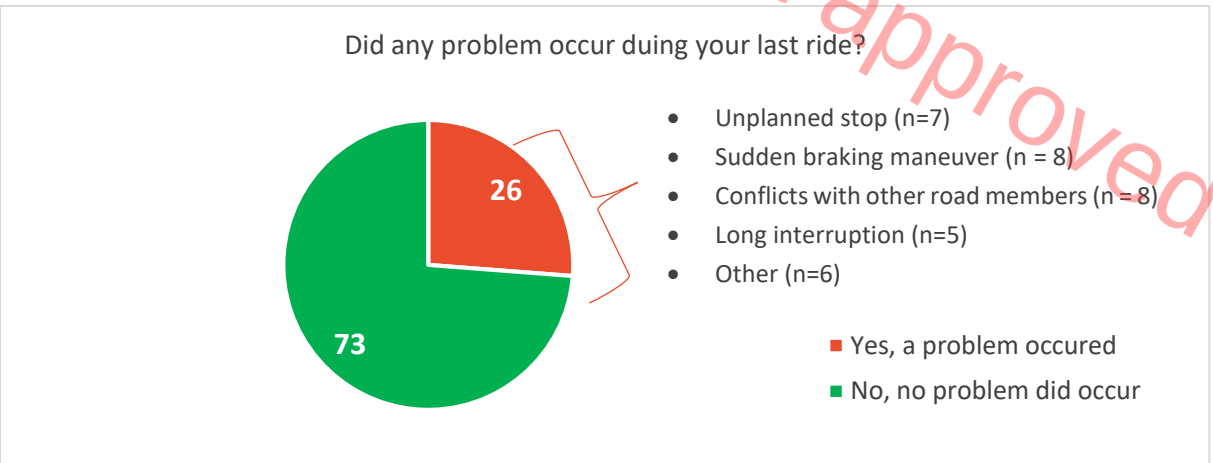


Figure 8.6 Problems occurred during the ride on the automated minibus (in %; n=62)

8.1.5 Willingess to use

The willingness to use the automated minibuses again is extremely high; 76% are very willing to use the automated minibus again, as is indicated in the first bar of Figure 8.7**Error! Reference source not found.**. Only 4% of the users hesitate to use it again, and none of the users indicate that they are not willing to use it again. The results of the representative survey among potential users, (see chapter 5), also point to a high willingness to use the automated minibus. If we filter the results from Copenhagen out of the general outcomes of the representative survey, we see that the willingness among citizens or potential users in Copenhagen is 3.9 out of 5 (the overall average being 3.1). So, the willingness to use the automated minibus (again) is significantly higher among users with specific experience (4.7) than among potential users (3.9).

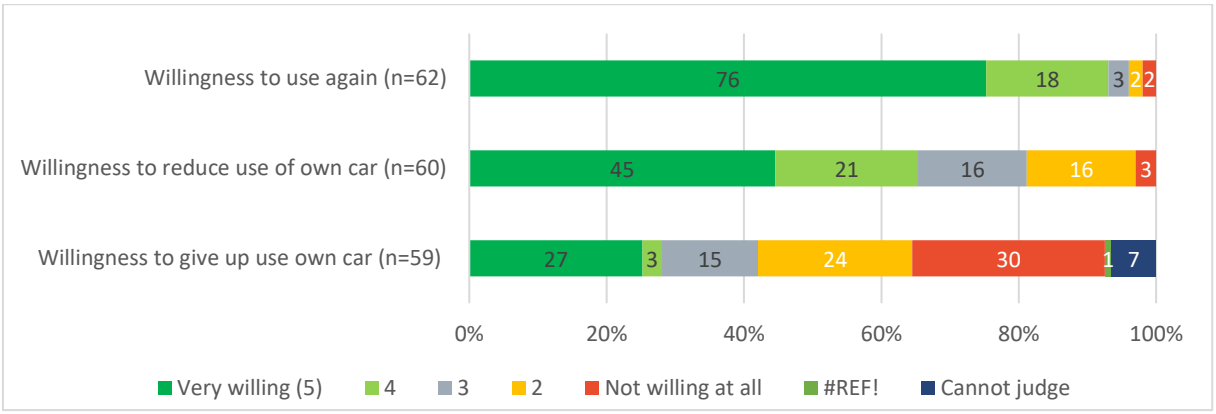


Figure 8.7 Willingness to use again (in %)

The opinions about the readiness of the technology are heterogenous; 32% of the users think that the technology is (completely) ready to be used on public roads, whereas 28% think that it is not ready (at all), as is visualized in **Error! Reference source not found.**Figure 8.8. The results from the representative survey (see chapter 5) show comparable results: 30% of the potential users in the representative survey in

Copenhagen say (completely) ready. Based on this comparison, we say that users are not more convinced than potential users. Nevertheless, 66% do not (at all) feel concerned that parts of the road traffic could become more and more "automated". A study in Switzerland (Neuhausen am Rheinfall and Stein am Rhein) shows comparable results with averages of 3,1 to 3,3 (Bernauer and Wicki 2018).

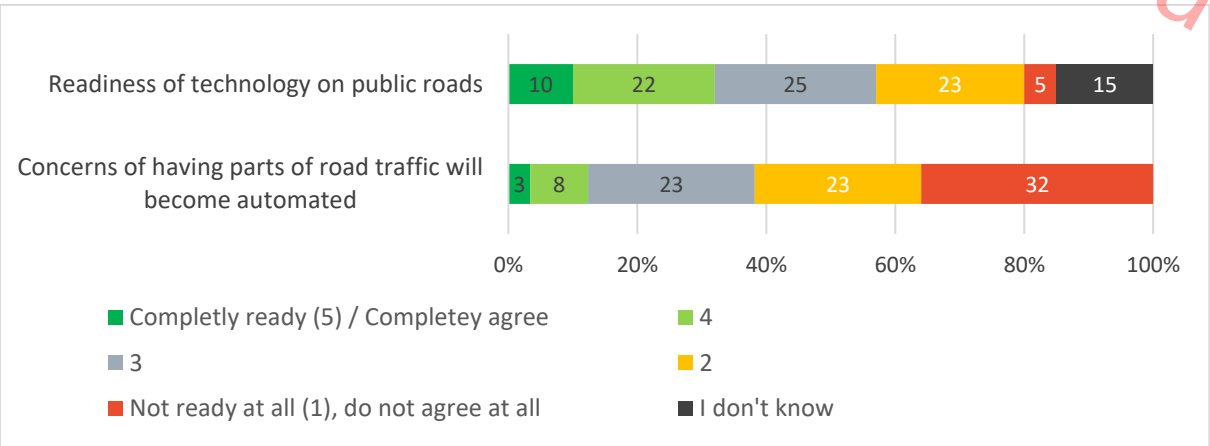


Figure 8.8 Readiness of technology (in %; n=60)

8.1.6 Advantages and concerns

To be able to assess the acceptance of automated minibuses, it is important to gain more detailed insights in the perceived advantages (Figure 8.9) and perceived concerns (Figure 8.10). A general impression is that the respondents have a positive perception on the benefits of automated minibuses. All items asked for have a minimum agreement of 50%, going up to an agreement of 76% for the perceived benefit that automated minibuses can be used for routes that are less popular. The perceived benefit that automated minibuses can reduce congestion is most critically assessed, with a small majority of 51% agreeing. These figures are comparable to those in the original survey of Keolis Downer in Australia (Keolis Downer 2018), the potential benefits were scored on a 10-point scale, ranged between 8.9 for the enhanced freedom for PRM to 8.1 for more efficient use of time.

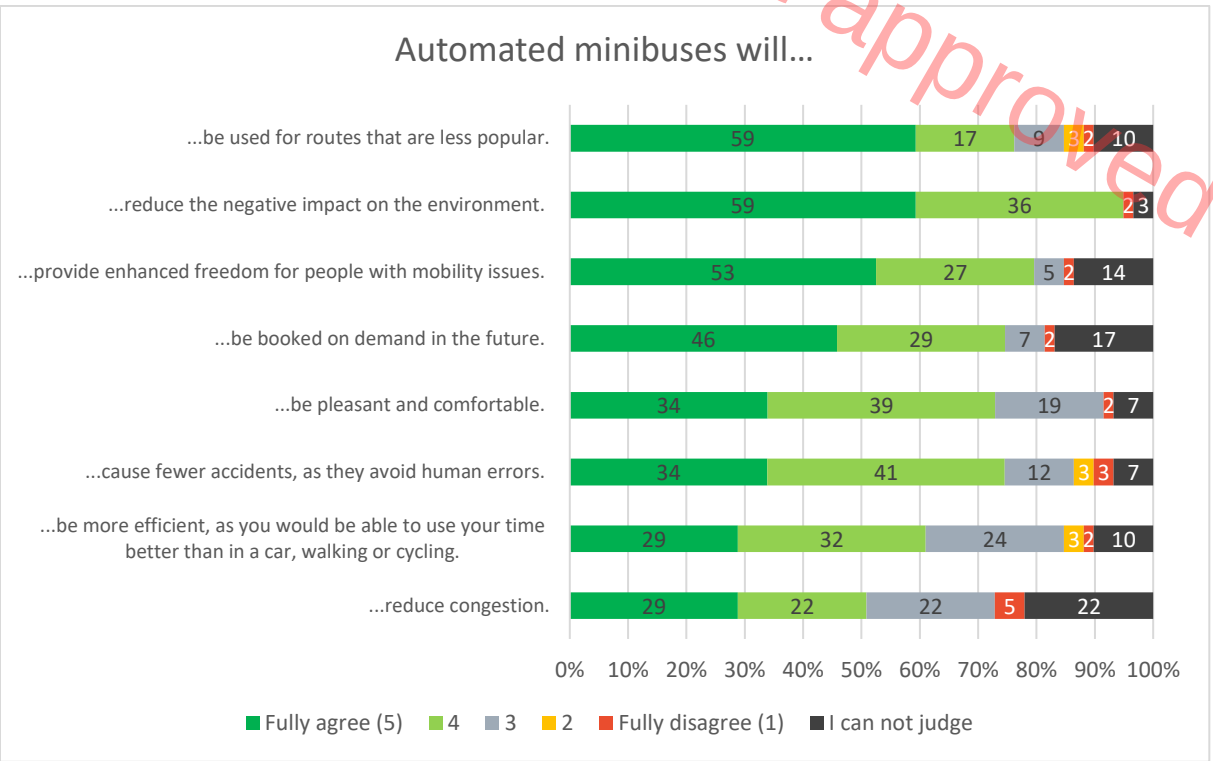


Figure 8.9 Perceived benefits of automated minibuses (in %; n=57)

On the perceived concerns we see a slightly more differentiated picture. Five out of ten concerns are not valued as such, by the majority of the users. Hence over 50% of the users do not agree with concern of privacy, pleasure of driving, learning to use the new system, loss of jobs and reliability of the systems. A smaller percentage of users do not agree with concerns regarding the functioning of the automated minibus (this includes the interaction with motorized and non-motorized traffic, its reaction to unforeseen situations and issues of liability in the case of an accident).

In a comparable study in Switzerland in 2018 (Neuhausen am Rheinfall and Stein am Rhein) (Bernauer and Wicki 2018) respondents were most concerned about software misuse, liability, loss of pleasure of driving, privacy issues and job loss (all >3, on a 5-point scale). Items that the respondents in Switzerland were less concerned about (all <3, on a 5-point scale) include system safety, system reliability and job loss. Thus, it seems that the results are not comparable. Whereas the users in Copenhagen are more concerned of the system functioning, the Swiss respondents were more concerned about the other items.

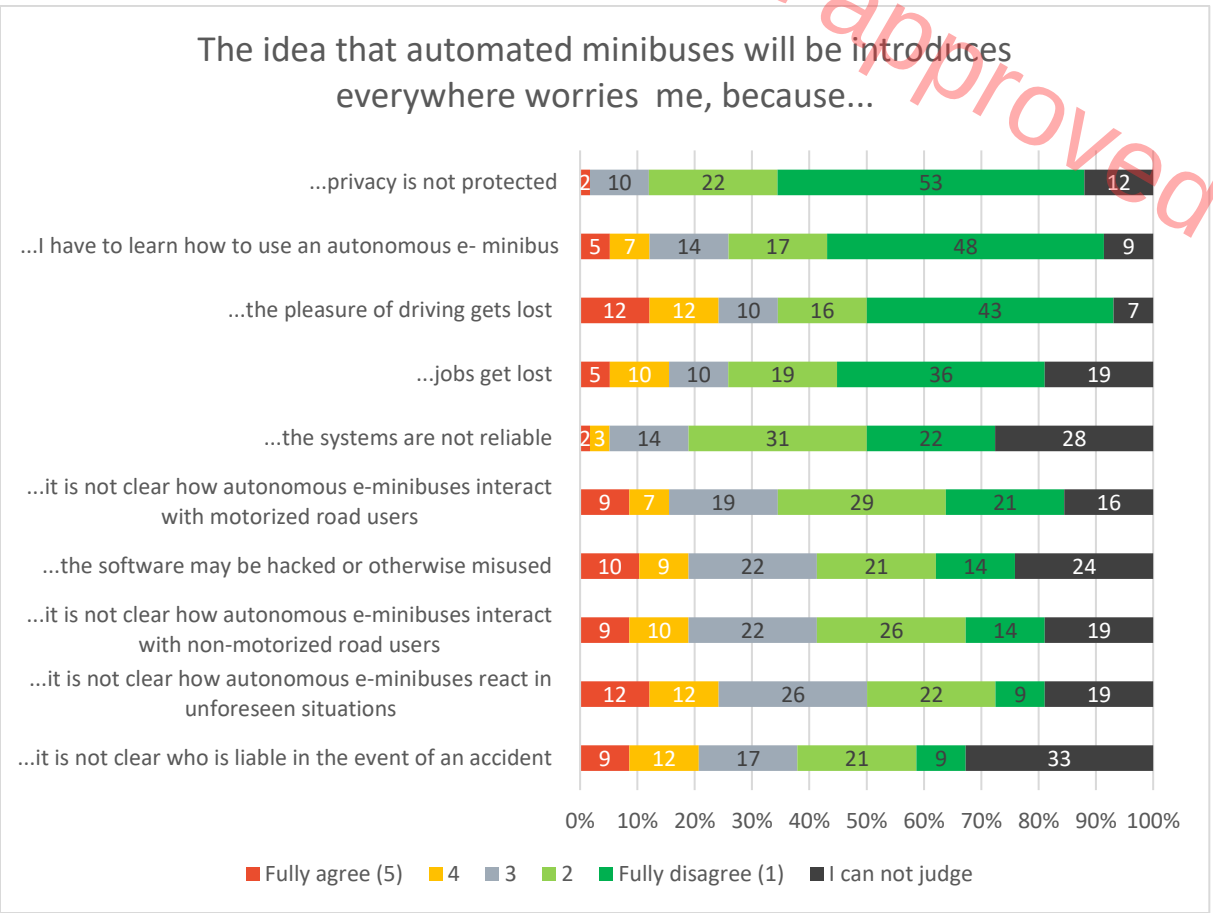


Figure 8.10 Perceived concerns about automated minibuses (in %; n=54)

In consequence the vast majority of the users (89%) expects the automated minibuses to be going to be an important mode of transportation in the future and is willing to promote it among friends and family (92%).

8.1.7 Services in the automated minibus

In the development of the automated minibuses, there is a quest for developing services beyond the service of transportation. An argument that is used to support the development of these services, is that it can increase the number of users, and can be an additional benefit of this system, compared to other transport systems. A service that is discussed is the presence of a safety operator. The opinion on whether a safety operator is necessary on board the automated minibus is diverging. For a smaller proportion of users (18%) the presence of a safety operator is (very) important. A larger proportion of users (53%) think that the safety operator is not important (at all). Whereas in Copenhagen, on the contrary, 54% of the potential users (see results chapter 4) state that a supervisor is (very) important.

The proposed services, including giving feedback via QR-codes, in-vehicle entertainment, access to Wifi, and an app to help plan your journey are generally not regarded important by the respondents of this survey, see Figure 8.11. Services that were proposed by respondents in the answer category 'other' include:

- Feedback from the vehicle with respect to its decision making and status
- Screen indicating the journey status (number of stops, estimated time of arrival, etc.)
- More handles in the bus, primarily for the passenger seat in the middle
- A plan indicating the location of the bus stops

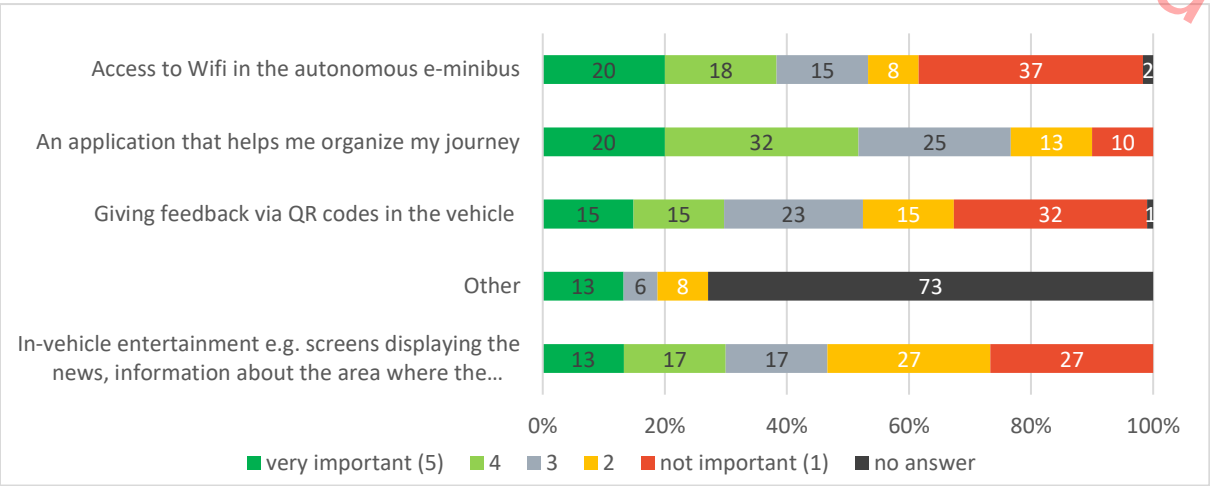


Figure 8.11 Evaluation of services (n=60, in %)

Price is an important selection criterion for users to use the automated minibus, a majority of 58% state that the price is (very) important for the decision to use the automated minibus. No one stated that price is not important at all. In order to investigate the possibilities for future use and business cases, a question was included to compare the willingness to pay for the automated minibus compared to other means of transport (Figure 8.12). While around a third (35%) of the potential users are not willing to pay at least the same amount or even more for using the automated minibus as for regular public transport, only 24% of the users refuse to pay the same or even more. Nevertheless, the fact that only 11% of the users are willing to pay more shows that users do not see such a strong improvement that would justify a higher willingness to pay. This can again be interpreted to mean that the automated minibus cannot completely replace other systems, but that this is seen as an obvious necessity which does not justify additional cost for the user.

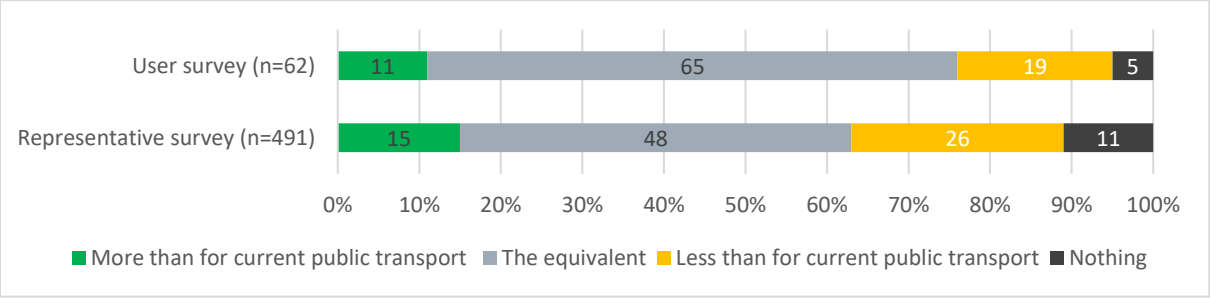


Figure 8.12 Willingness to pay, compared to results of representative survey 2021 (in %)

Overall, user experience is very satisfying and promotes a high willingness to use or re-use the automated minibuses. Nevertheless, the reduced service in the pilot sites does not yet lead to regular use.

8.1.8 Influences of COVID-19 on users

During the survey phase – August to December 2020 – the COVID-19 pandemic was still influencing daily life in Copenhagen. As the use of the automated minibus (and public transport in general) can be influenced by the pandemic, questions about the influence of COVID-19 were included in the survey. The majority of respondents (85%) state that in times of Covid-19 they feel just as safe in the automated minibus as in other transport systems. A slim majority of 53% state that their transport behaviour is not influenced at all, see Figure 8.13. About a third (29%) mention that the Covid-19 pandemic influenced their transport behaviour, that it is still altered, and will remain altered for a longer time. A total of 15% mention changes but expect that it already has returned to normal (3%) or will return to normal soon (12%). In a follow-up question on the type of changes, 81% state that they use less public transport; only 8% use more public transport and the remaining 11% indicate other changes.

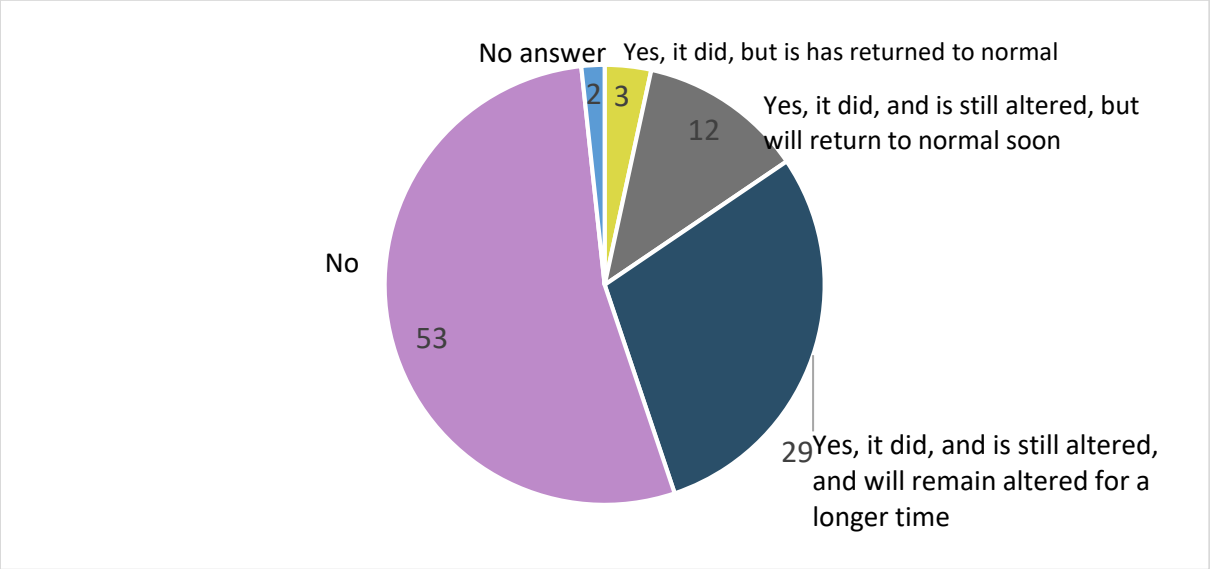


Figure 8.13 Effects of the COVID 19 pandemic on mobility behaviour (in %; n=58)

8.2 User survey Sion

8.2.1 General Insights

The AM service in Sion was been operational from May to August 2021. During this time, the service was stopped for about a month due to technical problems with the minibuses. The service therefore had a real pilot-site character, and has not been established as a real alternative to other public transportation means. To gain insights on the acceptance and satisfaction of the AM service, a group of students from HES were invited for a test-ride. The user survey was also open for general users of the AM service, however, we were only able to collect an additional 6 actual users. In interpreting the results from this survey, we should therefore be careful as the majority of the respondents were not spontaneous users, but rather invited respondents. Throughout the presentation of the results, it is indicated whether there are differences between these groups of respondents.

8.2.2 Awareness and acceptance of the automated minibus

As the majority of respondents of the user survey, were invited to test the automated minibus as part of their university training, the majority of the respondents (58%) became aware of the AM service through information provided by their university. The remaining 46% were already aware of the AM service, through other sources. From the information sources listed 16% learned about the service through having seen the AM on the test site or through word of mouth (14%). Other important sources of information were informal information by colleagues, through information brochures or the internet (9% each). Most of the survey participants were first time users of the automated minibuses (89%) (Figure 8.14). From the 11% who have previous experience with the automated minibuses, 80% have used the AM once or twice before and 20% have used it more than ten times.

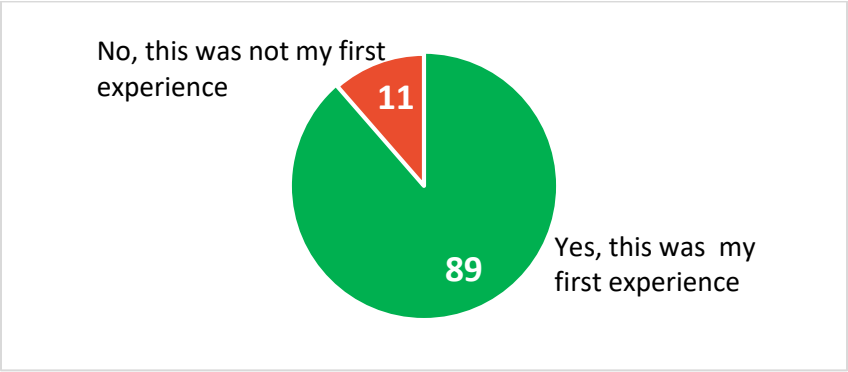


Figure 8.14 Experience with automated minibuses (in %; n=44)

8.2.3 Motivation to use an automated minibus

The large majority of the respondents indicated that they used the automated minibus out of curiosity or as part of the invited test route organised by HES. Smaller numbers of respondents indicate that they used the minibus, as it is faster than walking or out of spontaneity (9 % each). Previous experience with

the AM or routine usage of the minibuses were not cited as reasons by any respondents. The users that were not invited by HES, used the AM service out of curiosity or because it is faster than walking.

The automated minibus service is currently replacing primarily walking trips; 81% of the respondents indicate that if there wasn't an AM service, they would have walked. This includes all spontaneous users. Other means of transportation were cited much less frequently, with 12% of respondents who would have used their car, 2% their bike and 2% the tram (Figure 8.15).

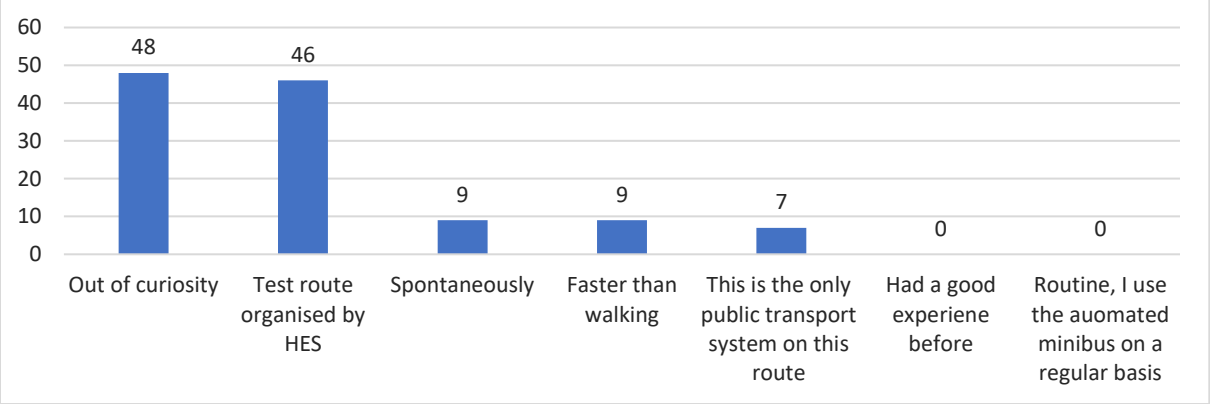


Figure 8.15 Reason to use the automated minibus (in %; n=44)

8.2.4 User experience and satisfaction

Users were asked to indicate their satisfaction with their last ride. Overall, the respondents were generally satisfied with their last ride on an automated minibus, with 64% indicating to be satisfied or very satisfied Figure 8.16.

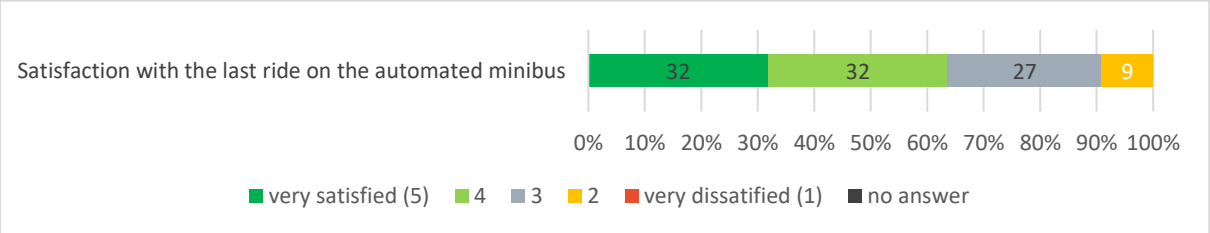


Figure 8.16 Detailed satisfaction with last ride (in %; n=44)

An analysis of what was most satisfying shows that especially the overall atmosphere in the automated minibus was experienced positively (see Figure 8.16 **Error! Reference source not found.**)

- Cleanliness (98% satisfied or very satisfied)
- Atmosphere in the bus (76% satisfied or very satisfied)
- Temperature (73% satisfied or very satisfied)
- Noise level in the bus (56% satisfied or very satisfied)

Aspects related to the service of the minibus are convincing and satisfying:

- Reliability (83% satisfied or very satisfied).
- Waiting time (56% satisfied or very satisfied)
- Accessibility (66% satisfied or very satisfied)

However, respondents are less satisfied with the punctuality of the minibus service, with only 32% being satisfied or very satisfied with the punctuality of the services. Furthermore, respondents are less satisfied with aspects related to the general integration of the minibus service;

- Security from outside the bus (54% satisfied or very satisfied
- Safety in the bus (44% satisfied or very satisfied).
- Interaction with motorized road users (34% satisfied or very satisfied)

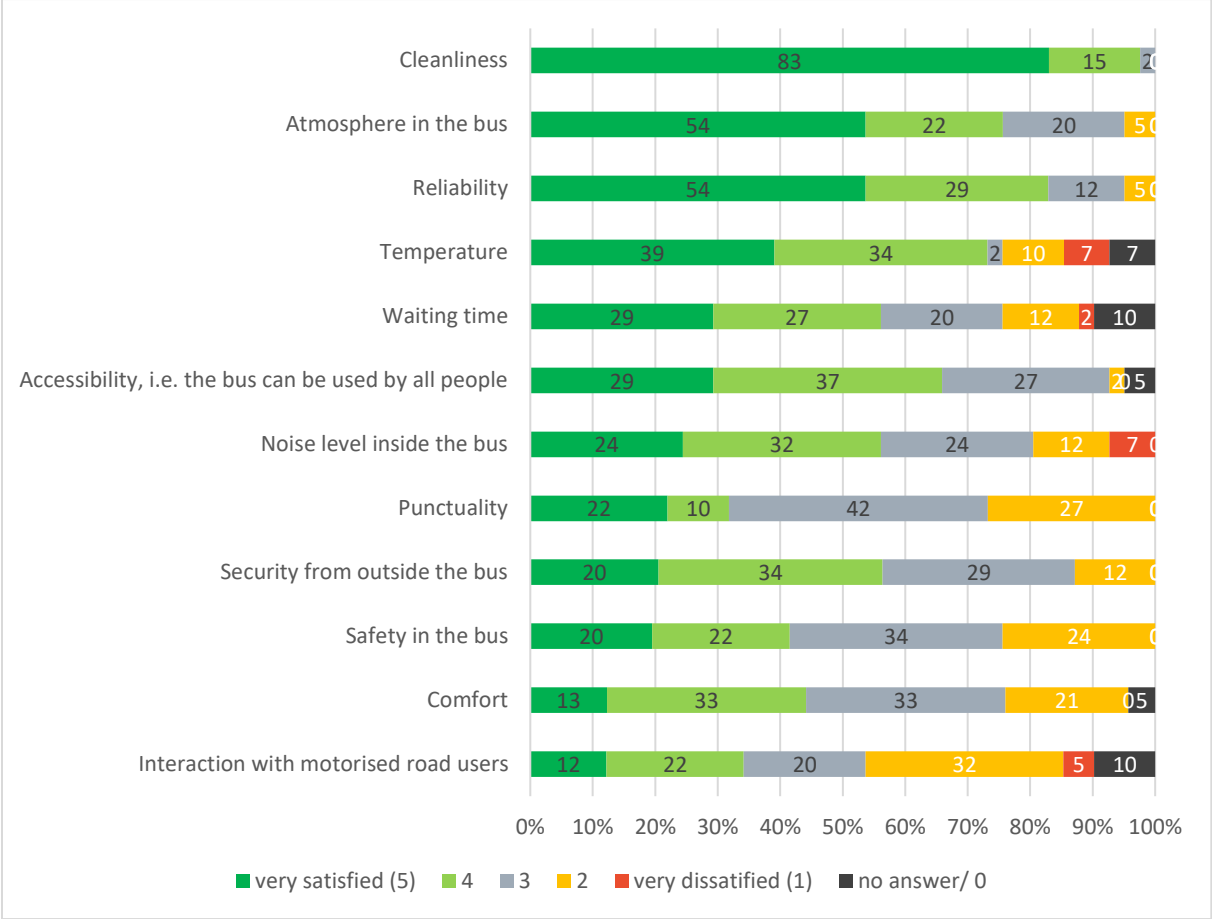


Figure 8.17 Detailed satisfaction with different aspects of automated minibuses (in %; n=41)

While the majority of users did not experience problems during their last ride, 45% said that a problem occurred (Figure 8.18**Error! Reference source not found.**). A sudden braking manoeuvre was cited 14 times and an unplanned stop seven times. Conflicts with other road members or long interruptions were only named twice.

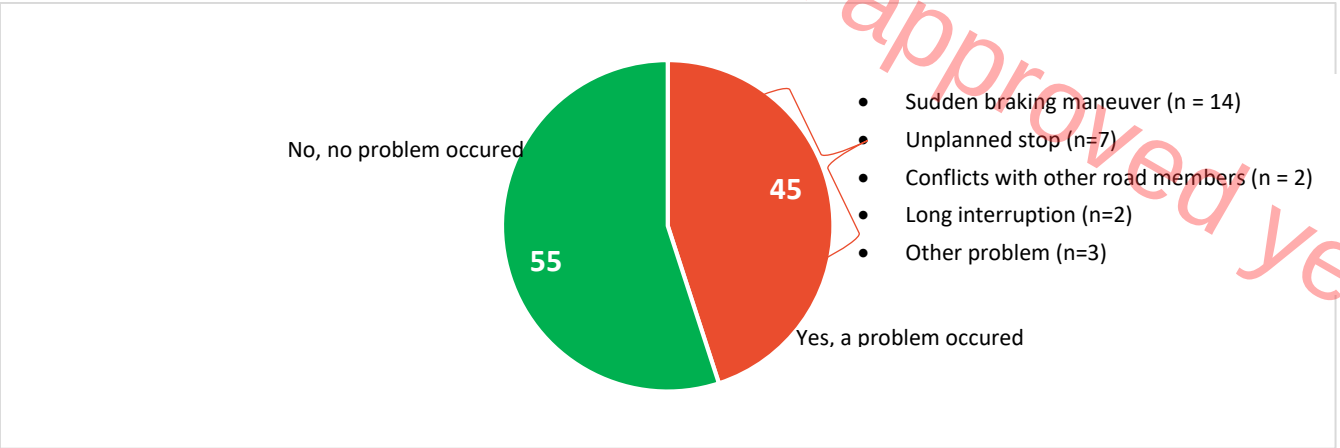


Figure 8.18 Problems occurred during the ride on the automated minibus (in %; n=40)

8.2.5 Willingness to use

Despite 45% of the respondents experiencing a problem, 55% of the survey participants were willing or very willing to use the AM again (Figure 8.19**Error! Reference source not found.**) and circa 83% would recommend the AMs to their friends and family. Nevertheless, overall the experiences in Sion were less positive in Sion, compared to Copenhagen. This also leads to a lower willingness to use again in Sion. Reasons hereof could be the fact that we primarily collected information from invited test-users in Sion, compared to interested, highly motived users in Copenhagen. Another reason could be the service offered by the automated minibus. In Copenhagen, the automated minibus service was located in a newly developed residential area and was an addition to the not yet fully developed public transport system. In Sion, however, the automated minibus service would replace existing public transport services.

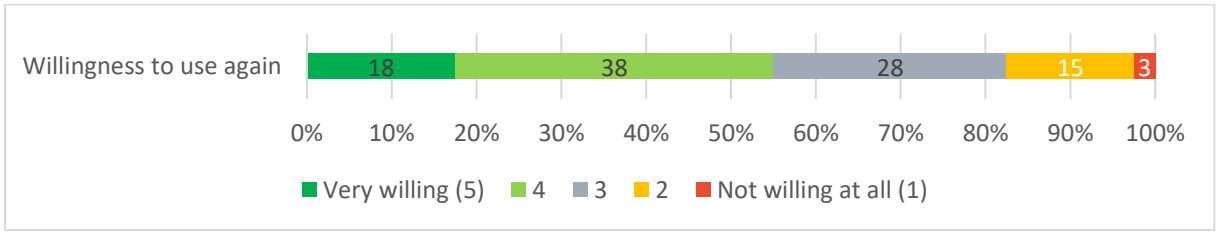


Figure 8.19 Willingness to use again (in %; n = 40)

The current automated minibus service in Sion is offered as a fixed line service, with a fixed time schedule. However, automated minibuses are well equipped to serve as an on-demand service, offering transport from door-to-door. Respondents were asked to reflect on their willingness to use the AM service, their willingness to reduce the use of their car, and their willingness to give up the use of their car, if the AM would offer such an on-demand, door-to-door service (Figure 8.20). The majority of respondents (74%) would be willing or very willing to use the minibuses in this scenario if they offer an on-demand, door-to-door service (74%) If AMs offered such a service, 66% of respondents would be willing to reduce the use of their own car, and 46% would even be willing to give up the use of their own car. However, 29% would not be willing to give up the use of their own car.

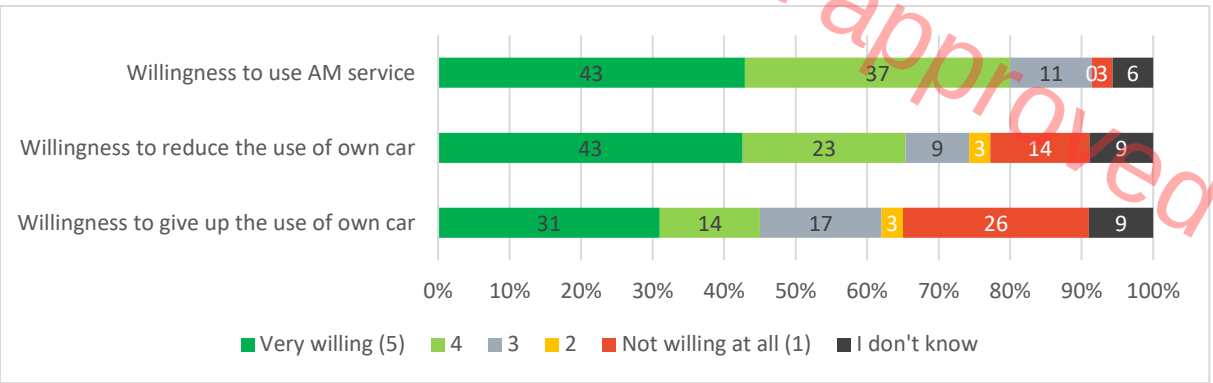


Figure 8.20 Willingness to use, reduce car use, and give up car use, if the automated minibus service is offered as an on-demand, door-to-door service (in %; n = 35)

In terms of willingness to pay for the automated minibuses, 14% of survey participants would be willing to pay more for the AM service than what is charged currently (Figure 8.21**Error! Reference source not found.**). 46% would be willing to pay the current price, while 37% would prefer to pay less. In the scenario that the AMs offered an on-demand door to door service, 54% would be willing to pay more for the service and 34% would be amenable to paying the current price. For the scenario that AMs offered a service that bridges the first and last mile, 21% would accept a higher price, whereas 46% would be ready to pay the equivalent of the present price. Lastly, if AMs were part of a seamless intermodal trip, 32% of the participants would be inclined to pay a price above the price that is currently charged, and about half of the participants would pay the current price.

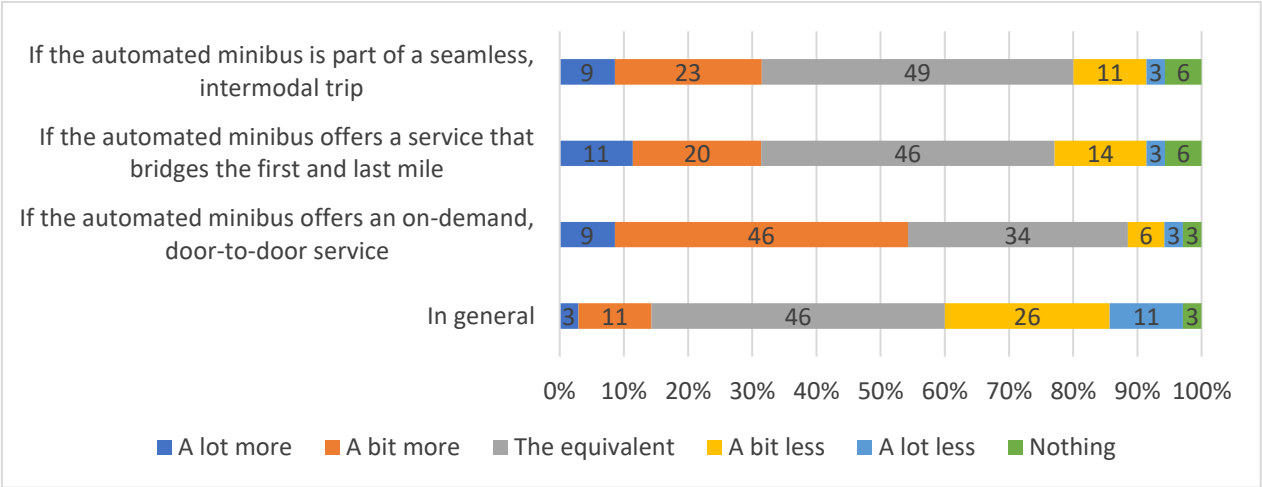


Figure 8.21 Willingness to pay for automated minibuses (in %; n = 35)

8.2.6 Advantages and concerns

Regarding the perceived benefits of automated minibuses, the three statements with which participants fully agree with most often are that AMs will be booked on demand in the future (54% of participants fully agree, mean = 4.41), that they will be used for routes that are less popular (49% fully agree, mean = 4.46) and that they will reduce the negative impact on the environment (46% fully agree, mean = 4.30) (Figure 8.22**Error! Reference source not found.**).

Respondents agree that automated minibuses could increase flexibility of public transportation systems. The statements that automated minibuses will increase flexibility by an increase of locations to get on the public transport as well as by an increase of frequency of public transport offers also received a high overall score of agreement, with mean values of 4.41 and 4.30 respectively.

The predictions about minibuses that the respondents agreed with the least were that AMs will be more efficient than other modes of transportation or guarantee security due to installed video cameras inside the bus (mean = 3.81 both), as well as that they cause fewer accidents, as they avoid human errors (mean = 3.73) or that they will reduce congestions (mean = 3.73).

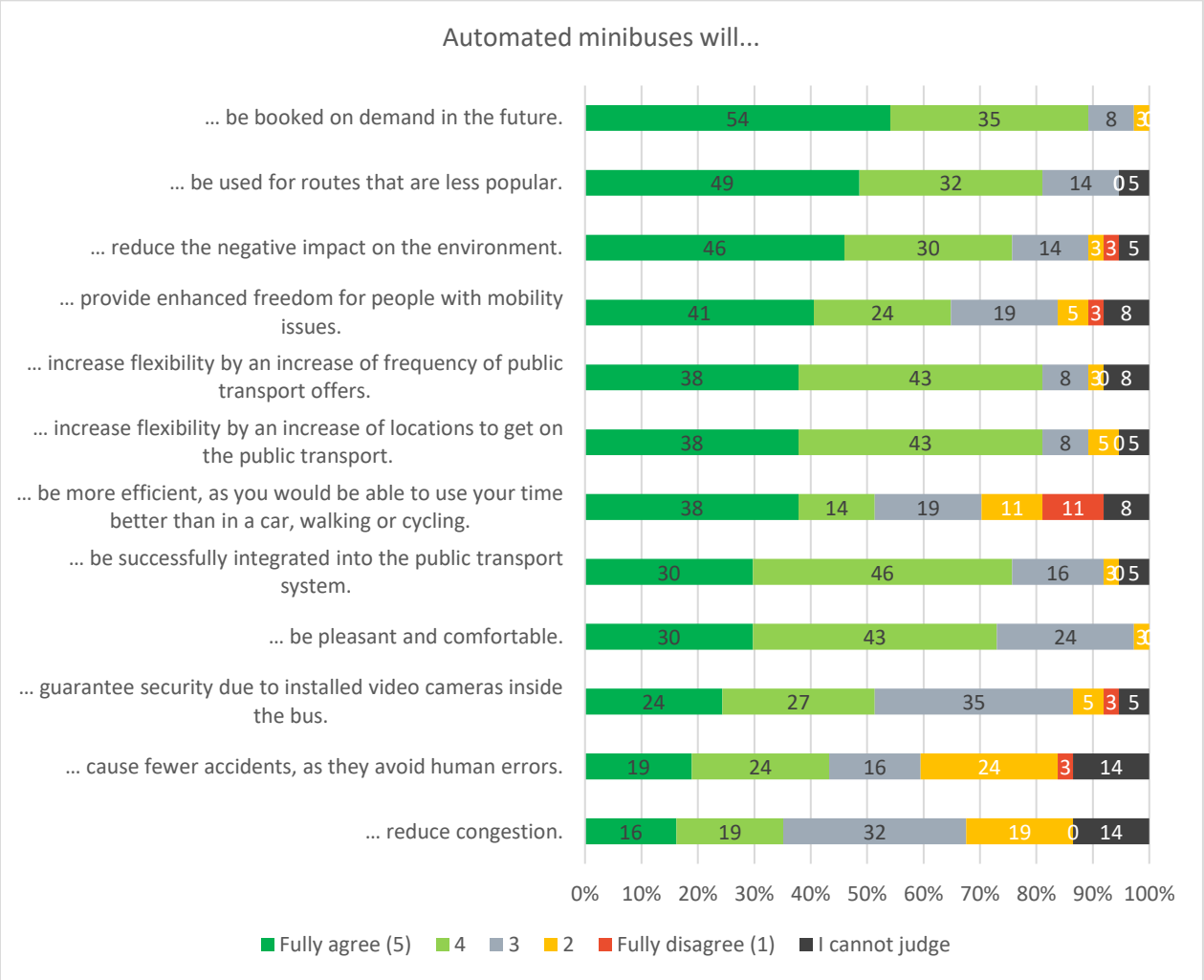


Figure 8.22 Perceived benefits of automated minibuses (in %; n=37)

When it comes to the perceived risks of automated minibuses (Figure 8.23), survey respondents are – comparable to Copenhagen - most afraid that it is not clear how AMs react in unforeseen situations (mean = 3.89) and that it is not clear how automated minibuses interact with motorized road users (mean = 3.67) (**Error! Reference source not found.**).Other statements that the respondents generally agreed with are that in an AM it is not clear who is liable in the event of an accident (mean = 3.58), that the software may be hacked or otherwise misused (mean = 3.58) or that it is not clear how automated minibuses interact

with non-motorized road users (mean = 3.56). The items "I have to learn how to use an automated minibus", "The pleasures or driving gets lost" and "Privacy is not protected" received the lowest agreement and are the items that respondents seem to be least worried about (mean values of 2.67, 2.61 and 2.58 respectively).

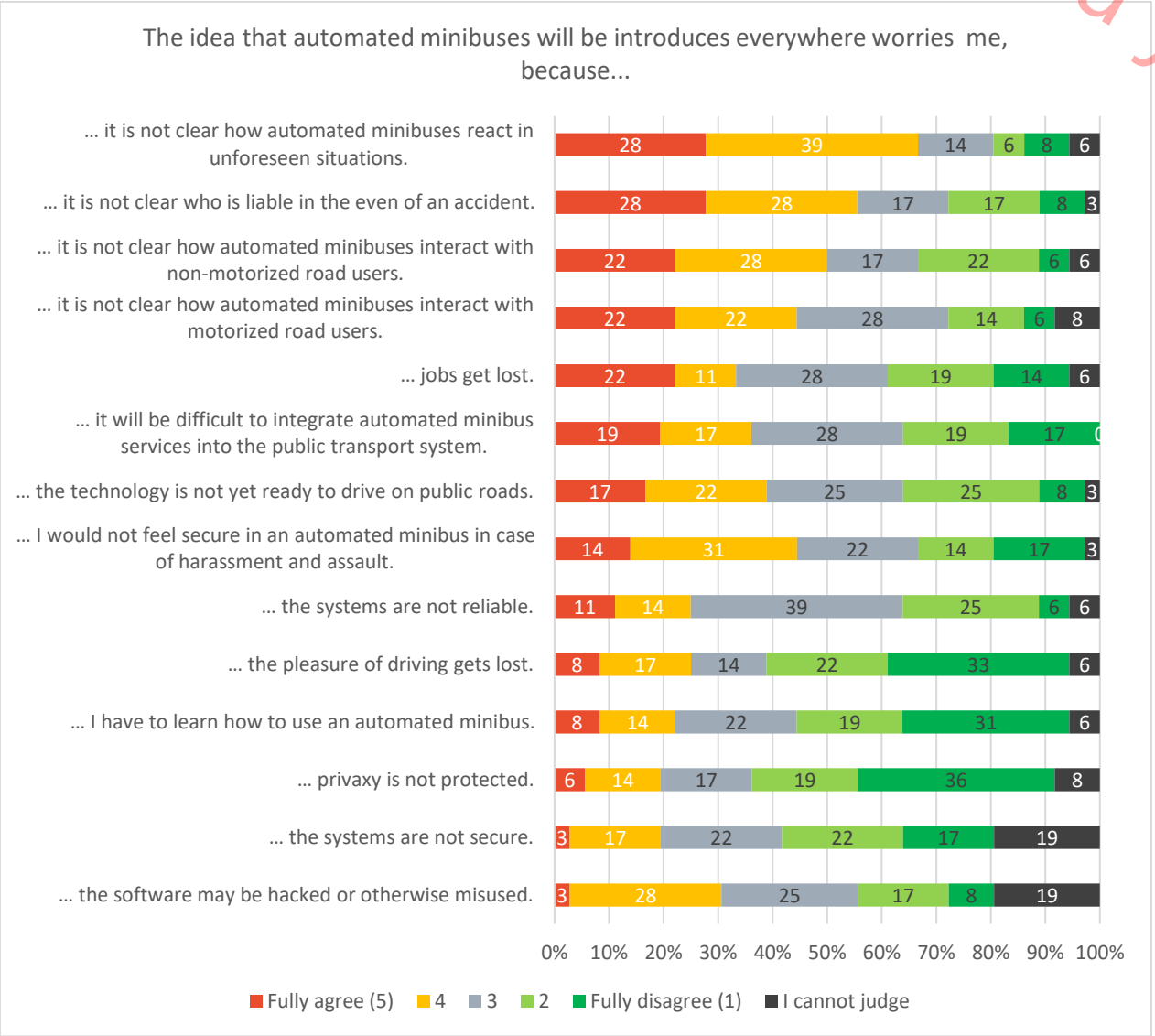


Figure 8.23 Perceived risks of automated minibuses (in %; n=36)

8.2.7 Services in the automated minibus

Concerning the minibus features that are most important to the respondents, 39% find it very important to have an app that helps them organize their journey (mean = 4.13) (Figure 6.24**Error! Reference source not found.**). In-vehicle information, e.g., about the area where the AMS operate and having a safety operator on board are also cited as very important by 33% and 31% of users respectively (mean values of 3.87 and 3.92). Access to Wifi in the minibuses and the ability to give feedback about the AM service via a QR code were moderately important to the participants (mean values of 3.10 and 3.36 respectively). Least

important to the respondents are in-vehicle entertainment, e.g., screens displaying the news (mean = 2.95) and in-vehicle information about the performance of the vehicle, for example about the speed of the AM (mean = 3.05).

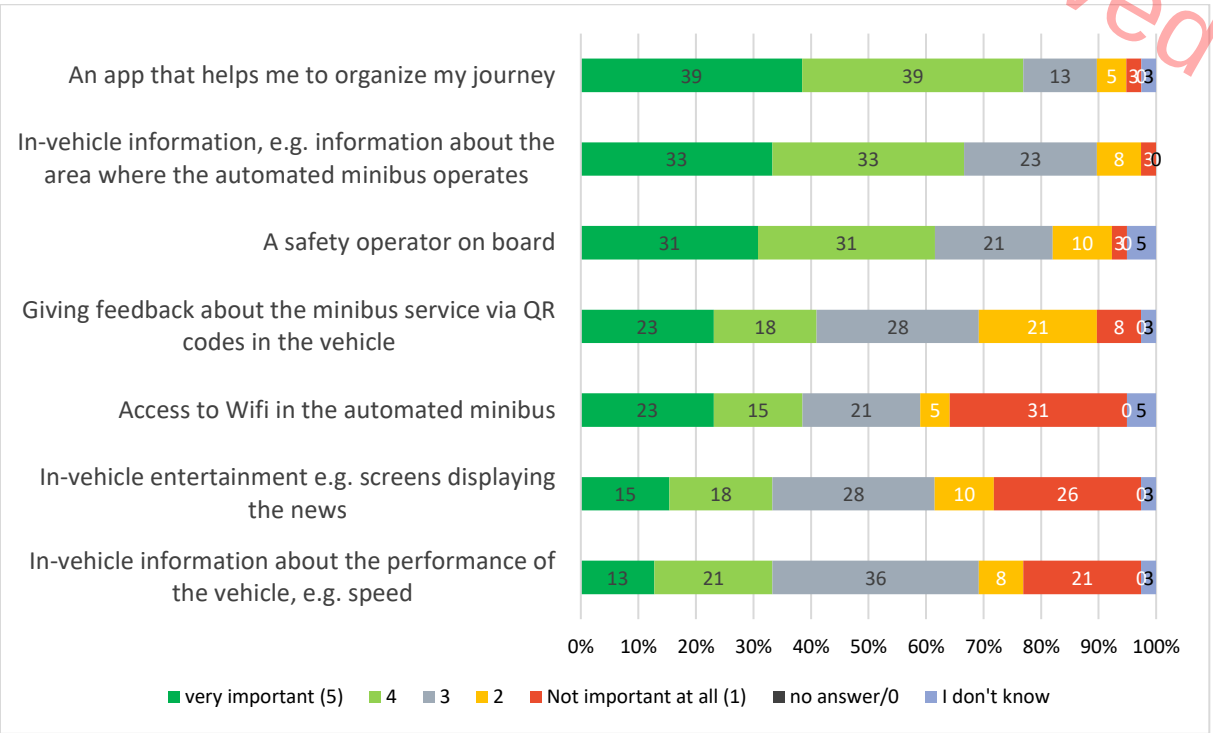


Figure 8.24 Evaluation of different aspects of automated minibuses (in %; n=39)

As far as the method of ordering the minibuses is concerned, 41% of the survey participants prefer ordering the minibuses via an App (**Error! Reference source not found.**). 18% would prefer to order the minibuses via a call column at the stop and only 3% would like to make a phone call.

8.2.8 Influences of COVID-19 on users

The Covid-19 pandemic had an influence on the mobility behaviour of 46% of survey participants (Figure 8.25**Error! Reference source not found.**). This includes 17% who say the pandemic influenced their mobility behaviour, however it has since returned to normal. 20% indicate it has been altered, but that they expect it will return to normal soon, while 9% indicate their mobility behaviour will remain altered for a longer time.

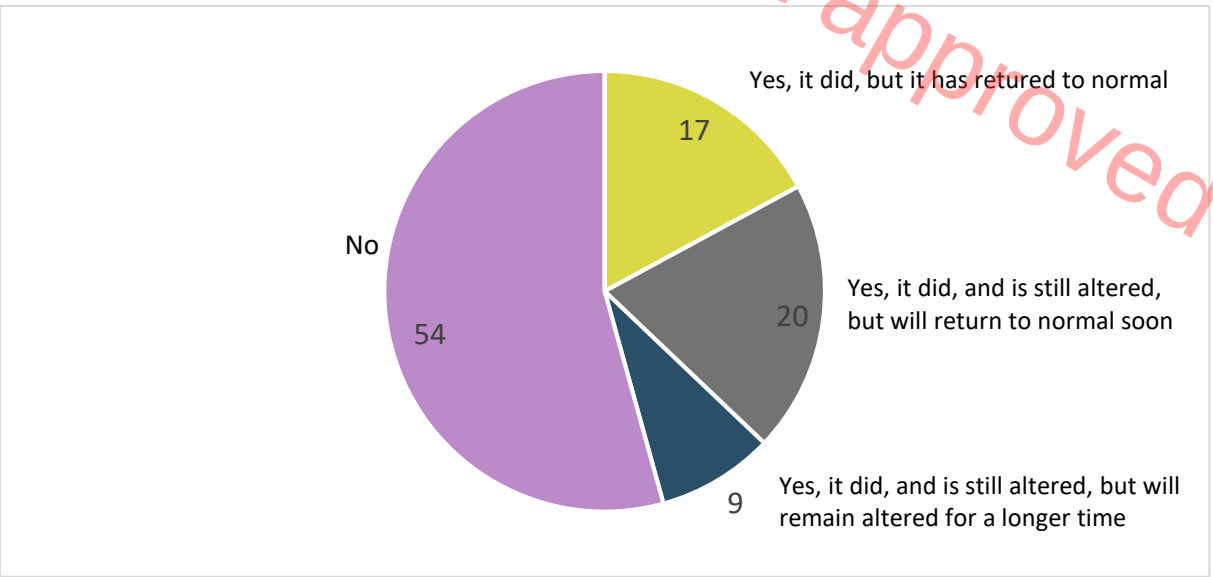


Figure 8.25 Effects of the COVID 19 pandemic on mobility behaviour (in %; n=35)

The changes in mobility behaviour that the pandemic has brought about can be divided into 70% of respondents who used public transport less and 19% of respondents who have used public transportation more 77% of the survey participants evaluate automated minibuses as equally safe as other public transportation systems, the rest is divided equally between people who think AMs are less safe or safer than other means of public transportation (Figure 8.26).

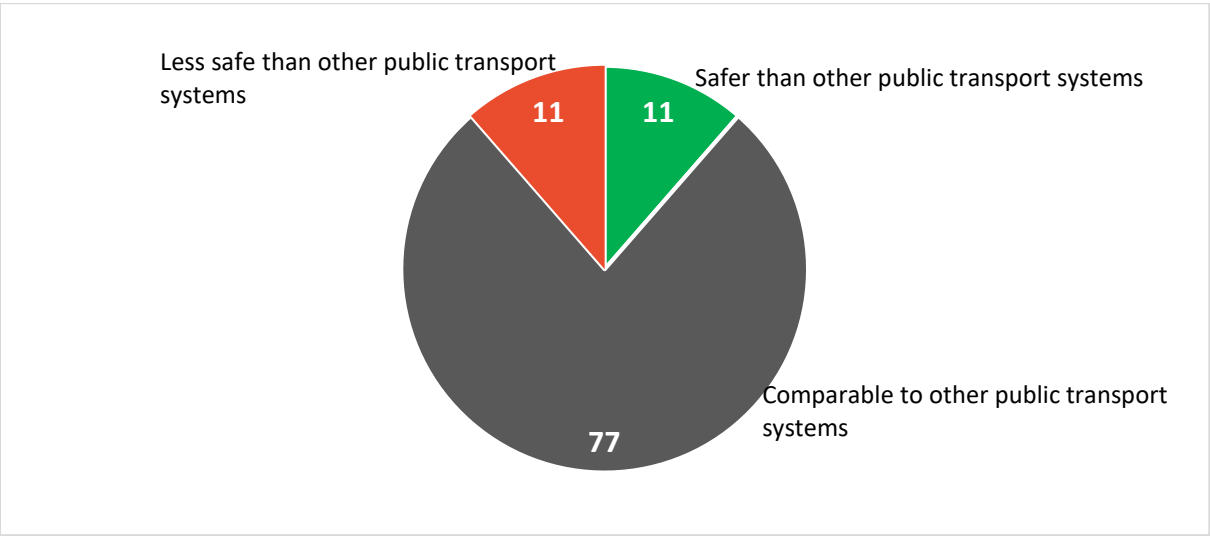


Figure 8.26 Feeling of safety in times of Covid 19 in the automated minibuses (in %; n=35)

Overall, users in Sion seem to be a bit more critical than in Copenhagen, but nevertheless, overall satisfaction, positive expectations towards the automated minibuses and willingness to use are again high

8.3 Ongoing user surveys

Due to postponement of deployment, due to COVID-19, it has not been possible to conduct user surveys in all sites prior to finalizing the social impact assessment. Currently, there are two surveys ongoing; in the replicator site Esch (Luxembourg) and Slagelse (Copenhagen). User surveys might be conducted in the other Avenue sites (most notably Lyon and Geneva), the results of these surveys will be integrated in WP7, Task 7.6.

This section will present some preliminary finding of the ongoing user surveys, in comparison with the finalized surveys. The focus hereby is on the most important questions.

@Jeroen: We will include the latest figures here, as close to the deadline of submission (hence, end of March).

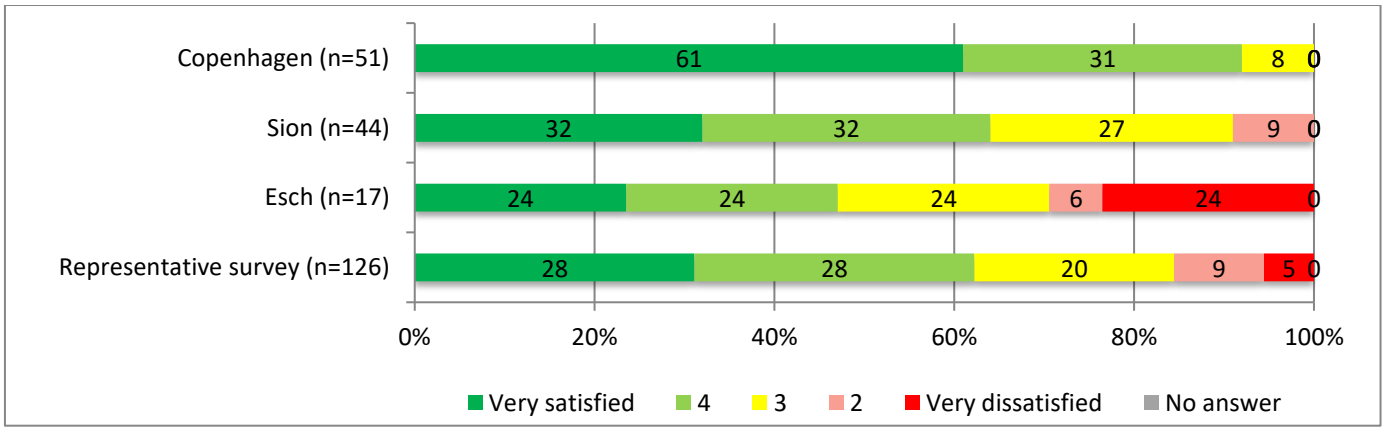


Figure 8.27 Satisfaction of last ride. Comparison between different users (in %)

Figure 8.28 Was this your first time to use an AM service? (in %)

	First time use	No, this was not my first time
Copenhagen Nordhavn (n=51)		
Sion (n=44)	89	11
Esch (n=8)	50	50
Copenhagen Slagelse (n=…)		

Figure 8.29 Willingness to use again. Comparison between the different users (in %)

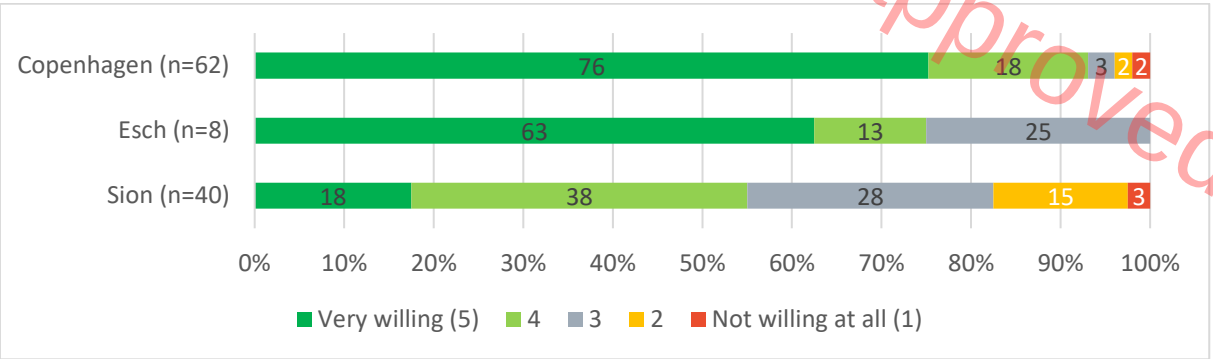
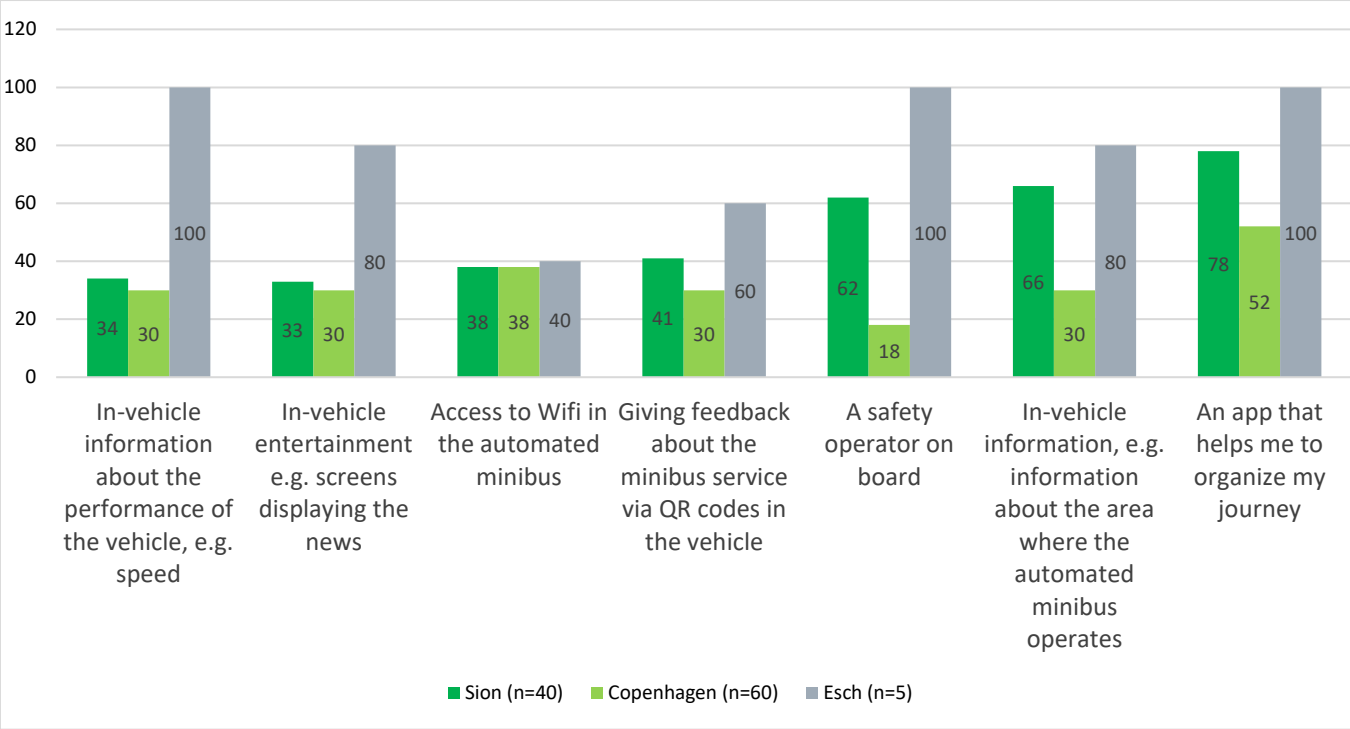


Figure 8.30 Importance of services in the automated minibuses. Comparison between users (shown are topbox 1-2: very important & important)



8.4 Users vs non-users

An important question is whether respondents that have used an AM, are more willing to use the AM in the several scenarios, and whether an experience with the shuttle reduced the perception of risks and increased the perception of benefits. In this section, we therefore compare responses of non-users with users. In the design of the questionnaires, we made sure to keep the same questions for the different target groups.

Table 8.1 and Table 8.2and present a comparison between the responses of citizens that have not used an AM (collected through the survey in the four AVENUE cities, 2021) with citizens that have experience with an AM service. For the latter group, we present the results in three groups, the users extracted from the survey in the four AVENUE cities (2021), the users of the Copenhagen site (2020), and users of the site in Sion (2021). Overall, users in Copenhagen seem to be most convinced followed by Sion. Somewhat less, but still partly more convinced than non-users are the users which could be identified in the representative survey. These effects may be explained by several reasons: Users may in advance be more open-minded than non-users. Above all, in Copenhagen, usage was strongly driven by curiosity. This in addition may explain, that these very open-minded users even show a higher goodwill.

The users in Copenhagen perceive the lowest risks and the highest benefits. This accounts especially for the statement that the AM will 'reduce the negative impacts on the environment' (95% of users in Copenhagen agree with this statement, compared to 60% of the non-users). All three user groups show a higher agreement with the statements that 'AM will be pleasant and comfortable', that the 'AM will cause fewer accidents' and that the 'AM will be more efficient'. However, non-users are not in higher agreement with the statement that the 'AM can reduce congestion'. There is a higher percentage of users that agree with the statement that *'the technology is not yet ready to drive on public roads'*.

Focusing on the risks again users in Copenhagen seem to be most good willing. The evaluation of risks is generally lower. On the other hand, users in Sion and users identified in the representative survey here do not strongly differ from non-users. This may be explained by some more critical experiences they may have had during their ride.

Table 8.1 Perceived benefits of AM services in Non-users and Users

Mean*	Top box 4 & 5 (agree) / Low box 1 & 2 (do not agree)	Non-users survey 2021 (n=1690)		Users survey 2021 (n=126)		Users Copenhagen (n=57)		Users Sion (n=37)	
… reduce the negative impact on the environment.		3.9 (n=1577)	60 10	3.8 (n=123)	66 12	4.6 (n=57)	95 2	4.2 (n=35)	76 6
… reduce congestion		3.6 (n=1509)	49 17	3.7 (n=120)	61 17	3.9 (n=46)	51 5	3.4 (n=32)	35 19
… be more efficient, as you would be able to use your time better than in a car, walking or cycling		3.6 (n=1520)	47 13	3.7 (n=113)	55 13	3.9 (n=53)	61 5	3.6 (n=34)	52 22
… provide enhanced freedom for people with mobility issues.		4.0 (n=1577)	64 7	4.0 (n=119)	60 12	4.5 (n=51)	80 2	4.0 (n=34)	65 8
… be pleasant and comfortable		3.8 (n=1497)	54 6	3.9 (n=122)	68 8	4.1 (n=55)	73 2	4.0 (n=37)	73 3
… be booked on demand in the future		3.8 (n=1480)	52 8	3.7 (n=113)	52 14	4.4 (n=49)	75 2	4.4 (37)	89 3
… cause fewer accidents, as they avoid human errors		3.3 (n=1483)	38 20	3.7 (n=114)	56 16	4.1 (n=55)	75 6	3.4 (n=32)	43 27

* Means: 1: is fully disagree, 5 fully agree. Hence, the higher the mean, the more positive. For the calculations of the means, we excluded those respondents that selected 'I cannot judge', therefore, the basis varies – and is depicted after every means.

Table 8.2 Perceived risks of AM services in Non-users and Users

Mean	Top box 4 & 5 (agree) in % / Low box 1 & 2 (do not agree) in %	Non-users survey 2021 (n=1690)		Users survey 2021 (n=126)		Users Copenhagen (n=57)		Users Sion (n=37)	
… It is not clear how automated minibuses react in unforeseen situations		3.8 (n=1501)	54 10	3.6 (n=117)	31 14	3.0 (n=47)	24 31	3.8 (n=34)	57 14
… it is not clear how automated minibuses interact with motorized road users		3.7 (n=1502)	49 13	3.4 (n=118)	47 18	2.4 (n=49)	16 50	3.5 (n=33)	44 20
… it is not clear how automated minibuses interact with non-motorized road users		3.7 (n=1477)	46 14	3.3 (n=117)	43 25	2.7 (n=47)	19 40	3.4 (n=34)	50 28
… it is not clear who is liable in the event of an accident		3.6 (n=1417)	24 14	3.3 (n=110)	24 42	2.9 (n=39)	21 30	3.5 (n=35)	56 25
… the software may be hacked or otherwise misused		3.6 (n=1439)	44 15	3.4 (n=118)	43 23	2.8 (n=44)	19 35	3.0 (n=29)	31 25
… the technology is not yet ready to drive on public roads		3.5 (n=1402)	31 16	3.3 (n=115)	44 26	X	x x	3.1 (n=35)	39 32
… the systems are not reliable		3.1 (n=1253	24 20	2.8 (n=109)	19 36	2.0 (n=42)	5 53	3.0 (n=34)	25 31
… the systems are not secure		3.2 (n=1332)	29 20	2.9 (n=109)	28 31	X	x x	2.6 (n=29)	20 39

* Means: 1: is fully disagree, 5 fully agree. Hence, the higher the mean, the more negative. For the calculations of the means, we excluded those respondents that selected 'I cannot judge', therefore, the basis varies – and is depicted after every means

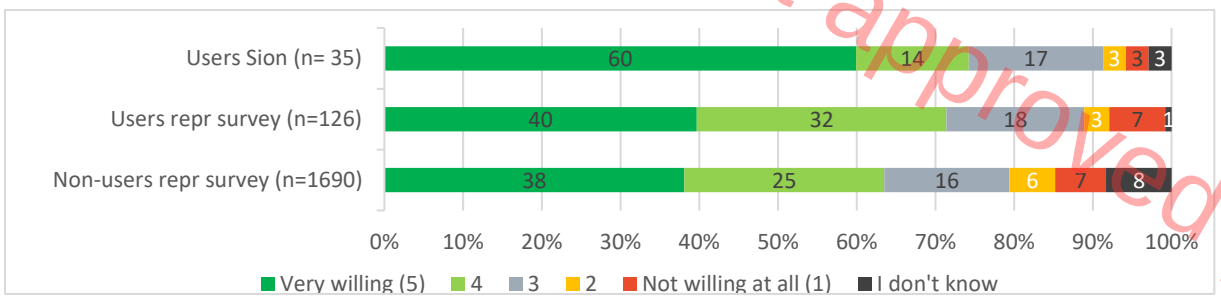


Figure 8.31 Willingness to use the AM under the condition that the service is offered on-demand, door-to-door (in %)

This question is not available for Copenhagen, 2020.

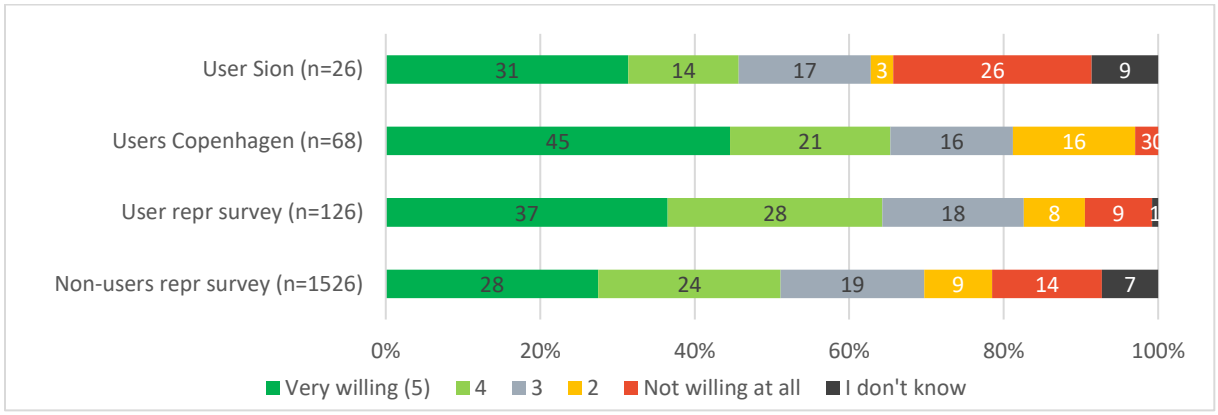


Figure 8.32 Willingness to give up car, under the condition that the AM service is offered on-demand, door-to-door (in %)

Willingness to give up use of car, if AM service is offered on demand

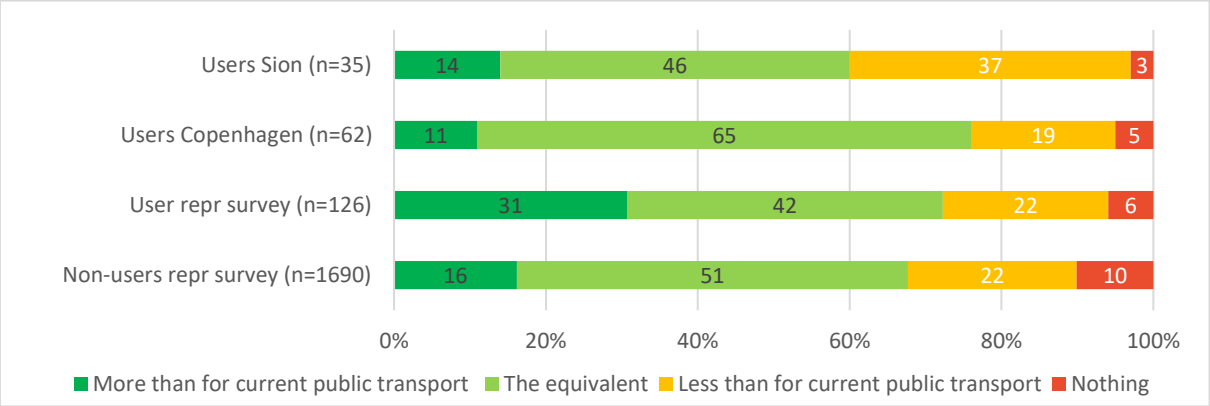


Figure 8.33 Willingness to pay (in %).

8.5 Conclusions

In this chapter we reported on the results of user surveys conducted in the Nordhavn line (Copenhagen) and Sion (Switzerland). The users that did use the automated minibus service, have been were highly satisfied with their experiences and most of them are willing to use the automated minibus again.

In Copenhagen, there is a high satisfaction with the public transport offer. The majority of the users would normally use their bike, or their own car. Based on these results, it seems there isn't an acute need for improved transport services. This does explain why the majority of users used the automated minibus at random, motivated by spontaneous interest and curiosity. Thus, even though users are satisfied, and state that they are willing to use the service again, the lack of an acute need for better alternatives prevents a situation of regular users.

The users state that, under the condition of an on-demand service, they are willing to reduce the use of their own car. Willingness to give up their own car, does only account for a smaller proportion of the users. It can therefore be assumed that users who currently urgently need a car even in a city like Copenhagen do not see any real alternative in the automated minibus even they were highly satisfied with their experience.

The users perceive risks less often, compared to potential users. User experience therefore, seems to be an important factor to reduce the perceived concerns and to increase acceptance of the automated minibus. Real experience in the automated minibus, does also have a positive effect on the trust in the system: Of the potential users, 35% state that the presence of the safety operator is important (chapter 4), whereas this only accounts for 18% of the users. This is an important result for the economic viability and possible business cases for the operation of automated minibus services. An additional insight for the economic analysis is that price is an important factor in deciding the automated minibus, and only about 10% is willing to pay more to use an automated minibus than current transport systems. Therefore, attractive economic models are needed.

Based on the user survey in Copenhagen, we can conclude that users are very open-minded, very satisfied but not yet convinced that the automated minibus could completely substitute their need of an own car. As user experience seems to be very convincing and reducing expectations towards any risks the awareness of the test sites and therefore the probability of its use should strongly be increased by communication, esp. using social media.

The results and conclusions show that each pilot site attracts different users. Therefore, it is of utmost importance to continue collecting data on user satisfaction and user needs.

9 Conclusions

The AVENUE Social Impact Assessment focuses on the social impacts of the deployment of automated minibuses in the four official AVENUE cities, Luxembourg, Copenhagen, Geneva and Lyon. The primary aim is to understand whether the introduction of automated minibuses in the public transport system will result in a changed mobility behaviour, which corresponds to the following research question:

What is the social impact of automated public transport systems, and how does this contribute to a changed mobility behaviour?

To answer this research question, six studies have been conducted and reported in the AVENUE social impact assessment:

- A qualitative study focused on the mobility needs, mobility gaps and the question whether automated minibuses can fulfil these mobility gaps in a prospective replicator site in Singen, Germany.
- A qualitative study focused on the mobility needs, mobility gaps and the question whether automated minibuses can fulfil these mobility gaps in the pilot site Nordhavn, in Copenhagen, Denmark.
- A qualitative study took the perspective of the safety operators. Their own experiences with the automated minibus, their observations and interaction with the users provided input on the AVENUE user experiences.
- A quantitative study focussed on mobility behaviour, attitudes on automated minibuses and social acceptances of automated minibuses in the four AVENUE cities. This study was conducted in 2019, as a zero measurement, and repeated in 2021.
- A study focused on the user experiences of passengers of the automated minibus service in four pilot sites; Nordhavn (Copenhagen), Sion (Switzerland), Esch (Luxembourg) and Slagelse (Copenhagen).
- A study on social media content about automated minibuses. This should also contribute to understand the social acceptance of automated minibuses.

These studies have been reported in this AVENUE social impact assessment, focussing on 1) Mobility attitudes and behaviour; 2) Mobility needs; 3) Attitudes and acceptance toward automated minibuses, 4) Target groups; 5) changes in mobility behaviour and 6) User experiences.

A first general insight, based on the results of all included studies, is that there is no acute need for a complete substitution of current public transport offers in the perception of citizens. In the following, the central conclusions are presented in detail.

9.1 Mobility needs

Satisfaction with the current offer of public transportation is negatively correlated with the need for improved local public transport services as offered by the automated minibuses. Our results show that in Singen, low satisfaction with the public transportation offers, results in a at least latent need for alternative transportation options, such as an automated minibus service. In cities like Copenhagen where the satisfaction with the offer of public transportation is higher, the need for new transportation services is

lower and not acute. The social media analysis shows similar results; more than the fact that there is no driver, people insist on social media what these new services will actually have to offer in addition to existing services. We can conclude that the only thing that matters to potential customers, is the benefit for them, as individual users. Potential benefits include; higher temporal and local flexibility, less waiting time, and cheaper transportation offer. We can therefore conclude that the automated minibus is primarily perceived as a possible solution for the current gaps in public transport offers, but only if it highly fulfils these benefits.

Potential users interviewed in the AVENUE cities perceive the current offer of public transport as being sufficient. Therefore, acute need for alternative offers is not indicated. This is also reflected in the user survey. The majority of users used the automated minibus at random, motivated by spontaneous interest and curiosity. It is not used out of conscious conviction. The use is rarely planned. Thus, even though users are satisfied, and state that they are willing to use the service again, the lack of an acute need for better alternatives prevents regular use. This insight is also confirmed by the observations and experiences of the safety operators.

9.2 Positive attitudes towards automated minibuses

An important finding is that the majority of the potential users interviewed in the AVENUE cities have not yet taken a clear position towards automated minibus, but tend towards a positive, receptive (goodwill) attitude. Therefore, there is the potential to convince those who are not yet refusing but open-minded, through well-targeted communication campaigns esp. in social media. We defined five target groups which do not only differ in their perception on perceived benefits and concerns, but also on their degree of knowledge, preferred transport system, their willingness to use and pay for travelling with automated minibus, and information sources used to build their attitudes.

A question that was raised in the social media monitoring, is 'if *two opposing logics are opposed, should we talk more about such and such points at such and such audience because they seem to interest them or, on the contrary, they are already convinced on this level and we must communicate on other points?*' Based on the different target groups identified, we conclude that both is necessary: increase the interest of the indifferent but also confirm enthusiasts with additional relevant information.

9.3 From high goodwill to regular use?

A risk for the target groups of unreserved goodwill and critical goodwill is that they may be disappointed if they recognize actual performance in terms of speed and flexibility. In order to ensure that the high level of goodwill actually leads to a high level of acceptance of the new systems, it is very important to increase both the speed and the flexibility of use via an on-demand service or at least improved temporal and local flexibility in comparison to the existing public transport offers.

This concern is also shared based on the users interviewed in Copenhagen. They state that, under the condition of an on-demand service, they are willing to 'reduce' the use of their own car. But willingness

'to give up' their own car, does only account for a smaller proportion of the users. It can therefore be assumed that users who currently urgently need a car even in a city like Copenhagen do not see any real alternative in the automated minibus even they were highly satisfied with the experiences they made during their ride with the automated minibus.

In addition, the safety operators also mention that they observe a high level of goodwill for the innovative service. In the opinion of the safety operators the users are highly satisfied, especially considering subjective aspects such as good atmosphere, not least because of the smaller number of passengers.

Based on their observations safety and accessibility are qualities that are also evaluated as satisfactory. In the viewpoint of the safety operators the automated minibuses are fulfilling the needs and demands of the users, and contribute to a positive user experience.

However, a high level of goodwill among potential users and a high level of satisfaction among users translates into a high level of willingness to use (again) and experience the new system for several times, the use is currently not deliberately planned, does not result in a regular usage or substitution of privately-owned car. This is especially visible in Copenhagen. Most of the users just used the automated minibus at random, motivated by spontaneous interest and curiosity. In general, users were highly satisfied with their experiences and most of them are willing to use the automated minibus again. However, due to the lack of an acute need for better alternatives, regular users could only be observed very rarely in Nordhavn.

9.4 Experience as key to increase acceptance

Most important factors for the social acceptance are the (perceived) need for improvement of the current situation and whether the proposed alternative service fulfils this need for improvement. Fears towards a lack of safety or security are currently of less importance for the social acceptance. Real experience in the automated minibus, has a general positive effect on the trust in the system: A comparison of the results of the quantitative survey with potential users and the quantitative survey with users in Nordhavn shows that user experience is an important factor to reduce the perceived concerns and to increase acceptance of the automated minibus. Where potential users perceive risks in the unknowing of how the system reacts to unforeseen situations or how it interacts with motorized or non-motorized road users, users do not perceive these risks. Also, users attach higher advantages to the automated minibuses, than the potential users. Whereas only every second potential user expects that the automated minibuses cause fewer accidents, among the users three out of four expect this advantage to be realistic. Differences are also visible in the economically important factor of safety operators. Of the potential users, 35% state that the presence of the safety operator is important, whereas this only accounts for 18% of the users.

The interviewed safety operators expect that their importance will decrease with an increasing number of passengers. This would mean that, depending on the business case and target group of various lines, buses can or cannot be equipped with a safety operator.

As user experience seems to be very convincing and reducing expectations towards any risks the awareness of the test sites and therefore the probability of its use should strongly be increased by communication, esp. using social media.

9.5 Final conclusions

Will be delivered shortly .

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Annex A: Full Survey representative survey

No.	Question	Sub-question	Source	Included in Lyon
1	Overall, how satisfied are you with your life these days	-	Eurofound, 2016 [39]	
2	How satisfied are you with each of the following items	Your present standard of living Your accommodation Your family life Your local area as a place to live Traffic situation in and around your city Public transport offer Environmental situation in your city	Eurofound, 2016	
3	How important each of the following items are in your life	Work Family Friends Making new experiences Politics Climate protection Health	European Value Study	
4	Would you consider the area in which you live to be open countryside/ small town/ medium to large town/ a city or suburb		Eurofound, 2016	
5	Please think about the area where you live now – the immediate neighbourhood of your home. Do you have major, moderate or no problems with the following items	Noise Air quality Litter or rubbish Heavy traffic Safety/security Nature/green space Public transport Access to supermarket	Eurofound, 2016	
6	What is your preferred transport system		x	

[39] European Quality of Life Survey, https://www.eurofound.europa.eu/surveys/european-quality-of-life-surveys/european-quality-of-life-survey-2016/questionnaire

7	Could you indicate what aspects are important in selecting your preferred means of transport?		Wohr, 2016[40]	
8	How often do you use the following means of transport			
9	Are there differences in your means of transport depending on good or bad weather conditions?			
10	Which means of transport do you mainly use when commuting between:[41]	Your home and the place you work/study Your home and the supermarket Your home and family/friends	Adapted from Wohr, 2016	
11	Regarding one-way transport, how much time do you on average travel between	Your home and the place you work/study Your home and the supermarket Your home and family/friends		
12	Regarding one-way transport, how many km do you travel between:	Your home and the place you work/study Your home and the supermarket Your home and family/friends		
13	In your opinion, what should be improved in public transport?	Information Accessibility, i.e. the can be used by all people Price Safety Speed/travel time Environmental friendliness Mobility on demand Entertainment		
14	Have you ever heard of automated minibuses before participating in this survey?	If yes, source of information	Adapted from Schoettle &	

[40] Adapted from: Wöhr, M. (2016). Social Acceptance of Alternative Mobility Systems in Tunis, Tunisia. Exploring Social Acceptance Based on an Innovative Mobility System Called "Minibus". University of Pforzheim, Pforzheim, Germany.

[41] Adapted from: Wöhr, M. (2016). Social Acceptance of Alternative Mobility Systems in Tunis, Tunisia. Exploring Social Acceptance Based on an Innovative Mobility System Called "Minibus". University of Pforzheim, Pforzheim, Germany.

			Sivak (2014) [42]	
15	Have you ever travelled with an automated minibus?			
16	16. Do you know whether tests with automated minibuses are planned or already taking place in your city?	If yes, source of information	Adapted from Wicki & Bernauer (2018) [43]	
17	Do you think that automated minibuses are going to be an important mode of transportation in the future?		Adapted from Keolis Downer (2018) [44]	
18	How willing are you to use automated minibuses?		Adapted from Wöhr (2016) [45]	
19	Imagine that automated minibusses could be called like a taxi and bring you from door to door to your destination, how willing would you be to reduce the use of your own car?			
20	Imagine that automated minibusses could be called like a taxi and bring you from door to door to your destination, how willing would you be to give-up your own car?			

[42] Adapted from: Schoettle, B. and Sivak M. (2014). A survey of public opinion about automated and self-driving vehicles in the US, the UK, and Australia. The University of Michigan, Michigan, USA.

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21	Imagine that your private car could be automated but the car would be much more expensive, would you prefer the cheaper automated minibus, the expensive automated private car or an none automated private car?			
22	How important is it to you that there is a supervisor on board the automated minibus?		Adapted from Amobility (…)[46]	
23	In your opinion, is the current technology ready to have automated minibuses on the public road?			
24	How much do you agree with the following statements? Automated minibuses will…	… provide enhanced freedom for people with mobility issues … reduce the negative impact on the environment. …be used for routes that are less popular …be booked on demand in the future cause fewer accidents, as they avoid human errors … be more efficient, as you'd be able to use your time better than in a car, walking or cycling … be pleasant and comfortable	Adapted from Keolis Downer, 2018[47]	
25	To what extend do you agree with the following statements? The idea that automated minibuses will be introduced everywhere worries me, because…	… privacy is not protected … jobs get lost … it is not clear who is liable in the event of an accident … it is not clear how automated minibuses interact with motorized road users	Adapted from Keolis Downer, 2018[48]	

[46] Adapted from amobility

[47] Adapted from: Keolis Downer (2018). Future-driven autonobus pilot project at la Trobe University. Australia.

[48] Adapted from: Swiss Federal Institute of Technology Zurich - ETH (2019). User Survey on automated shuttles in Neuhausen am Rheinfall.

		… it is not clear how automated minibuses interact with non-motorized road users … the software may be hacked or otherwise misused … I have to learn how to use an automated minibus ... The systems are not secure … the pleasure of driving gets lost … it is not clear how automated e-buses react in unforeseen situations		
26	You have thought about concerns and benefits of automated minibuses, considering all; what would you be willing to pay to use automated minibuses in general?		Adapted from ETH, 2019[49]	
27	Do you have any further thoughts on automated minibusses?			

[49] Adapted from Amobility

Annex B: additional tables mobility behaviour

Which age group do you belong to? * What is your preferred transport system? Crosstabulation

			What is your preferred transport system?												
			Own car	Motorbike	Scooter	Bus	Train	Metro	Tram	Taxi	Car-sharing	Bike	Walking	E-bike / E-scooter	Total
Which age group do you belong to?	16 to 25	Count	55	2	2	18	9	8	4	1	2	22	20	3	146
		% within What is your preferred transport system?	5,7%	8,0%	6,9%	15,0%	11,3%	18,2%	12,5%	20,0%	28,6%	9,7%	8,4%	7,5%	8,1%
	26 to 35	Count	160	3	6	24	9	8	4	0	1	44	40	6	305
		% within What is your preferred transport system?	16,5%	12,0%	20,7%	20,0%	11,3%	18,2%	12,5%	0,0%	14,3%	19,5%	16,9%	15,0%	16,8%
	36 to 45	Count	188	5	2	21	18	6	7	0	1	46	44	6	344
		% within What is your preferred transport system?	19,4%	20,0%	6,9%	17,5%	22,5%	13,6%	21,9%	0,0%	14,3%	20,4%	18,6%	15,0%	19,0%
	46 to 55	Count	197	6	11	13	19	8	8	0	0	45	48	14	369
		% within What is your preferred transport system?	20,4%	24,0%	37,9%	10,8%	23,8%	18,2%	25,0%	0,0%	0,0%	19,9%	20,3%	35,0%	20,4%
	56 to 65	Count	191	8	5	21	16	6	7	0	3	37	44	7	345
		% within What is your preferred transport system?	19,7%	32,0%	17,2%	17,5%	20,0%	13,6%	21,9%	0,0%	42,9%	16,4%	18,6%	17,5%	19,0%
	66 to 75	Count	140	1	3	19	6	6	2	3	0	24	33	3	240
		% within What is your preferred transport system?	14,5%	4,0%	10,3%	15,8%	7,5%	13,6%	6,3%	60,0%	0,0%	10,6%	13,9%	7,5%	13,2%
	76 +	Count	37	0	0	4	3	2	0	1	0	8	8	1	64
		% within What is your preferred transport system?	3,8%	0,0%	0,0%	3,3%	3,8%	4,5%	0,0%	20,0%	0,0%	3,5%	3,4%	2,5%	3,5%
Total		Count	968	25	29	120	80	44	32	5	7	226	237	40	1813
		% within What is your preferred transport system?	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Gender * What is your preferred transport system? Crosstabulation

			What is your preferred transport system?												
			Own car	Motorbike	Scooter	Bus	Train	Metro	Tram	Taxi	Car-sharing	Bike	Walking	E-bike / E-scooter	Total
Gender	Female	Count	497	5	9	77	42	24	19	4	6	105	152	18	958
		% within What is your preferred transport system?	51,4%	20,0%	31,0%	64,2%	52,5%	54,5%	59,4%	80,0%	85,7%	46,5%	64,1%	45,0%	52,9%
	Male	Count	467	20	20	43	37	20	13	1	1	120	85	22	849
		% within What is your preferred transport system?	48,3%	80,0%	69,0%	35,8%	46,3%	45,5%	40,6%	20,0%	14,3%	53,1%	35,9%	55,0%	46,9%
	Other / unknown	Count	3	0	0	0	1	0	0	0	0	1	0	0	5
		% within What is your preferred transport system?	0,3%	0,0%	0,0%	0,0%	1,3%	0,0%	0,0%	0,0%	0,0%	0,4%	0,0%	0,0%	0,3%
Total		Count	967	25	29	120	80	44	32	5	7	226	237	40	1812
		% within What is your preferred transport system?	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

PRM:

No * What is your preferred transport system? Crosstabulation

			What is your preferred transport system?											
			Own car	Motorbike	Scooter	Bus	Train	Metro	Tram	Taxi	Car-sharing	Bike	Walking	E-bike / E-scooter	Total
No	not quoted	Count	67	1	4	17	5	2	0	4	1	3	18	8	130
		% within No	51,5%	0,8%	3,1%	13,1%	3,8%	1,5%	0,0%	3,1%	0,8%	2,3%	13,8%	6,2%	100,0%
		% within What is your preferred transport system?	6,9%	4,0%	13,8%	14,2%	6,3%	4,5%	0,0%	80,0%	14,3%	1,3%	7,6%	20,0%	7,2%
	quoted	Count	901	24	25	103	75	42	32	1	6	224	219	32	1684
		% within No	53,5%	1,4%	1,5%	6,1%	4,5%	2,5%	1,9%	0,1%	0,4%	13,3%	13,0%	1,9%	100,0%
		% within What is your preferred transport system?	93,1%	96,0%	86,2%	85,8%	93,8%	95,5%	100,0%	20,0%	85,7%	98,7%	92,4%	80,0%	92,8%
Total		Count	968	25	29	120	80	44	32	5	7	227	237	40	1814
		% within No	53,4%	1,4%	1,6%	6,6%	4,4%	2,4%	1,8%	0,3%	0,4%	12,5%	13,1%	2,2%	100,0%
		% within What is your preferred transport system?	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Car owner * What is your preferred transport system? Crosstabulation

			What is your preferred transport system?											
			Own car	Motorbike	Scooter	Bus	Train	Metro	Tram	Taxi	Car-sharing	Bike	Walking	E-bike / E-scooter	Total
Car owner	None	Count	4	0	3	53	14	19	7	3	1	87	76	15	282
		% within Car owner	1,4%	0,0%	1,1%	18,8%	5,0%	6,7%	2,5%	1,1%	0,4%	30,9%	27,0%	5,3%	100,0%
		% within What is your preferred transport system?	0,4%	0,0%	10,3%	44,2%	17,5%	43,2%	21,9%	60,0%	14,3%	38,5%	32,1%	37,5%	15,6%
	Car owner	Count	962	25	26	67	66	25	25	2	6	139	161	25	1529
		% within Car owner	62,9%	1,6%	1,7%	4,4%	4,3%	1,6%	1,6%	0,1%	0,4%	9,1%	10,5%	1,6%	100,0%
		% within What is your preferred transport system?	99,6%	100,0%	89,7%	55,8%	82,5%	56,8%	78,1%	40,0%	85,7%	61,5%	67,9%	62,5%	84,4%
Total		Count	966	25	29	120	80	44	32	5	7	226	237	40	1811
		% within Car owner	53,3%	1,4%	1,6%	6,6%	4,4%	2,4%	1,8%	0,3%	0,4%	12,5%	13,1%	2,2%	100,0%
		% within What is your preferred transport system?	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%	100,0%

Appendix C: Interview guides longitudinal study

KICK-OFF INTERVIEW

General Introduction 7 Min.

- Introduction into AVENUE European Research Project
- The role of HS Pforzheim
- Methodology: Longitudinal Study
- Data protection declarations
- Rules of the Interview
- Introduction of interviewer and interviewee: current life situation, job/professional background/ career, age, children, hobbies and interests

Warm-Up: Copenhagen & Lifestyle 10 min.

A) Copenhagen

- Since when do you live here in Copenhagen?

Checklist:

- Relationship to the city Copenhagen (birth/moved to)
- Benefits or Disadvantages living there
- Favorite spots, activities in Copenhagen

B) Lifestyle

- When your are thinking about your life: what is especially important to you?/ What fulfills you especially in your life?

Checklist:

- Importance of different life terms: work/career, family/friends, making new experience/travel, politics, climate protection, health
- Needs: Freedom, Independence, Responsibility, Peace, Truth, Love, Fairness, realizing self actualization
- Feelings when needs are satisfied
- Definition of pure happiness

Mobility of the respondents 7 Min.

Instructions: explorative, respondent should talk about his typical mobility

- When you are thinking about your last week: Could you tell me about the routes you have done to come from one place to another?

Instructions: narrativ, take up occasions of previous exploration

- Remember when you drove/went to ***[work],*** how did you move until you arrived at ***[work]?*** Which means of transport do you use for those situations? Please start from the time you left your front door)

Checklist:

- Mobility routes last week – distances, duration
- Usage of means of transport:
  Which mode of transport for which routes/ situations? How often each mode of transport?
- Private VS. Public: Does the respondent use more private vehicles or more public transport?
  For which situations is public transport more preferred? / For which situation are private vehicles more preferred?

  → Typical/not typical?

Mobility: preferences and attitude 15-20 Min.

A) General

- Which mode of transport do you prefer to use (as most)?
- What are the reasons that .... is the most preferred mode of transport?

Checklist:

- Motives behind using a certain mode of transport?
- What are the benefits of using a certain mode of transport?
  What are the disadvantages of using a certain mode of transport?
- Important aspects during mobility: Mobility needs (Time saving, convenience, costs, environment, fun): depends on different scenarios/situations?
- Reason behind the importance: children, work, environmental protection, mobility limitations (reduced mobility)

B) Focus on Copenhagen

Instructions: explorative, respondent should talk about the mobility in Copenhagen

- Could you please describe to me the mobility situation:
  - in the area you are living/next to your home
  - next to working place, school etc. (all areas that are regularly visited)

Checklist:

- Current mobility situation in Copenhagen: availability of public transport, the situation of the road traffic and usage of private vehicles
- Satisfaction with the mobility:
  once with the public transport and on the other side with the private vehicle/ walking etc.
- Problems while moving from one to another place:
  what kind of problems, with which mode of transport, any limitations of mobility (Unpunctuality, inconvenience, frequent changes, long walk to the stop, waiting times, inappropriate

departure times, parking situation, traffic jams, other road users, road layout, construction sites, lack of bicycle paths)
- Dissatisfaction of the motives
- Mobility gaps: Missing offers and possibilities in public transport?

Introduction – Automated driving 7 Min.

Instruction: associative, distinguish between PKW and public transport
- What comes to your mind when you are hearing the term "automated driving"?

Checklist:
- Knowledge and perception regarding automated driving: first impression
- Personal definition and comprehension of automated driving: Functions behind automated driving
- Personal experiences with automated driving: self driving, user experiences with automated shuttles, articles, documentation
- Feelings and Thoughts: acceptance (preferences, well-being, hopes) or rejection (fears, worries, barriers)
- Reasons for a certain perception/ feeling/ thought (bad experience, influenced by a certain source of information/…)

Transition to automated minibus – Collage

Automated minibus 25 Min.

A) General

Instruction: Show collage and ask those questions:
- Have you ever heard of automated minibus?/ Have you ever used the automated minibus?

A1) Instruction: Ask questions to respondents with user experience(s)and removing images
- First impression: “What are the first 3 terms coming to your mind spontaneously when you are thinking about your experience with the automated minibus?”

  Instruction: Explore those terms detailed

A2) Instruction: Ask questions to respondents with non user expierence.
- Have you ever seen the automated minibus driving around in Copenhagen?
- First impression: “What are the first 3 terms coming to your mind spontaneously when you are looking at those pictures// thinking about the moment when you have seen it driving around in Copenhagen?

  Instruction: Explore those terms detailed

Instruction: Show scale to EVERYONE, 1 means "no way" and 5 means "definitely"

- How is your willingness to integrate the use of the automated minibus in your typical mobility?: How do you rate yourself on this scale?

Checklist:

- Knowledge and experience regarding automated minibus
- For users:
  - Occasions/situations of using the automated Minibus in the past, Frequency
  - Feelings during using the automated Minibus
  - Potential for using the automated Minibus in further occasions/situations
- ***For non-users***: Potential occasions/Situations of using the bus
  - Reason for choosing a certain value on the scale
  - For what occasions will the shuttle be used? Substitution of own car, bike, walking? Why?
- What are the arguments for its use? What are the arguments against the use?
  - Social aspects:
    - Safety – trust in AI, traffic accidents, AI intervention
    - Security - data protection, harassments, human component
  - Economic aspects:
    - Indirect consequences: Job loss (bus drivers)/ Job creation (operator/ IT), automotive industry, faster/more flexible → Efficiency
    - Costs: Assessment of price (more expensive/more cheap than conventional means of transport), willingness to pay, requests for a certain price
  - Environmental aspects:
    - What kind of benefits: Noise protection/nuisance, reduction of CO2 emissions, no fossil fuels
    - Importance of the environmental benefit of automated driving for the respondent

B) Future Perspective:

- When you are thinking about the future: Do you plan to take the bus more often?

Checklist:

- Potential for future usage
- In what kind of mobility situations/occasions? (Mobility in leisure time/ Mobility to work/other Responsibilities)
- Substitution: Willingness to reduce another mode of transport due to the availability of the automated Minibus
- What must be given to integrate more the usage of the automated Minibus in your mobility/ increase the value on the scale?

C) Focus on Copenhagen

- Now that the automated Minibuses operates in Nordhavn: what do you think about the current operations there?

- Could it change your behavior regarding the mobility?
- Would you rather think it is a chance for you / the residents living in Copenhagen or a more barrier?

Checklist:

- Evaluation about the current integration/operation of the automated Minibuses
- (Possible) Changes due to the automated Minibus in mobility/life quality
- Automated Minibus in Copenhagen: future prospects?/ areas of application?/ opportunities and risks (competitive environment)
- Optimization proposals: What needs to be done to increase usage / attract more users in Copenhagen? What should be changed to increase the benefit for the residents (regarding their mobility/life quality)?

Conclusion max. 5 Min

- Remaining questions
- Comments to the project/ study etc.
- Thank you for your participation!
- Reminder: receiving mails with questionnaires in the next few weeks & follow-up Interview

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EXAMPLE OF WEEKLY SURVEY
(programmed in Unipark/Questback)

General Questions

1. How would you describe your last week? (Single answer)
   - My week was a good combination of work and life
   - I had a few days off and enjoyed my days in Copenhagen
   - I had a few days off and went to another place
   - I had a lot of work to do
   - Other descriptions of my last week:

2. How often have you used the following means of transportation in the last week? (**Categories:** Everyday on 6 to 4 days on 3 or 2 days on one day never)

   Please click on the corresponding category for each mode of transport.
   - Own car
   - Bike
   - Bus
   - National Train
   - Tram/ S-Train
   - Taxi
   - Automated minibus

- Car-Sharing
- Bike/ E-Bike
- Motorbike
- E-Scooter
- Walking

(Filter: Question Nr.2: only the means of transport > never)

3. When you think about the used means of transport in the last week: For how long have you used the certain mode of transport **total?**
(**Categories:** >5 hours 2-5 hours 1-2 hours about one hour less then one hour)

Please click on the corresponding category for each mode of transport:

- Own car
- Bike
- Bus
- National Train
- Tram/ S-Train
- Taxi
- Automated minibus
- Car-Sharing
- Bike/ E-Bike
- Motorbike
- E-Scooter
- Walking

(Filter: only the chosen means of transport)

4. For which occasions did you use the certain mode of transport in the last week? (Multiple answer possible)
   - To got to my place of work
   - As part of a leisure trip/ride
   - For a business trip
   - To go shopping
   - Fun, it is always a pleasure to use this mode of transport
   - Other occasions: _____

The following few questions are referring to the automated minibuses, which are operating at the moment in the area Nordhavn in Copenhagen.

5. Have you heard something about the automated minibuses since the Kick-off Interview?
   - Yes, I have heard about the automated minibuses since the Kick-off interview
   - No, I haven't heard anything about the automated minibuses since the Kick-off Interview

(Filter: if question nr. 5 = answer Nr. 1 –yes)

6. What was the source of information?
   - Newspaper
   - Radio/ TV
   - Social Media
   - Friends
   - Seen on test side
   - Word of mouth
   - Internet
   - Information brochure
   - Formal information offered by employer
   - Informal information by colleagues
   - Other: _____

7. Have you seen the automated minibuses driving around in Copenhagen/Nordhavn? (single answer)
   - Yes, I have seen them but haven't tried them yet
   - Yes, I have seen them and used them already
   - No, I have not seen them

(Filter: If Nr. 7 = answer nr. 2 – travel experience)

8. How satisfied were you with your last ride on the automated minibus?

Please tell us on a scale from 1 to 5, where 1 means very dissatisfied and 5 means very satisfied. With the other points on the scale you can grade your answer:

Very dissatisfied				Very satisfied
1	2	3	4	5

(Filter: If Nr. 7 = answer nr. 2 – travel experience)

9. How many times have you used the automated minibus the **last two weeks?** (single answer)
   - 1 to 2 times
   - 3 to 5 times

- 6 to 10 times
- 11 or more times
- I can not remember

(Filter: If Nr. 7 = answer nr. 2 – travel experience)

10. For what occasion did you use the automated minibus the last times? (Multiple answer possible)

- To go to my place of work or back home
- As part of a leisure trip/ride
- For a business trip
- To go shopping
- Especially for protecting myself from bad weather (rain/storm etc.) while moving to another place
- To show the automated minibus to a friend/someone else
- No specific occasion, just wanted to try the automated minibus
- No specific occasion, I just like the experience to use an automated vehicle
- Other occasion:_____

(Filter: If Nr. 7 = answer nr. 2 – travel experience)

11. Does the automated minibus affect your use of other means of transport?

- Yes, it has affected the use of other means of transport
- No, it has not affected the use of other means of transport

(Filter: if question nr. 11 = yes)

12. Which mode/means of transport did you substitute when using the automated minibus? Multiple answers possible

- Own car
- Bike
- Bus
- National Train
- Tram/ S-Train
- Taxi
- Automated Minibus
- Car-Sharing
- Bike/ E-Bike
- Motorbike
- E-Scooter
- Walking

(Filter: if question Nr. 7 = answer Nr. 1 – **no** travel experiences)

13. Even that you haven't travelled yet with the automated shuttle services, could you imagine to use such automated minibus?

- Yes, I can imagine to use them one day
- No, I can't imagine to use them one day

(Filter: if question Nr. 7 = answer Nr. 3 – **no** travel experiences, **not** seen)

14. Even that you haven't seen yet the automated minibus, could you imagine to use such automated minibus?

- Yes, I can imagine to use them one day
- No, I can't imagine to use them one day

For all (except for question Nr. 13 and Nr. 14 = answer Nr. 2 – **can't imagine**)

15. For what occasion could you generally imagine to use the automated minibus?

- To go to my place of work or back home
- As part of a leisure trip/ride
- For a business trip
- To go shopping
- Especially for protecting myself from the bad weather (rain/strom etc.) while moving to another place
- No specific occasion, just like to try the automated minibus one day
- Other occasion:_____

For all (except for question Nr. 13 and Nr. 14 = answer Nr. 2 – **can't imagine**)

16. What mode of transport could you generally imagine to substitute with the automated minibus?

- Own car
- Bike
- Bus
- National Train
- Tram/ S-Train
- Taxi
- Automated Minibus
- Car-Sharing
- Bike/ E-Bike
- Motorbike
- E-Scooter
- Walking

(Filter: If Nr. 7 = answer nr. 2 – travel experience)

17. Now that you have tested the automated minibus, how willing are you to use it again?
Please tell us on a scale from 1 to 5, where 1 means unwilling and 5 means willing, with the other points on the scale you can grade your answer.

Not willing at all Very willing

1 2 3 4 5

(Filter: If Nr. 7 = answer nr. 2 – travel experience)

18. What did you like the most about the automated minibus when you think about your travel experiences with it? (You can answer spontaneously in terms or phrases)

- ○ _____

(Filter: If Nr. 7 = answer nr. 2 – travel experience)

19. Is there something you would criticize about the automated minibus, when you think about your travel experiences?

- ○ Yes
- ○ No

(Filter: if Question Nr. 19 = yes)

20. What do you criticize about the automated e-minbus? (You can answer spontaneously in terms or phrases)

- ○ _____

For all:

21. Do you think that automated minibuses are going to be an important mode of transportation in the future?

- ○ Yes, why? _____
- ○ No, why? _____

(Filter: If Nr. 7 = answer nr. 2 – travel experience)

22. Would you promote the use of the minibus among your friends and family?

- ○ Yes
- ○ No

COMMENTS

Do you have any additional comments to your mobility or any questions regarding the automated Minibus/ the AVENUE project?

If yes, you are welcome to write them down in the following text field:

Thanks for participating in the first questionnaire!

Have a good week and I wish you all the best!

FINAL INTERVIEW

AVENUE – Automated Minibus

'Does the operation of the automated minibus influence mobility behavior and the perception on the automated minibus?'

General Introduction 5 Min.

- Welcome and thanks for participating
- Incentive?
- Data protection declarations

    - Request for audio recording
    - Use of citations for reporting
- Rules of the Interview
    - Again: Open Discussion, spontaneous and honest answers, limited English skills
- Short introduction of interviewer

Warm-Up: Corona - Changes 5 min.

- How is the current situation in Copenhagen with Corona?

Checklist:

- Current Situation Corona
- Corona: developed more or less strict within the last weeks (more measures for restrictions)
- Changes in Life general: different values, priorities, activities
- Feelings due to Corona: restrictions in certain life aspects, which are important to the respondent (like traveling/ going out/ sport activities)
- Changes in mobility due to Corona: switch to other means of transports/more or less transport

Opinion on Survey 5 min.

- How did you experience the study in the last week?

Checklist:

- Opinion on online surveys and total study
    - Preferences: what was good? What did you like?
    - Dislikes during the survey? What and why?

- Opinion on topic “automated Minibus/ vehicles”
    - Interest towards automated vehicles/Minibuses:
        - already interested towards the topic before the study/
        - became interested due the to study/ → Why?
        - still not interested also after the study → Why?
    - Relevant topic for the future in general and for itself? (Imagine having more discussions and higher involvement regarding automated vehicles than before)

Mobility Behavior 15 min.

A) Mobility behavior last six weeks

- How did you experience mobility during the last six weeks? Different or as before?

Instructions: Refer to the mobility behavior analyzed in the Kick-Off interview

- I can remember that you mentioned in the first interview that …. is an important mode of transport for you - would you still agree?

Checklist:

- Mobility behavior in the last six weeks – any changes:
  - If changes: what kind of changes? more/less public transport, switch to other mode of transport due to some problems
  - Possible reasons or the changes: due to weather condition? (now December, Kick-off Interview in the mid of October)
- **Comparison:** Most preferred mode of transport at the time of the kick-off Interview and at the moment (if change: why?)
- Special changes in times of Corona in the last months
  - Is mobility behavior and preference different to the time before Corona?
  - If yes: what is different?
  - What mobility aspects became more important due to Corona?

B) Mobility behavior in general and analysis of different means of transport

- When you think generally about all your used means of transport in Copenhagen what is your most preferred mode of transport?

Checklist:

- Advantages and reasons for using the most preferred mode of transport
- In general important mobility aspects, needs (especially in Copenhagen?)
- What is fulfilled by the preferred mode of transport? Satisfaction of mobility needs? (Mobility aspects/mobility needs)
- Analysis of other used means of transport:
  - What about… ? Is this mode of transport fulfilling the mobility aspect…?
  - Problems when using other mode of transport; satisfaction of the mobility needs
- Observation of changes in the last times (compared to Kick-Off interview)

*Important aspects during mobility: Mobility needs (Time saving, flexibility, convenience, costs, environment, fun): depends on different scenarios/situations?

Focus: Mobility in Copenhagen 10 min.

- When you think about the mobility situation in Copenhagen: How satisfied are you on a scale from 1 to 10, when 1 means “not satisfied at all” and 10 means “very satisfied”?

Checkliste:

- Satisfaction with the mobility: once with the public transport and on the other side with the private vehicles/ walking etc. – Justification of the value: Why this value?
- Satisfaction of the mobility needs and important mobility aspects in Copenhagen with the offered and available means of transport
- Problems while moving from one to another place **in the last times**
    - What kind of problems*
    - With which mode of transport
    - Any limitations of mobility **in the last times** *(Unpunctuality, inconvenience, frequent changes, long walk to the stop, waiting times, inappropriate departure times, parking situation, traffic jams, other road users, road layout, construction sites, lack of bicycle paths)
- Dissatisfaction of the important motives and mobility needs
- **Any positive/negative changes** in the mobility situation within Copenhagen in the **last 2 months?**

*(f. e.: unpunctuality, inconvenience, frequent changes, long walk to the stop, waiting times, inappropriate departure times, parking situation, traffic jams, other road users, road layout, construction sites, lack of bicycle paths)

Automated Driving 7 Min.

- Can you remember that automated driving has been an issue for you in recent weeks? Have you had some experience or touch points with it?

Instructions: Comparison to the perception of the automated driving in the Kick-Off interview

Checklist:

- Deal with automated driving **in the last time:** read articles/ TV shows/ discussed with friends
    - What kind of information? (source)
    - Opinion towards the information
- Experience in the last time
- Feelings and thoughts: **acceptance** (preferences, well-being, hopes) or **rejection** (fears, worries, barriers)
- Advantages and Disadvantages in implementing automated driving
- In which areas: public transport VS. privat transport
- Comparison to the perception of the Kick-Off Interview: positive/negative change → why?

Automated Minibus 25 Min.

A) Knowledge about automated Minibus

- Besides the online surveys, have you heard/ read or seen something about the automated Minibus in the last weeks?

Checklist:

- Source of information
- What kind of information, topics, discussion points etc.
- Discussion with friends?
- Feelings and opinions regarding the information (relevant, trustworthy, convincing – reasons for the opinion)
- Perception of the automated Minibus based on the information: positive or negative

B) User Experience

- Have you used the automated Minibus in the last weeks?

A1) Instruction: Ask questions to respondents with user experience(s)
First impression: "What are the first 3 terms coming to your mind spontaneously when you are thinking about your experience with the automated minibus?"
A2) Instruction: Ask questions to respondents with non user expierence.

- First impression: "What are the first 3 terms coming to your mind spontaneously when you are looking at those pictures/ thinking about the moment when you have seen it driving around in Copenhagen?
  → Instruction: Explore those terms detailed

Checkliste:

- For users:
  - Experience using the automated Minibus: preferences and criticism
  - Frequency (how many times of using the bus)
  - Occasions/ situations of using the automated Minibus in the past
  - Any problems during the ride?
  - Expectations like reality? (Satisfaction of the expected attributes)
  - Feelings during using the automated Minibus
  - Comparison of the different time of usage (first time of use vs. second time of use)
  - Experience regarding: preferences or criticism?
    - Automated Minibus appearance (easy to recognize, find the stop easily, easy enter and stop, door opening and closing)
    - Inside the bus (comfort: interior of the bus, enough place to sit/stand, enough handles, stop request button, SOS button)

- For non-users:
  - Reasons against using it – why not?

- Imagine to use it
  - Yes: Potential occasions/ Situations of using the bus
  - No: What are the arguments against using it? What has to be given to use it?

C) Future Perspective and Perception of the automated Minibus

Instruction: Show scale - 1 means "no way" and 5 means "definitely"

- How is your willingness to integrate the use of the automated minibus in your typical mobility? How do you rate yourself on this scale?

Checkliste:

- Willingness to use it in future
- In what kind of mobility situations/ occasions the integration of automated Minibus? (Mobility in leisure time/ Mobility to work/ other responsibilities)
- Substitution: Willingness to reduce another mode of transport due to the availability of the automated Minibus? Which one?
- **Referring to Kick-Off Interview:** change of perception/willingness (more acceptance/more rejection, positive/negative user-experience)
  - If yes, why?

- What are the arguments for its use? What are the arguments against the use?
  - Social aspects:
    - Safety – trust in AI, traffic accidents, AI intervention
    - Security - data protection, harassments, human component
  - Economic aspects:
    - Indirect consequences: Job loss (bus drivers)/ Job creation (operator/ IT), automotive industry, faster/more flexible → Efficiency
    - Costs: Assessment of price (more expensive/more cheap than conventional means of transport), willingness to pay, requests for a certain price
  - Environmental aspects:
    - What kind of benefits: Noise protection/nuisance, reduction of CO2 emissions, no fossil fuels
    - Importance of the environmental benefit of automated driving for the respondent

Automated Minibus Concept & Mobility needs 15 min

- Do you think that the automated Minibus become an important mode of transport in the future? Why? (In case of big change compared to the Kick-Off Interview: explore this more detailed →what are the reasons?)

Checkliste:

- Role of the automated Minibus in the future (once for the city in general and especially for the respondent)
- Comparison to the evaluation in the kick-off Interview: more rejection/acceptance for the future → why?
- Satisfaction of the mobility needs/important aspects regarding mobility
- What must be given to integrate more the usage of the automated Minibus in your mobility/ increase the value on the scale? When does it offer a benefit/added value for you?

Instruction: (ranking of different aspect***, which are important for the Minibus to integrate it more in the future mobility)
& explore the most important aspects for the automated Minibus more detailed

- Why is this important; how can this be satisfied by the bus (through which attributes)
- Expectations and Requirements of the automated Minibus for the certain aspect
- Obstacles/barriers of the automated Minibus regarding the certain aspect

- All in all, how could the ideal concept of the automated e-mini-bus look like in Copenhagen? (Optimal for the city and optimal for the participant and his mobility)
    - Location: Where should the automated Minibuses be implemented? Which routes should it take?
    - Usage: more as last mile or as a whole substitution for a often used mode of transport like bus system, bicycle, s-train
    - Importance of on-demand: how could it work? (via application?)

  Importance of local/temporal Flexibility
    - Economical: Pricing and ticketing

Conclusion max. 5 Min

- Remaining questions
- Comments or questions to the project/ study etc.
- Thank you for your participation!
  Incentive?

***

- High Comfort inside the bus
- High flexibility (local/ temporal → what is more important)
- Order via application
- Accessibility for everyone (f.e. with wheelchair)
- High peed and travel time
- Safety and trust feeling
- Pleasure and joy
- Punctuality and Reliable
- Justified Price
- Environmental friendly (f.e. green electricity)

Annex D: Additional figures Social media analysis